Venture Capital, Social Capital and the Funding of Women-led Businesses

by

JMG Consulting, LLC
&
Wyckoff Consulting, LLC

for

Under contract no. SBAHQ-10-R-0023

Release Date: April 2013

The statements, findings, conclusions, and recommendations found in this study are those of the authors and do not necessarily reflect the views of the Office of Advocacy, the United States Small Business Administration, or the United States government.

Table of Contents

TABLE OF TABLES

TABLE OF FIGURES

Executive Summary

Studies of Women-Led Businesses (WLBs) have increased dramatically over the past 15 years. One consistent finding in this research is that WLBs receive less outside funding than Men-Led Businesses (MLBs). Further, Venture Capital (VC) funding of WLBs consisted of only 6% of the total funds invested in the United States between 1997 and 2000. Are there unique features to the VC firms that invest in WLBs? And how does investing in WLBs affect the subsequent performance of VC firms? Our study addresses these questions using a social capital lens.

Our data for this study consist of all U.S. VC investments from 2000 through 2010. The dataset includes 2,500 VC firms, 18,900 portfolio companies (those companies VC firms invested in during the 11 year period of the study), 92,500 individual management team members and 90,000 investment rounds. Using this data, we examine how the co-investing relationships among VC firms affect the funding of WLBs. We proposed that those VC firms without strong social capital, created through co-investing with other VC firms, would be more likely to invest in WLBs. Our results were mixed. VC firms that co-invest with other VC firms that do not co-invest with one another invest in a lower percentage of investments in WLBs. This social capital measure is called "structural holes." VC firms with lower rates of structural holes invest in a higher percentage of WLBs. Another finding is that VC firms that have long-term co-investing relationships with other VC firms that co-invest frequently with these other firms invest in a higher percentage of WLBs when compared to VC firms without long-term relationships. Finally, our study finds that the performance of VC firms improves as the ratio of investment in WLBs increases. This study provides insights for VC firms looking to improve their performance and to WLBs searching for VC funding.

Introduction

Research in women's entrepreneurship has increased during the past 15 years. One consistent finding in this research is that women-led businesses (WLBs) receive less funding than those companies led by men (MLB). Additionally, WLBs tend to be smaller and in slower growth industries. Studies examining the access to venture capital (VC) funding by WLBs have been limited, primarily due to lack of accurate and complete data. Further, most studies focus on aspects specific to the WLB, not the VC firm.

The first U.S. VC firm was established in 1946. VC funding remained quite small and stable until a significant increase in VC firms and funds occurred in the early 1980's. This increase was due, in part, to legal changes allowing pension funds to invest in venture capital. At the same time, the computer industry was experiencing substantial growth. These two factors created much of the growth in the nascent VC industry. Investment strategies of VC firms are categorized by investment stage and industry focus. Investment stage refers to the life-cycle stage of the portfolio company when the investment is made. Early stage investments are used as initial funding of start-ups, while later stage funding is available for product development and growth purposes. Additionally, VC firms may focus on a specific industry, such as telecommunications or computer hardware. VC firms commonly invest as a group, or syndicate, in entrepreneurial firms. A syndicate is created for each funding round of each portfolio company.

In this paper, we utilize a social capital lens to examine what factors influence VC firms' investments in WLBs. We utilize the definition of social capital, as "the sum of the actual and potential resources embedded within, available through and derived from the network of relationships possessed by an individual or social unit" as provided by Nahapiet and Ghoshal (1998: p. 243). Specifically, we use the three dimensions of social capital, structural, relational and cognitive. Structural social capital is who you know and how you know them. For example, the individuals you know at work are a part of your structural social capital or network. Additionally, the individuals they know are also a part of the network. Another dimension of social capital is relational social capital, which is defined by the strength of the relationship between two actors. For example, you may have a close friend that you have known your entire life and see weekly. The length of the relationship as well as the strength, in addition to the frequency of interaction, creates a strong tie between the two of you, or a high level of relational

social capital. In comparison, you may have met another individual during the past year, and have seen him or her a few times at social functions. There is a lower level of relational social capital between the two of you when compared to that of your life-long friend. Cognitive social capital is shared language and codes. For example, two attorneys from different cities meet at a conference. Although they have never met before, so they do not share any structural or relational social capital, they begin to discuss the latest Supreme Court decisions. Because these two individuals share an understanding of legal language and codes, they are able to establish a relationship based upon these codes and language, thus creating cognitive social capital. The structural and relational dimensions of social capital have been found to influence the investments of VC firms. Cognitive social capital studies are few, so we include this dimension of social capital to better understand its influence on VC firm investments. We examine these dimensions to understand how they influence VC firms' investments in WLBs.

This paper is organized as follows. The next section briefly reviews the relevant literature on these topics and sets forth the hypotheses to be tested. The following section discusses the research design, including specific information on data gathering and preparation, the calculation of the variables, and the empirical model. The next section reports descriptive statistics, frequencies, and the findings of the study relative to the hypotheses. The fifth section discusses these results, and the final section provides concluding remarks.

Literature Review and Hypotheses

Entrepreneurial firms have accounted for 65 percent to 90 percent of net new job creation in the United States during the past 15 years (Headd, 2010). One of the fastest growing groups of entrepreneurial firms is women-led businesses (Brush, De Bruin, & Welter, 2009). In 2008, women-led businesses (WLBs) had a $3 trillion annual impact on the U.S. economy and accounted for 16% of all U.S. jobs (Research, 2009). As a whole, these businesses "are the fastest-growing sector of new venture creation in the USA, representing nearly 40% of all firms" (Amatucci & Sohl, 2004). For all new firms, one of the key fundamental building blocks is money (Bates, Jackson, & Johnson, 2007). Research, however, has found that women-led businesses (WLBs) have lower levels of overall funding (Carter & Rosa, 1998; Watson, 2002) and receive significantly less VC funding than companies led by men (MLBs) (Brush, Carter,

Gatewood, Greene, & Hart, 2004; Greene, Brush, Hart, & Saparito, 2001). Indeed, from 1997 to 2000, WLBs received *less than 6%* of the $185.5 billion in VC invested during this historic period of investment activity (Brush, Carter, Gatewood, Greene, & Hart, 2001). Studies point to multiple factors that explain this disparity. First, VC firms invest in high-growth companies with products targeted at growing markets (Gompers & Lerner, 2001) and WLBs tend to not be in these markets (Brush et al., 2004). Second, women's social networks tend to consist primarily of other women (Aldrich, 1989). As a result, these networks have a much smaller likelihood of including venture capitalists, because few of them are women (Brush et al., 2001). Finally, WLBs experience lower growth and profitability, due in part to limited access to funding and lower growth aspirations (Alsos, Isaksen, & Ljunggren, 2006). These factors may contribute to the perception that WLBs are more risky than MLBs (Cliff, 1998). In fact, Brophy (1997) states that women entrepreneurs "carry an extra burden of prejudgment" by potential investors (Brophy, 1997, p. 7). In other words, *VC firms may perceive* WLBs as possessing greater risk than MLBs. This perception of riskiness may influence VCs decisions to invest in WLBs. Even if a WLB is able to overcome these factors, Brush et al. (2004) state that an entrepreneur must have relevant network connections to even begin negotiating with venture capitalists.

These earlier studies, however, utilize data limited by timeframe (1997 to 2000) (Brush et al., 2001), location (Norway, Britain) (Alsos et al., 2006; Carter & Rosa, 1998) or type of funding (banking) (Carter, Shaw, Lam, & Wilson, 2007). Additionally, while such previous studies have advanced our understanding of how, why, and to what extent WLBs are funded, the predominant perspective has been from the WLB or demand-side. In this study, we take a more supply-side view, by considering VC investing in WLBs from the VC firm's perspective. We propose that networks and social capital factors specific to VC firms, rather than WLB firms, will influence the tendency to invest in WLBs. Our discussion of VC firms and their funding of WLBs follows.

Which Venture Capital Firms Invest in Women-Led Businesses?

Venture capital investments are important to high growth companies, with many VC backed companies going public or being acquired by larger firms (Busenitz, Arthurs, Hoskisson, & Johnson, 2003; Chang, 2004; Gulati & Higgins, 2003). In fact, 20 out of 74, or 31%, of the companies that completed initial public offerings (IPOs) during the first half of 2010 were

funded by VC firms (NASDAQ.com). These companies are innovative and create jobs, factors critical to economic growth. While firms receiving VC funding are a small percentage of new companies, they develop innovative products, create new jobs, and generate wealth for investors, entrepreneurs and employees (Arthurs & Busenitz, 2006; Chang, 2004).

Studies have found that entrepreneurs with a direct relationship with a VC firm or venture capitalist are more likely to receive VC funding than entrepreneurs without a direct tie to a VC firm (Hsu, 2007). This confirms earlier research (Fried & Hisrich, 1994) that VC firms seldom fund businesses that are not endorsed by a member of the VC network. In a similar vein, other studies have found that VC firms fund companies that are recommended by a trusted third party (Shane & Cable, 2002). In other words, the lack of a direct or indirect tie to a VC or VC firm is a significant handicap to entrepreneurs seeking VC funding.

From the VC perspective, VC firms use their social networks to source potential investment opportunities (Hochberg, Ljungqvist, & Lu, 2007). This use of such network references serves to decrease the risk associated with investing in start-up companies. New VC firms, however, do not have the network ties of more established VC firms and, thus, receive far less information regarding potential investment opportunities. Not surprisingly, new VC firms suffer from the same "liabilities of newness" (Stinchcombe, 1965) as any other new firm and have limited access to new deal flows. Indeed, one study found that VC firms with fewer network ties (lower social capital) invest in riskier portfolio companies (Podolny, 2001). As discussed earlier, VC firms view WLBs as higher risk. The result of this view could result in new VC firms with limited network connections tending to invest in WLBs.

Does Investing in Women-Led Businesses Affect Future Venture Capital Firm Activity?

A VC firm's performance is solely a function of the success, or failure, of its portfolio companies. If the investments are successful, investors in the VC firm will receive a positive return on their investment, which, in turn, encourages investors to provide additional funding for the VC firm to invest in new portfolio companies. The performance of the WLB will therefore influence the VC' firm's performance and ability to raise future capital. How then, will investing in WLBs affect the VC firm's performance and subsequent investment practices?

It is possible that WLBs that receive VC funding are examined more thoroughly than MLBs receiving VC funding. The WLB may have endured more intensive due diligence on its product, management team, customers, etc. In other words, the WLB had to clear higher hurdles than the MLBs receiving VC funding. Other minority-owned business funded by VCs may have faced similar scrutiny. Research has found that minority-oriented VC firms investing in businesses owned by minorities (African Americans, Hispanic Americans and Asian Americans) had average internal rates of return (IRR) of 23.9 percent, compared with 20.2 percent for all U.S. VC firms (Bates & Bradford, 2003). We expect investing in WLBs may similarly affect VC firm performance.

Finally, as previously discussed, VCs invest in deals sourced from their networks. Once a VC firm invests in a WLB, a relationship is established between the VC firm and the WLB. In other words, the women executives in the WLB will now have a VC firm in their networks. These women may introduce or recommend members of their network to the VC firm. Since women tend to have a high percentage of women in their networks, the VC firm may receive more proposals from new WLBs and, if the initial investment was successful, increase their investments in new WLBs.

Hypotheses

Given the literature review, the study will test the following hypotheses:

1. Investment in WLBs by VC firms will be negatively associated with the VC firms' (a) relationships with other, well-connected VC firms, (b) relationships with other VC firms sharing the industry or investment stage focus, and (c) frequency and duration of co-investing with other, high-status VC firms.

2. VC firms' performance will be positively associated with investing in WLBs.

3. Future investment in WLBs by VC firms will be positively associated with previous investments in WLBs by these VC firms

Research Design

The hypotheses developed in the previous section predict the influence of investing in WLBs on VC firm performance, as well as future investments in WLBs. The unit of analysis is

the VC firm. The hypotheses are tested using panel data from 2000 through 2011. These data include repeated observations of variables for each VC firm. This dataset allows for reporting of fixed-effects regression estimates. Use of longitudinal data, as well as social network measures, create additional complexities.

Data Collection

The first step in data collection was to obtain every investment by a U.S.-based VC firm in a U.S.- based company (portfolio company) during the eleven-year period of 2000 through 2010 from the Thomson-Reuters VentureXpert database. These data include VC firm name, founding date, industry investing preference, investment stage preference, and zip code.

The data for investment transactions (rounds) include VC firm name(s), portfolio company name, and round date. Frequently, multiple VC firms co-invest with one another in a round. This co-investment is the basis for relationships among VC firms.

The data for portfolio companies include company name, founding date, industry, location, status (public, subsidiary, private, or defunct) and management team members' titles and first and last names. A portion of the names include prefixes of Mr., Ms., or Dr.

The dataset includes 2,500 VC firms, 18,900 portfolio companies, 92,500 individual management team members, and 90,000 investment rounds.

Gender Identification

The first step in gender identification was to identify each management team member's sex. This multi-phase process started with a review of those names with prefixes of Mr. or Ms. These data were sorted by first name and reviewed for appropriate gender identifier. All questionable prefixes, Mr. Barbara Jones, for example, were researched and corrected if necessary.

The next phase was to identify those individuals with Dr. or without a prefix. These data were also sorted by first name and those with obvious male (William or Robert, for example) or female (Deborah or Kathleen, for example) first names were assigned the appropriate prefix.

The final step was to assign gender prefixes to each individual with non-gender-specific names, such as Pat, Chris, Carol, Xin and Naghmeh. The multi-step process in identifying gender for these individuals included searching multiple databases, including Hoover's, BusinessWeek, Forbes, the Securities and Exchange Commission and LinkedIn. Also, many individuals were located on company websites. The use of name, company, location and title ensured the correct "Pat Jones" was identified in this process.

With the gender identification process completed, each portfolio company was coded as WLB if there was a female on the management team. This definition is consistent with extant WLB research (Brush, Carter, Gatewood, Greene & Hart, 2001; Brush, De Bruin, & Welter, 2009; for examples). All other portfolio companies were coded as MLB.

Performance Measures

Each portfolio company was identified in VentureXpert as public, subsidiary (acquired by or merged with another company), private, or defunct. Portfolio companies identified as public and subsidiary were included as exits in calculating firm performance.

Dependent Variables

We test our hypotheses using the ratio of investments in WLBs as the primary dependent variable (Brush, et al., 2004). Accordingly, we calculate the WLB Investment Ratio (WIR) for each VC firm *i* at time *t* as follows:

$$WIR_{it} = \text{No. of WLB Investments}_{it} \ / \ \text{Total No. of Investments}_{it} \quad (1)$$

Consistent with extant research (Brush et al., 2001; Brush, Carter, Gatewood, Greene, & Hart, 2006) we identify a WLB as a portfolio company in which a woman is a member of the company's senior executive management team. Thus, to calculate the numerator for the dependent variable, we sum the number of portfolio companies with at least one woman as a member of the senior executive management team. This is a continuous variable with values between 0 and 1. We calculate this variable for time 0 (T0) and T1.

Our second dependent variable is VC firm performance. We calculate firm performance Perf for each VC firm *i* at time *t* as follows:

$$Perf_{it} = \text{No. of Portfolio Company Exits}_{it} \ / \ \text{Total No. of Investments}_{it} \quad (2)$$

Consistent with extant research (Hochberg et al., 2007) we identify a portfolio company exit as the completion of an initial public offering (IPO) or merger with another company. This is a continuous variable with values between 0 and 1.

Independent Variables

Measures of VC Firm Social Capital

Lin (2001) defines social capital as "resources embedded in a social structure that are accessed and/or mobilized" (p. 29, italics added). In turn, Nahapiet and Ghoshal (1998: p. 243) state that social capital is "the sum of the actual and potential resources embedded within, available through, and derived from the network of relationships possessed by an individual or social unit." Thus, consistent with extant research, (Gulati & Higgins, 2003; Hochberg et al., 2007; Podolny, 2001), we identify a social network *tie* between two VC firms by their co-investment in the same portfolio company. These co-investments include both initial and subsequent rounds of financing. Per prior research (Guler, 2007; Podolny, 2001), we will use a rolling three-year (36 month) window to define these co-investment ties. This shorter timeperiod reflects the velocity of the VC industry. More formally, in a matrix of VC co-investment ties for a given time period *t*, each element or dyad of the matrix equals 1 if VC firms i and j have co-investment in the prior 36 months and zero otherwise.

The social capital and network measures are based upon co-investing relationships, as described above. For example, both Accel Partners and Greylock Partners invested in Facebook in 2006. This co-investment results in a dyad of Accel and Greylock in 2006.

Crosstab matrices were created for each three-year period in 2000 through 2010. Each matrix was at 1,000 lines by 1,000 columns, each line and column representing a VC firm. These matrices were imported to UCINET VI and used to calculate degree centrality, closeness and structural holes measures. The dyad tables were used to calculate the relationship frequency and duration, as well as shared industry and investment stage focus. All social capital and network measures were calculated for rolling three-year periods.

The social capital established by such ties has at least three dimensions (Nahapiet & Ghoshal, 1998). The first is the *structural* aspect, which deals with whom you know and how

you know them. The second is the *relational* aspect of social capital, which encompasses "those assets created and leveraged through relationships" (Nahapiet & Ghoshal, 1998). Finally, the *cognitive* aspect refers to the meanings, systems, and representations shared by the group or network. Thus, we will use the social network analysis program, UCINET VI, to calculate the social capital measures as described below.

Structural Social Capital

The concept of network centrality corresponds to the social structures that connect a given firm to other actors within an overall network. The three dimensions of network centrality explicated by Freeman (1979) are degree centrality, closeness, and structural holes (betweenness). We use all three measures of centrality to analyze the structural dimensions of social capital and the subsequent impact on WLB investments by VC firms.

Degree Centrality. Degree centrality indicates how "connected" a VC firm is to the other VC firms in the network. Specifically, it indicates that for a given VC firm the number of ties (i.e., degrees) to all otherVC firms is calculated as,

$$D_{it} = [d(n_i)]_t \quad (3)$$

We define $d(n_i)$ as the number of direct co-investment ties for VC firm i. As a result, if a VC firm has co-investments with every other VC firm in the network of 100, then its degree centrality measure will be 100. If, on the other hand, a VC firm has co-investments with only half of the VC firms in the network, then its degree centrality measure will be 50. This is a continuous variable. Per our hypotheses, we expect a VC firm's degree centrality to be related negatively to its WLB investment ratio.

Closeness. This measure indicates the "degrees of separation" between VC firms in a network. While there are numerous measures of closeness (Bavelas, 1950; Beauchamp, 1965; Moxley & Moxley, 1974; Rogers, 1974), we use the Sabidussi (1966) measure, which calculates closeness as follows:

$$C_{it} = [(g-1) / \sum_j d(n_i, n_j)]_t \quad (4)$$

Again, g-1 is the total number of possible direct ties in the network, but in this case $d(n_i, n_j)$ is the distance between VC firms i and j (Wasserman & Faust, 1994). The distance indicates

the number of "moves" to connect VC firms i and j. A direct tie between VC firms i and j, for example, has a distance of 1, whereas an indirect tie established by a shared connection to a third VC firm has a distance of 2, and so on. This is a continuous variable.

Per our literature review and hypotheses, a high closeness score indicates how efficiently a VC firm can access information in the network through its links to other VC firms who are well connected. To be clear, a VC firm can have a high closeness score through a tie to another node with high degree centrality, even if the focal VC firm has few direct links in the network or low degree centrality. Again, we expect a VC firm's closeness to be related negatively to its WLB investment ratio.

Structural Holes. Burt's (1992) theory of structural holes highlights the importance of gaps in the structure of social networks where ties between actors fail to form. Such structural holes present opportunities for actors to "broker" connections across these gaps, but it also means these acts are less embedded (i.e., more autonomous) in the network. In fact, per our literature review, we contend that those VC firms that span structural holes have an advantage in terms of deal information flows.

We use a widely accepted indicator of structural holes to measure the degree of autonomy of a VC firm in the network (Burt, 1992). This measure follows from previous research (Podolny, 2001) and is calculated as follows:

$$A_{it} = [1 - \Sigma_j(p_{ij} + \Sigma_q p_{iq} p_{qj})^2]_t \qquad \text{where } i \neq j \neq q \qquad (5)$$

Here, p_{ij} is the proportion of VC firm i's total number of investment deals that are co-investments with VC firm j. In other words, p_{ij} is zero if VC firm i has no co-investments with VC firm j and is equal to 1 if all of i's investments are co-investments with j. In turn, the term $\Sigma_q p_{iq} p_{qj}$ captures the indirect ties to firm j by the shared co-investment patterns with VC firm q. In particular, p_{iq} is the proportion of VC firm i's co-investments with VC firm q and p_{qj} is the proportion of VC firm q's co-investments with VC firm j. Thus, overall, the summed term in parentheses captures the direct ($p_{ii'}$) and indirect ($\Sigma_q p_{iq} p_{qi'}$) ties between VC firms i and j. More importantly, A_i ranges from 0 to 2 with lower values of A_i indicating the VC firm is more autonomous (i.e., spans many structural holes) and higher values indicating the VC firm is more deeply embedded in a network of redundant connections. This is a continuous variable.

Relational Social Capital

The preponderance of social capital research in business environments has focused on the relational dimension. This dimension of social capital can clearly be distinguished from the structural dimension because the former refers to the nature of the relationship between two actors (or nodes) in a dyad, whereas the latter refers to the relationships across multiple actors. Tie strength is frequently used as an independent variable in research on the relational dimension of social capital. The concept of strong and weak ties was explicated by Granovetter (1973), where tie strength was defined as a linear function of "a combination of the amount of time, the emotional intensity, the intimacy (mutual confiding) and the reciprocal services which characterize the tie" (p. 1361). However, since research on tie strength finds mixed results for single, rather than multiple, measures (Marsden, 2005; Marsden & Campbell, 1984), we use relationship duration and frequency as measures of relational social capital.

Relationship Duration. We calculate relationship duration in increments of six months from the first co-investment. That is, if a new VC firm invests with only one other VC firm and that relationship is a year old, the duration will be 2 (12 months divided by 6 months). In turn, we calculate the average tie duration for each VC firm by summing the individual duration measures and dividing that by the number of ties for that firm. Formally, the calculation is,

$$R_{it} = [\sum_j (r_{ij}/6) / d(n_i)]_t \quad (6)$$

where r_{ij} is the number of months since the first co-investment between VC firms i and j and $d(n_i)$ is the number of degrees (direct ties) for VC firm i. This is a continuous variable.

Relationship Frequency. We estimate relationship frequency by using a measure of multiplexity. In his study of VC firms, Podolny (2001) utilizes the number of shared deals to measure tie strength as a function of frequency of interaction. Thus, for this measure, each shared deal is defined as an investment in a *new* portfolio company, rather than an existing portfolio company. We then calculate an average multiplexity measure for each VC firm by summing the individual frequency measures for the VC firm and dividing that sum by the total

number of ties for that firm. If a new VC firm co-invests with only one other VC firm, in three companies, this measure will be 3 (3 divided by 1). This measure is calculated as

$$M_i = [\sum s_{ij} / d(n_i)]_t \quad (7)$$

where s_{ij} is the number of co-investments in *new* portfolio companies between VC firms i and j and $d(n_i)$ is the number of degrees (direct ties) for VC firm i. This is a continuous variable.

Cognitive Social Capital

Because empirical studies examining the cognitive aspect of social capital are scarce, if not nonexistent, we could not identify extant measures of cognitive social capital. Simsek, Lubatkin and Floyd (2003) propose a definition of firm-level cognitive embeddedness as "the degree of similarity among network actors…concerning their beliefs about types of issues perceived to be important, how such issues are conceptualized and, perhaps, alternative approaches for dealing with such issues" (Simsek, Lubatkin and Floyd, 2003, p.433). They do not, however, engage in empirical work on cognitive social capital.

It is common for VC firms to focus their investments in a specific industry (e.g., telecommunications or biotechnology) or investment stage. Thus, to capture the cognitive social capital of VCs we measure shared industry and investment stage foci. We calculate shared industry focus for each VC firm, where each co-investor focuses on the same specific industry, such as telecommunications or biotechnology.

Shared Industry Focus[i] If the focal VC firm co-invests with another VC firm that shares the same industry focus, we code it as a 1; if the industry focus is not the same, the coding is 0. In turn, we calculate the shared industry focus ratio by summing these and then dividing by the number of co-investors (ties) for that firm. Formally, the calculation is

$$IND_{it} = [\sum_j u_{ij} / d(n_i)]_t \quad (8)$$

where u_{ij} is the number of shared industry focus co-investments between VC firms i and j and $d(n_i)$ is the number of degrees (direct ties) for VC firm i. This is a continuous variable.

Shared Investment Stage Focus[ii] Using this same approach, we calculate shared investment stage focus for each VC firm dyad, where investment-stage focus is defined as early, middle or late stage. The calculation is as follows:

$$INV_{it} = [\sum_j v_{ij} / d(n_i)]_t \quad (9)$$

where v_{ij} is the number of shared investment-stage focus co-investments between VC firms i and j and $d(n_i)$ is the number of degrees (direct ties) for VC firm i. This is a continuous variable.

Control Variables

In addition to the social capital variables described above, the following control variables are defined for each VC firm. *VC Firm Age* is the number of months since the founding date of the firm. *VC Firm Location* is the state in which the firm's primary office is located. Dummy variables were used for Massachusetts, New York, California, Texas and Illinois. These five states were selected because they are the top 5 states where VCs make investments and they make up 62.2% of all VC investments. We utilized dummy variables for each year, 2001 through 2010.

Model Specification

To test our model, we estimate a system of two simultaneous equations for two reasons. First, our data violate the independence assumption of normal regression models, as the social capital measures are non-independent based on the method of calculation. As an example, two of the structural social capital measures—degree centrality and closeness—share, respectively, the same information in the numerator and denominator. Second, there is the issue of endogeneity introduced by the simultaneity of the dependent variable and the VC firm performance variable as well as an omitted variable bias. As a result, we estimate the following system of equations:

$$WIR_{it} = \beta X_{it} + Perf_{it} + \varepsilon_{it} \quad (10)$$

$$Perf_{it} = \beta X_{it} + WIR_{it} + \varepsilon_{it} \quad (11)$$

We estimate this system of equations via three-stage least squares (3SLS) estimation. By combining instrumented variable or two-stage least squares (2SLS) estimation with seemingly unrelated regression (SUR), three-stage least squares can handle many of the expected irregularities in our data and model specifications while relaxing many of the MLE assumptions and providing a full set of diagnostic tools and procedures.

Results

Descriptive statistics are reported in Table 1. One surprising result is that the average ratio of investing in WLBs is 41%. This differs from earlier reported data where WLBs receive only 6% of VC funding. This difference is due to two factors: first, our measure is the investment in WLBs, not the dollar amount invested. Further, our data are for all VC investments during the 11 year period. Earlier studies examined only those transactions where funding data were available for a 2 year period. We believe the extensive data utilized in this study support our analysis and conclusions and reflect the investments in WLBs.

Table 1 Descriptive Statistics

	Minimum	Maximum	Mean	Std. Deviation
WLB Ratio	.00	1.00	.4131	.33312
WLB Ratio T1	.00	1.00	.4131	.33312
Success Ratio	.00	1.00	.1597	.25950
Closeness	50.037090	55.639099	50.32141026	.447813867
Degree	2	255	16.20	22.069
Structural Holes	.5621188	1.9966847	1.135608892	.3274860557
Frequency	.06	4.27	1.1286	.60667
Duration	.00	139.05	27.5291	22.21675
Shared Industry Focus Ratio	.00	4.05	.8570	.65937
Shared Investment Focus Ratio	.00	4.05	.8585	.65777
MA	0	1	.09	.288
CA	0	1	.27	.444
NY	0	1	.16	.367
TX	0	1	.05	.221
IL	0	1	.05	.217
Age	0	99	10.12	9.247

Table 2 shows the results of our testing of our first hypothesis – the impact of social capital on investing in WLBs. As noted in Model 1, our base model, the significant control variables are age, the states of Massachusetts and California, as well as the dummy variables for years 2002, 2004, 2005, and 2008.

Table 2 Dependent Variable WLB Investment Ratio

	Model 1		Model 2		Model 3		Model 4	
(Constant)	.349	***	-1.794		.435	***	.432	***
2001	.003		-.080	***	-.093	***	-.073	***
2002	.034	**	-.039	*	-.042	*	-.036	
2003	.019		-.017		-.034	*	-.012	
2004	.039	**	-.023		-.045	**	-.023	
2005	.033	**	-.047	**	-.055	***	-.047	**
2006	.006		-.031		-.038	*	-.023	
2007	.025		-.038		-.053	**	-.030	
2008	.036	**	-.027		-.034		-.026	
2009	.012		-.035		-.041	**	-.030	
2010	.014		-.013		-.037	*	-.017	
MA	.035	***	.025		.019		.021	
CA	.042	***	.021		.023		.019	
NY	.010		.018		.024		.025	
TX	-.022		-.033	**	-.034	**	-.035	**
IL	.013		.010		.008		.014	
Age	.031	***	.012		.004		.011	
Closeness			-.573					
Degree			.610					
Structural Holes			-.074	***				
Frequency					.056	***		
Duration					.107	***		
Shared Industry Focus							.039	
Shared Investment Stage Focus							.080	
R-Squared	0.09		0.13		0.14		0.16	
F-Statistic	7.764		7.525		8.561		9.896	
N	13638		13638		13638		13638	

*significant at .01, ** significant at .005, *** significant <.001

In Model 2 we include the measures of structural social capital. Interestingly, both closeness and structural holes had the negative impact we hypothesized, but only the structural holes variable was significant. The significance of age and Massachusetts and California lost significance. Texas, however, was significant and negative. Hypothesis 1 is partially supported for structural social capital.

In Model 3, we introduce the relational social capital measures. Both frequency and duration of the relationships among VC firms were significant, but positive. Hypothesis 1 is not supported for relational social capital.

In Model 4, our measures of cognitive social capital are not significant, thus not supporting hypothesis 1 for cognitive social capital.

Table 3 Dependent Variable Success Ratio

	Model 1		Model 2	
(Constant)	.155	***	.128	***
2001	.156	***	.156	***
2002	.097	***	.093	***
2003	.060	***	.058	***
2004	.028	*	.024	
2005	-.031	**	-.034	***
2006	-.063	***	-.064	***
2007	-.087	***	-.090	***
2008	-.110	***	-.113	***
2009	-.058	***	-.059	***
2010	-.042	***	-.044	***
MA	-.007		-.011	
CA	.005		.001	
NY	.041	***	.040	***
TX	-.021	*	-.019	
IL	-.005		-.006	
Age	.048	***	.045	***
WLB Investment Ratio			.101	***
R-Squared	0.173		0.183	
F-Statistic	178.398		179.784	
N	13638		13638	

*significant at .01, ** significant at .005, *** significant <.001

Table 3 includes the results of our testing of hypothesis 2, that investing in WLBs will have a positive influence on VC firm performance. The dependent variable is the VC firm's success ratio. Model 1 is our base model and Model 2 includes the independent variable of WLB investment ratio. The effect of WLB investment ratio on VC firm success is positive and significant, supporting hypothesis 2.

Table 4 shows the results of our testing of hypothesis 3. The dependent variable is the subsequent investment in WLBs. Again, Model 1 is our base model and Model 2 included the earlier investment in WLBs. The effect of the WLB investment ratio is positive and significant, supporting hypothesis 3.

Table 4 Dependent Variable Subsequent Investment in WLBs

	Model 1		Model 2	
(Constant)	.349	***	.325	***
2001	.003		-.016	
2002	.034	**	.023	
2003	.019		.012	
2004	.039	**	.035	**
2005	.033	**	.037	**
2006	.006		.013	
2007	.025		.036	**
2008	.036	**	.049	***
2009	.012		.019	
2010	.014		.020	
MA	.035	***	.036	***
CA	.042	***	.041	***
NY	.010		.005	
TX	-.022		-.019	
IL	.013		.014	
Age	.031	***	.025	**
Investment in WLBs at T0			.121	*
R-Squared	.009			
F-Statistic	7.764			
N	13638		13638	

*significant at .01, ** significant at .005, *** significant <.001

Discussion

As discussed above, our findings show partial support for our first hypothesis regarding the influence of social capital on a VC firm's investments in WLBs. Interestingly, structural social capital, specifically structural holes, has the hypothesized negative effect on investing in WLBs. This is similar to the earlier research finding that VC firms spanning more structural holes invested in "safer" investments. Another aspect of our findings is that the three measures of structural social capital have different effects on investing in WLBs. This supports the belief that the different dimensions of structural social capital result in different outcomes.

Our findings did not support our thesis that relational social capital had a negative influence on the ratio of investments in WLBs. Unexpectedly, both frequency and duration had significant and positive results. One interpretation of these results is that VC firms that co-invest frequently with the same firms tend to invest more in WLBs because they are able to share the risk of the investment with other VC firms.

Our cognitive social capital measures were not significant. This may be because our measure doesn't capture cognitive social capital. As discussed earlier, extant research has not identified cognitive social capital measures, so our measures were exploratory. This does not mean that cognitive social capital is not a valid construct, but that the ability to measure it remains elusive.

Finally, overall, our findings support the belief that there are multiple dimensions of social capital and these dimensions may have different, even conflicting, effects on outcomes. It would be interesting to examine the interaction of these measures to gain a greater understanding of social capital's influence on VC firm investment decisions.

Our second hypotheses, that investing in WLBs results in improved VC firm performance was supported. This may be the result of more vigorous due diligence on WLBs compared with MLBs or the influence of a heterogeneous management team.

Finally, our third hypothesis that VC firm initial investment in WLBs would lead to subsequent investments in WLBs was supported. Additionally, we tested the influence of the VC firm success measure on the future tendency to invest in WLBs and the results were also positive and significant.

Concluding Remarks

This study set out to explore the effects of VC firm social capital on investing in WLBs. Our approach to the question of VC funding of WLBs was different from extant research in that we viewed the question from the perspective of the VC firm, rather than the WLB. Our analysis indicates that VC firms' social capital influences their investments in WLBs, but in different and sometimes conflicting ways. The investment in WLBs does have a positive influence on VC firms' results, measured as the public offering or acquisition of portfolio companies in which the VC firm has invested.

Further analysis is certainly called for. An examination of the effect of the interaction of the various dimensions of social capital on WLB investment could be a first step. One also wonders how these results would be affected if the definition of a WLB is limited to firms with women founders. A number of the women executives in these portfolio companies are in administrative roles, such as finance or human resources. This finer grained examination may improve our understanding of the factors affecting the funding of WLBs.

References

Aldrich, H. 1989. Networking Among Women Entrepreneurs. In O. Hagan & C. Rivchun & D. L. Sexton (Eds.), *Women-Owned Businesses*: 103-132. New York, NY: Praeger.

Alsos, G. A., Isaksen, E. J., & Ljunggren, E. 2006. New Venture Financing and Subsequent Business Growth in Men- and Women-Led Businesses. *Entrepreneurship: Theory & Practice*, 30(5): 667-686.

Amatucci, F. & Sohl, J. 2004. Women Entrepreneurs Securing Business Angel Financing: Tales from the Field. *Venture Capital*, 6(2/3): 181-196.

Arthurs, J. D. & Busenitz, L. W. 2006. Dynamic Capabilities and Venture Performance: The Effects of Venture Capitalists. *Journal of Business Venturing*, 21(2): 195-215.

Bates, T. & Bradford, W. 2003. Minorities and Venture Capital: A New Wave in American Business: Kauffman Foundation.

Bates, T., Jackson, W. E. I., & Johnson, J. H. J. 2007. Introduction to the special issue on advancing research on minority entrepreneurship. *Annals of the American Academy of Political Science and Social Science*, 613: 10-17.

Brophy, D. J. 1997. Financing the Growth of Entrepreneurial Firms. In D. L. Sexton & R. W. Smilor (Eds.), *Entrepreneurship 2000*: 5-28. Chicago, Ill: Upstart Publishing Company.

Brush, C., Carter, N., Gatewood, E., Greene, P., & Hart, M. 2001. An Investigation of Women-Led Firms and Venture Capital Investment: U.S. Small Business Administration, Office of Advocacy, National Women's Business Council.

Brush, C., Carter, N., Gatewood, E., Greene, P., & Hart, M. 2004. Gatekeepers of Venture Growth: A Diana Report on the Role and Participation of Women in the Venture Capital Industry. Kansas City, MO: Kauffman Foundation.

Brush, C., De Bruin, A., & Welter, F. 2009. A Gender-Aware Framework for Women's Entrepreneurship. *International Journal of Gender and Entrepreneurship*, 1(1): 8-24.

Busenitz, L. W., Arthurs, J. D., Hoskisson, R. E., & Johnson, R. A. 2003. Venture capitalists and information asymmetries in the pricing of IPO securities. *Academy of Management Proceedings*: E1-E6.

Carter, S. & Rosa, P. 1998. The financing of male- and female-owned businesses. *Entrepreneurship & Regional Development*, 10(3): 225-241.

Carter, S., Shaw, E., Lam, W., & Wilson, F. 2007. Gender, Entrepreneurship, and Bank Lending: The Criteria and Processes Used by Bank Loan Officers in Assessing Applications. *Entrepreneurship: Theory & Practice*, 31(3): 427-444.

Chang, S. J. 2004. Venture capital financing, strategic alliances, and the initial public offerings of Internet startups. *Journal of Business Venturing*, 19(5): 721-741.

Cliff, J. E. 1998. Does one size fit all? exploring the relationship between attitudes towards growth, gender, and business size. *Journal of Business Venturing*, 13(6): 523-542.

Fried, V. H. & Hisrich, R. D. 1994. Toward a Model of Venture Capital Investment Decision Making. *Financial Management*, 23: 28-37.

Gompers, P. & Lerner, J. 2001. The Venture Capital Revolution. *Journal of Economic Perspectives*, 15(2): 145-168.

Greene, P. G., Brush, C. G., Hart, M. M., & Saparito, P. 2001. Patterns of venture capital funding: is gender a factor? *Venture Capital: An International Journal of Entrepreneurial Finance*, 3(1): 63-83.

Gulati, R. & Higgins, M. C. 2003. Which Ties Matter When? The Contingent Effects Of Interorganizational Partnerships On IPO Success. *Strategic Management Journal*, 24(2): 127 - 144.

Headd, B. 2010. An Analysis of Small Business and Jobs: Small Business Administration, Office of Advocacy.

Hochberg, Y. V., Ljungqvist, A., & Lu, Y. 2007. Whom You Know Matters: Venture Capital Networks and Investment Performance. *Journal of Finance*, 62(1): 251.

Hsu, D. H. 2007. Experienced Entrepreneurial Founders, Organizational Capital, and Venture Capital Funding. *Research Policy*, 36: 722-741.

Podolny, J. M. 2001. Networks as Pipes and Prisms of the Market. *American Journal of Sociology*, 107(1): 33-60.

Research, C. f. W. s. B. 2009. The Economic Impact of Women-Owned Businesses in the United States: 1 - 12 Center for Women's Business Research.

Shane, S. & Cable, D. 2002. Network Ties, Reputation, and the Financing of New Ventures. *Management Science*, 48(Issue 3): 364-381.

Stinchcombe, A. L. 1965. Social Structure and Organizations. In J. G. March (Ed.), *Handbook of Organizations*. Chicago: Rand McNally & Company.

Watson, J. 2002. Comparing the Performance of Male- and Female-Controlled Businesses: Relating Outputs to Inputs. *Entrepreneurship: Theory & Practice*, 26(3): 91-100.

Glossary

Industry Stage – The stage in the life-cycle of a portfolio company. VC firms often prefer to invest in particular industry stages. For a listing of the industry stage classifications used in this paper, see Figure 7.

Social Capital – The benefit found in the relationship between two or more actors. For example, knowing the President of a local bank could provide benefits to an individual. There are three dimensions of social capital.

> Cognitive Social Capital – The shared codes, terms or language of a group. For example, members of the military have shared language and terms, such as "deployment" or "TDY" that carry unique meanings in the military environment.
>
> Relational Social Capital – The strength of the relationship between two or more actors. For example, immediate family members may have strong relational social capital. Neighbors in a large city might have weak social capital. Relational social capital is measured by frequency of interaction, duration of relationship and depth of confiding.
>
> Structural Social Capital – The existence of a relationship between two or more actors. Frequently described as a "tie". A tie exists between two actors if they know each other. Structural social capital also includes the ties among a group of actors.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Sum Of Females	18913	.0	28.0	.618	1.1336
Max Of Round Number	18913	1	24	3.20	2.617
Founding Date	15754	1/01/1813	12/01/2010	12/11/1994 21:09:38.089	6150
Valid N (listwise)	15754				

Figure 1 Portfolio Company Descriptive Statistics

Status

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Defunct	697	3.7	3.7	3.7
	Private	15080	79.7	79.7	83.4
	Public	1293	6.8	6.8	90.3
	Registration	2	.0	.0	90.3
	Status Unknown	1	.0	.0	90.3
	Subsidiary	1824	9.6	9.6	99.9
	Withdrew Registration	16	.1	.1	100.0
	Total	18913	100.0	100.0	

Figure 2 Portfolio Company Status Statistics

Industry Group

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Biotechnology	1031	5.5	5.5	5.5
	Communications and Media	2147	11.4	11.4	16.8
	Computer Related	6541	34.6	34.6	51.4
	Medical/Health/Life Science	2105	11.1	11.1	62.5
	Non-High-Technology	6059	32.0	32.0	94.6
	Semiconductors/Other Elect	1030	5.4	5.4	100.0
	Total	18913	100.0	100.0	

Figure 3 Portfolio Company Industry Statistics

Number of Rounds

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	6357	33.6	33.6	33.6
	2	3626	19.2	19.2	52.8
	3	2591	13.7	13.7	66.5
	4	1855	9.8	9.8	76.3
	5	1342	7.1	7.1	83.4
	6	1079	5.7	5.7	89.1
	7	665	3.5	3.5	92.6
	8	491	2.6	2.6	95.2
	9	314	1.7	1.7	96.9
	10	203	1.1	1.1	97.9
	11	138	.7	.7	98.7
	12	79	.4	.4	99.1
	13	61	.3	.3	99.4
	14	48	.3	.3	99.7
	15	22	.1	.1	99.8
	16	14	.1	.1	99.9
	17	12	.1	.1	99.9
	18	4	.0	.0	99.9
	20	3	.0	.0	100.0
	21	3	.0	.0	100.0
	22	2	.0	.0	100.0
	23	3	.0	.0	100.0
	24	1	.0	.0	100.0
	Total	18913	100.0	100.0	

Figure 4 Frequency of Rounds

Number of Female Managers

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.0	12123	64.1	64.1	64.1
	1.0	4053	21.4	21.4	85.5
	2.0	1641	8.7	8.7	94.2
	3.0	619	3.3	3.3	97.5
	4.0	236	1.2	1.2	98.7
	5.0	118	.6	.6	99.3
	6.0	47	.2	.2	99.6
	7.0	29	.2	.2	99.8
	8.0	19	.1	.1	99.9
	9.0	6	.0	.0	99.9
	10.0	11	.1	.1	99.9
	11.0	5	.0	.0	100.0
	13.0	2	.0	.0	100.0
	14.0	1	.0	.0	100.0
	17.0	1	.0	.0	100.0
	22.0	1	.0	.0	100.0
	28.0	1	.0	.0	100.0
	Total	18913	100.0	100.0	

Figure 5 Frequency of Female Managers

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
WLB Company Ratio	2414	.000	1.000	.38894	.293790
WLB Investments Ratio	2414	.000	1.000	.39901	.303335
Success Ratio	2414	.000	1.000	.18255	.241072
Structural Holes Measure	2005	.620	1.999	1.14113	.334733
Number of ties	2005	2.0	417.0	24.635	38.1175
California=1	2414	0	1	.25	.433
Texas=1	2414	0	1	.06	.231
New York State=1	2414	0	1	.16	.371
Mass=1	2414	0	1	.08	.275
Illinois=1.	2414	0	1	.05	.211
Firm age in years	2312	1	100	14.26	9.328
Valid N (listwise)	1919				

Figure 6 VC Firm Statistics

	Frequency	Percent	Valid Percent	Cumulative Percent
	843	6.7	6.7	6.7
Acquisition	705	5.6	5.6	12.3
Balanced	1090	8.7	8.7	21.0
Control-block Purchases	24	.2	.2	21.2
Distressed Debt	77	.6	.6	21.9
Early Stage	3781	30.2	30.2	52.0
Expansion	841	6.7	6.7	58.7
First Stage Financing	363	2.9	2.9	61.6
Fund of Funds	26	.2	.2	61.8
Fund of Funds of Second	4	.0	.0	61.9
Generalist PE	255	2.0	2.0	63.9
Industry Rollups	17	.1	.1	64.0
Joint Ventures	6	.0	.0	64.1
Later Stage	539	4.3	4.3	68.4
Leveraged Buyout	1558	12.4	12.4	80.8
Management Buyouts	163	1.3	1.3	82.1
Mezzanine	304	2.4	2.4	84.5
Open Market	10	.1	.1	84.6
Other	57	.5	.5	85.1
Private Placement	12	.1	.1	85.2
Public Companies	23	.2	.2	85.3
Recapitalizations	202	1.6	1.6	87.0
Research and Development	57	.5	.5	87.4
Second Stage Financing	165	1.3	1.3	88.7
Seed	801	6.4	6.4	95.1
Special Situation	56	.4	.4	95.6
Start-up Financing	184	1.5	1.5	97.0
Startup	306	2.4	2.4	99.5
Turnaround	66	.5	.5	100.0
Total	12535	100.0	100.0	

Figure 7 VC Firm Investment Stages

[i] VC firms tend to invest in specific industries, such as hardware, software, social media, etc. We include a list of the industry classifications used in this study in Figure 3.

[ii] Portfolio companies are classified by their stage of development. VC firms may focus on a specific stage of development, such as early stage, later development, etc. These stages reflect the progress a portfolio company has made since founding. We include a list of these stages in Figure 7.