VENTURE CAPITAL FIRM NETWORK AND INITIAL PUBLIC OFFERING CHARACTERISTICS

XU JUN

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XU JUN

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_____ (Signed)

Xu Jun
_____ (Name of student)

Venture Capital Firm Network and Initial Public Offering Characteristics

Abstract

I explore three ways in which VC firms' network affects the IPO characteristics of their portfolio companies. First, adding more values to their portfolio companies, the better-connected VC firms can make their portfolio companies perform better after IPO. Secondly, the better-connected VC firms have stronger bargaining power, leading to more stringent disciplining on their portfolio companies. Thirdly, the better-connected VC firms have more channels to disseminate the information of its portfolio companies to the public market.

First, I find that IPO companies invested by more central VC firms have higher rate of return on assets (ROA) and spend more R&D in the post-IPO years. Second, companies invested by more central VC firms have lower levels of earnings management in the several years prior to their IPO. Third, companies invested by more central VC firms are associated with larger absolute values of offer price revisions. Fourth, companies invested by more central VC firms have greater IPO market valuation, which are reflected in the higher Tobin's q. Fifth, companies invested by more central VC firms induce greater interest on some important financial market players. Such companies will be followed by more sell-side analysts and higher percent of their shares will be hold by institutional investors.

Lastly, the stocks of IPO companies invested by more central VC firms enjoy higher market turnover and better one year post-IPO performance. Overall, my results are consistent with the notion that more central VC firms are able to provide more value-adding service to their portfolio companies, to improve the corporate governance of their portfolio companies, and to draw greater market attention to their portfolio companies.

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Contents

1. Introduction

Networks play significant roles in venture capital industry. Instead of investing alone, VC firms usually co-invest with other VC firms. Thus, they develop relationships, and further form networks with other VC firms through their current and past investments. Hochberg, Lyungqvist, and Lu (2007) argue that the central location of a VC firm in a network and the nature and extent of its connections to other agents in that network will affect its fund performance. Bajo, Chemmanur, Simonyan, and Tehranian (2016) show how underwriters collect and disseminate information about companies they underwrite by the investment banking networks during the IPO process. Likewise, the way that VC firms are connected with each other (through participating in the same investment round with other VC firms) can influence their ability of extracting and disseminating information during the IPO process.

The aim of this paper is to explore whether VC firms' connectedness will influence their portfolio companies' post-IPO performance. Through observing data about how VC firms interact with each other within investment syndicates for different investment rounds, I am able to construct VC firm network produced by the interaction among VC firms in a syndicate in an investment round and to characterize the centrality of each VC firm in the network through measures from social network analysis. I then empirically analyze how these measures of network centrality of VC firms affect the performance of IPO companies invested by them.

Follow prior literature of social network analysis, I use centrality measures to describe the relative position of a VC firm in its network. The main measure is *Degree. Degree* measures how many other VC firms that a VC firm was connected with through participation in the same syndication over the past 5 years. The other measures of VC firm centrality are *Outdegree*, *Indegree*, *Betweenness*, *Eigenvector*, and *2-StepReach*. I define and discuss these measures in

detail in section 4. Consistent with Hochberg, Lyungqvist, and Lu (2007), a syndicate is defined as the collection of VC firms that participate in a specific portfolio company investment round.

VC firms' centrality in the network can affect the IPO characteristics of their portfolio companies in three ways. First, as Hochberg, Lyungqvist, and Lu (2007) put it, VC firms that have connections to many other VC firms may have access to a wider range of knowledge, technology, and poor of capital, and are thus expected to add more value to their portfolio companies. Then, for the portfolio companies that are invested by better-connected VC firms, they will receive more value-adding service during their rearing stage, and such advantage will be reflected in their post-IPO performance. Thus, it is reasonable to expect that for portfolio companies that eventually go public, those invested by better-connected VC firms will produce more favorable IPO characteristics than others.

Secondly, better-connected VC firms can help improve the corporate governance. Lerner (1995) shows that the representation of venture capitalists on board has monitoring effects on private companies. Hochberg (2012) finds that venture-backed companies have better corporate governance, manifested as lower lever of earnings management and more independent board structures. Hochberg, Lyungqvist, and Lu (2010) show that strong networks among VC firms can improve their bargaining power over entrepreneurs. Thus, well-connected VC firms can have a better disciplining effect on the companies they invest, forcing the private companies to regulate their corporate governance.

Thirdly, Bajo, Chemmanur, Simonyan, and Tehranian (2016) illustrates underwriters' role in the information extraction and dissemination during the IPO process, and I assume that VC firms also play such a role. Joining in the same investment round with other VC firms, a VC firm can have connections to many other VC firms. Its location in this VC firm network can be captured by

social network analysis measures. Each VC firm in the network may also have ties to many institutional investors through repetitive previous interactions.[1] Under this circumstances, then, through this network, the position of a VC firm in its network can affect its ability to draw attention from institutional investors to the companies it has been financing and is about to take public and to disseminate information about the IPO company to these institutional investors. Second, this location can affect the VC firm's ability to obtain information from institutions about their interest on the IPO firm's equity after it draws the attention of these institutions to IPO companies. Therefore, connected to more institutional investors, a more central VC firm will be able to draw a larger number of institutional investors' attention to its portfolio companies.

Accordingly, I empirically analyze how VC firms' centrality in the network can affect the IPO characteristics of their portfolio companies. The followings are my main findings. First, I find that IPO companies invested by more central VC firms have higher rate of return on assets (ROA) and spend more R&D in the post-IPO years. Second, companies invested by more central VC firms have lower levels of earnings management in the several years prior to their IPO. Third, companies invested by more central VC firms are associated with larger absolute values of offer price revisions. Fourth, companies invested by more central VC firms have greater IPO market valuation, which are reflected in the higher Tobin's q. Fifth, companies invested by more central VC firms induce greater interest on some important financial market players. Such companies will be followed by more sell-side analysts and higher percent of their shares will be hold by institutional investors. Lastly, the stocks of IPO companies invested by more central VC firms enjoy higher

[1] One possible situation that such connections are formed is prior IPO process. When a VC firm is going to take its portfolio company public, it will interact with the company's underwriters. It is also possible for these VC firms to meet other institutional investors during the IPO road shows.

market turnover and better one year Post-IPO performance. Overall, my results are consistent with the notion that more central VC firms are able to provide more value-adding service to their portfolio companies, to improve the corporate governance of their portfolio companies, and to draw greater market attention to their portfolio companies.

An alternative explanation for the value-adding role of venture capital firm network is that well-connected venture capital firms are always old age, thus it is the experience and reputation that help the portfolio companies perform better, not the network itself (e.g., Kaplan, Martel, and Stromberg (2003)). Nahata (2008) find that more reputable VC firms will have a higher exist rate in their portfolios, and their portfolio companies will access public markets faster. Krishnan, Ivanow, Masulis, and Singh (2011) also document that venture capital firms' reputation has significant positive association with long-run firm performance and corporate governance measures. To rule out the possibility that my measure of network centrality merely proxy for VC experience and reputation, I conduct robust tests to control for a variety of measures that proxy for VC experience and reputation, and the results still remain significant.[2]

Another concern is the endogeneity issue of the VC firms' network. The argument is that it is the venture capitalists' original skills that improve their portfolio companies, and such skills also enable VC firms to improve their network positions. Thus, it is these original skills, rather than the network that produce my results. However, the method I use to measure the VC firm centrality makes such explanation less likely. On the one hand, the centrality measures are based on the venture capital firms' previous syndication. A VC firm will have a tie with another VC firm only if these two firms have co-invested in the same company-round during the past five calendar years.

[2] While some studies distinguish reputation from experience, Hsu (2004) assumes that reputation comes from experience. Here, I agree with Hsu (2004) and regard reputation and experience as a single quality.

A VC firm will become more central in the network as the number of such ties increases. Thus, the VC firm centrality is unrelated to the characteristics of companies that it is about to invest. On the other hand, after a VC firm invests a private company, it usually takes several years to take this company public. During the nurture year of a portfolio company, the centrality measures are based on the venture capital firms' previous syndication. Therefore, such reverse causality is unlikely to be the reason of my empirical findings. [3] The details of this part will be fully explained in section 4.

The rest of this paper is organized as follows: in section 2, I will review the related studies, and point out how my work is different from others. I will also illustrate the contribution of my paper. In section 3, I will come up with my hypothesis about the venture capital centrality and IPO characteristics. In section 4 will discuss how the social network measure is calculated. In section 5, I will show you the Data, regression results and the robust test. The last section is the conclusion.

[3] Hochberg, Lyungqvist, and Lu (2007) also find little evidence that past performance drive future network position.

2. Literature review and contribution

My paper is related to two streams of literature. The first literature is about how financial market players' social network affects their behavior and performance. Hochberg, Lyungqvist, and Lu (2007) show how venture capitalists' social network affects the performance of venture capital funds. Their results show that if a VC firm is well-connected to other VC firms, their portfolio companies will have a higher rate of IPO exits or being sold to another company. Hochberg, Lyungqvist, and Lu (2010) show that strong network among incumbent VC firms in local market can limit the entrance of outside VC firms, increasing the incumbent VC firms' bargaining power over private companies. Chulum (2015) and Bajo, Chemmanur, Simonyan, and Tehranian (2016) examine how the network of underwriters will affect the IPO outcomes of the firm they underwrite. Their results show that a more central underwriter in the investment banking network will produce more favorable IPO outcomes for the firm it underwrites, such as higher market valuation, higher second market liquidity, and so on. Other research examines CEOs' and boards' social network. For example, Larcker, So, and Wang (2013) shows that well connected boards have higher merge and acquisition returns. In the same way, El-Khatib, Fogel, and Jandik (2015) show that well-connected CEOs will produce better takeover performance.

The second literature my paper is related to is how VC firms affect its portfolio companies' characteristics and IPO outcomes. In early studies, Barry, Muscarella, Peavy, and Vetsuypens (1990) show that venture capitalists hold concentrated shares of their portfolio companies and serve on the board to monitor their portfolio companies. Lerner (1995) also shows the representation of venture capitalists on board has monitoring effects on private companies. Recent studies show how the different features of VC firms are associated with portfolio performance and IPO outcomes. For example, Hochberg (2012) show that compared with other IPO companies,

venture capital backed IPO companies will have better corporate governance, represented as lower degree of earnings management and more independent boards. Tian (2012) studies how venture capital syndication will create value for entrepreneurial companies. His results show that venture capital syndicates enhance market value of entrepreneurial companies' products, nurture innovation for their portfolio companies. Also, venture capital syndicates can help their portfolio companies to achieve better post-IPO performance. Krishnan, Ivanov, Masulis, and Singh (2011) show that more reputable VC firms will improve the corporate governance of their portfolio companies, leading to better post-IPO outcomes if their portfolio companies go public.

My paper contributes to existing literature in three aspects. First, my paper is the first one to document how VC firms' social network will affect their portfolio companies' IPO characteristics. Hochberg, Lyungqvist, and Lu (2007) explore the relationship between VC firms' connectedness and the performance of VC funds. They show that VC firms that have connections to many other venture capital firms may have access to a wider range of technology, skills, pools of capital and investment opportunities, and are thus expected to add more value to their portfolio companies. But they do not show whether the added value will be reflected in the portfolio companies' post-IPO performance. My study fills in this gap. Secondly, my paper contributes to the literature of the monitoring role of VC firms on private companies. Private studies have shown that VC firms oversee the boards, leading to better corporate governance. My paper illustrates that such monitoring effect will be stronger if the VC firm is in a more central position in the network. Thirdly, my paper is the first one to study the attention-drawing effect of VC firms' network. Bajo, Chemmanur, Simonyan, and Tehranian (2016) illustrate underwriter network's role in drawing attention of financial market players during the IPO process. My results show that VC firm' network also have such effects. One work similar to mine is the paper by Krishnan, Ivanov,

Masulis, and Singh (2011). When they study how the VC firms' reputation affect portfolio companies' post-IPO performance, they control for the VC firms' social network, and show that better connected VC firms are associated with higher post-IPO returns of assets (ROA).[4]

[4] Krishnan, Ivanov, Masulis, and Singh (2011) only use the centrality measure as a control variable, not the variable of interest in their paper, and all of my results are new to theirs.

3. Hypothesis development

As mentioned above, I explore three ways in which VC firms' network affects the IPO characteristics of their portfolio companies. First, adding more values to their portfolio companies, the better-connected VC firms can make their portfolio companies perform better after IPO. Secondly, the better-connected VC firms have stronger bargaining power, leading to more stringent disciplining on their portfolio companies. Thirdly, the better-connected VC firms have more channels to disseminate the information of its portfolio companies to the public market.

3.1. VC firms network and post-IPO ROA and R&D spending

Hsu (2004) assumes that better VC firms will provide more value-adding service to their portfolio companies. Hochberg, Lyungqvist, and Lu (2007) show that better-connected VC firms will add value to their portfolio companies. Specifically, if a VC firm is in a more central position in its network, then it will have more access to all kinds of expertise and technologies that will be beneficial to its portfolio companies' innovation and future performance.[5] For example, VC firms in a more central position will be connected to investors that will later become customers, supplier, or strategic alliance for their portfolio companies. All of these investors are likely to provide valuable services make their portfolio companies become more competitive. Then, for the portfolio companies that are invested by better-connected VC firms, they will receive more value adding service during their rearing stage, and I expect that such advantage will be reflected in their post-IPO performance. Thus, I come up with the first two hypothesis:

H1: VC firms' centrality and their portfolio companies' post-IPO return of assets (ROA) are positively associated.

[5] Bygrave (1988) finds that syndication networks promote the sharing of information, contacts, and resources among VCs. A VC firm may use resources obtained from past syndicate members on its current portfolio companies.

H2: VC firms' centrality and their portfolio companies' post-IPO R&D spending are positively associated.

3.2. VC firms network and corporate governance

Previous evidence suggests that VC firms play governance role in their portfolio companies. Kaplan and Stromberg (2003) document that VC firms negotiate control rights with entrepreneurs when they are making investment decisions. Hellmann and Puri (2002) show that the existence of VC firms is associated with CEO turnover. Lerner (1995) also shows the representation of venture capitalists on board has monitoring effects on private companies. Hochberg, Lyungqvist, and Lu (2010) show that strong networks among VC firms can improve their bargaining power over entrepreneurs. Thus, it is reasonable to expect that well-connected VC firms can have a better disciplining effect on the companies they invest, forcing the private companies to regulate their corporate governance.

One feature of poor corporate governance is the presence of earnings management. Earnings management will generate substantial costs to investors. Chan, Chan, Jegadeesh, and Lakonishok (2006) find that companies with higher levels of earnings management will have significantly less annual returns than firms with lower levels of earnings management. Teoh, Welch, and Wong (1998b) find that IPO companies will experience lower post-IPO return if they adopt more aggressive accounting policy. Motivated by getting another round of funding or reaching public market, entrepreneurs may engage in earnings management to boost their accounting income. However, such earnings are quite likely to reverse in the future. As most VC firms still need to hold shares of IPO companies for a period, they will suffer from the drop of stock price caused by the reverse of earnings. Considering these consequences, VC firms will try to inhibit entrepreneurs' behavior of earnings management. Consistent with this notion, Hochberg (2012) finds that

venture-backed companies have lower levels of earnings management. As better-connected VC firms have stronger bargain power over entrepreneurs, I expect that companies invested by more central VC firms have lower levels of earnings management in the several years prior to their IPO.

H3: VC firms' centrality and their portfolio companies' level of earnings management are positively associated.

Beneish (2001) argues management usually manipulate accrual part if they engage on earnings management. However, the mere existence of accruals does not necessarily indicate that a company is engaging on earnings management. The accruals consist of nondiscretionary part and discretionary part. The former represents the portion of accruals that is required under GAAP, while the latter is the portion of accruals that is due to earnings management. I use the modified Jones (1991) model to separate the nondiscretionary component of accruals from the discretionary component to examine the relationship between a VC firm's centrality and the amount of discretionary accruals of its portfolio companies.

3.3. VC firms network and information dissemination

A VC firm will be connected to many other VC firms through repeated participation in the same portfolio company investment round. Each VC firm in the network may also have ties to many institutional investors through repetitive previous interactions. Under this circumstance, the position of a VC firm in its network can affect its ability to draw attention from institutional investors to the companies it has been financing. In the same time, the VC firm will also use its network to disseminate information about its portfolio companies to these institutional investors. After a VC firm attracts the attention of institutional investors to the IPO company, it may use its network to obtain information from institutional investors about their demand for the IPO company's shares. A more central VC firm is able to be in a better position to obtain information

about investors' interest on its portfolio companies. All of the information will be useful for valuing the IPO companies' shares. Under such circumstances, the IPO offer price will be revised[6] for larger amounts:

H4： VC firms' centrality and the amounts that IPO offer price will be revised are positively associated.

Well-connected VC firms will be able to draw more institutional investors' attention to their portfolio companies. When they are going to take their portfolio companies public, they can easily use their network to disseminate the information of these companies to the institutional investors.[7] This will lead to higher demand of shares of the IPO companies. Considering this, the market valuation of IPO companies invested by more central VC firms will be higher. Thus, I come up with the following hypothesis:

H5: VC firms' centrality and the market valuation of IPO companies are positively associated.

I have argued that a well-connected VC firm can be able to draw a larger number of institutional investors' attention to its portfolio companies that are about to go public. This means that shares purchased by institutional investors will be greater for IPO companies invested by more central VC firms. Given that sell-side analysts engages on collecting information about public companies and sell these information to the buy-side institutional investors, I would expect that IPO

[6] Price revision is measured as the percentage difference between the offer price and the midpoint of initial range. For now, there is no formal theoretical model has been presented in the existing literature with respect to the process by which an underwriter and issuer choose this initial offer price range, and some researchers use the midpoint of the initial IPO offer price range equal to its expectation of the final IPO offer price.

[7] Each VC firm in the network are likely to have a long run partnership with some institution investors. The cost will be smaller for these institutional investors if they pay attention to VC firms that they are connected.

companies invested by better connected VC firms will have greater analysts following. Thus, I come up with the following hypothesis:

H6: VC firms' centrality and the institutional investor holdings of IPO companies are positively associated.

H7: VC firms' centrality and the IPO companies' analysts following are positively associated.

Merton (1987) assumes that a necessary condition for an investor to buy a stock is he pays attention to it. Bajo, Chemmanur, Simonyan, and Tehrania (2016) assume that the cost is low when the information about a particular IPO is brought to investors' attention by an investment bank with which it has had previously interacted with. I also make a similar assumption that an institutional investors' cost of obtaining information from private companies will be low if the institutional investor obtains such information from the VC firms with which it has interacted during the previous IPO process. This assumption implies that an institutional investor is more likely to pay attention to information about a particular private company (that is about to go public) if it receives this information from a VC firm with which it has interacted during the previous IPO process. From the above discussion, institutional investors will pay attention to well-connected venture capital backed IPOs. As these institutional investors usually have a long run relationship with VC firms, they will consistent pay attention to these IPO companies for a long period of time after IPO.[8] Thus, I expect that the stocks of IPO companies invested by more central VC firms enjoy higher market turnover and better Post-IPO performance.

[8] Bajo, Chemmanur, Simonyan, and Tehrania (2016) also assume that the cost incurred by paying attention to a company is a sunk cost, thus the private companies that attract investor attention should continue to receive attention from the same investors for a significant period of time after the IPO.

H8: VC firms' centrality and the secondary market turnover of IPO companies invested by them are positively associated.

H9: VC firms' centrality and the long-run post-IPO stock returns of companies invested by them are positively associated.

4. Social network measures

Considering the characteristics of venture-backed IPO, the change in the size of VC firms syndicates, and the change of the degree of concentration of the VC industry, I following Hochberg, Lyungqvist, and Lu (2007) and Bajo, Chemmanur, Simonyan, and Tehrania (2016) to calculate the social network measures using 5-year trailing periods. Therefore, to study the influence of a VC firm centrality on its portfolio company in a given year, I consider the investment round syndicate the VC firm has taken part in during the previous five years. I use six centrality measures, *Degree*, *Indegree*, *Outdegree*, *Betweenness*, *Eigenvector*, and *2-StepReach*, to describe different facets of VC firm network. These measures are largely used in the social network analysis research. *Degree*, *Indegree*, *Outdegree*, and *Eigenvector* calculate how many connections a VC firm has with other VC firms. *2-StepReach* measures the how many VC firms can be reached by a certain VC firm within two steps. This measure assumes that indirect ties also make sense. The final centrality measure, *Betweenness*, captures the ability of a venture capital firm to act as a bridge among other disconnected venture capital firms.

4.1. Degree

Degree calculates the total number of ties that a VC firm has in the network. The network is made up of VC firms that are tied to each other by taking part in the same investment round for at least once during the previous five-year period time. Considering the adjacency matrix V, *Degree* (D_i) for VC firm i is

$$D_i=\sum_j V_{ij}\,, \tag{1}$$

Which is the sum of the row in this matrix. Consistent with Hochberg, Lyungqvist, and Lu (2007), a syndicate is defined as the collection of VC firms that participate in a specific portfolio company investment round. Formally, V_{ij} equals to 1 if VC firm i and j show up in the same syndicate for at

least once in the past 5 years. It is often assumed that *Degree* can be influenced by the network size. It is quite possible that over the sample period, as more and more VC firms enter the industry, the size will become larger, leading to higher *Degree*. Thus, I normalize *Degree* by the maximum possible number of connections N-1:

$$ND_i=\sum_j V_{ij}/(N-1)= D_i/(N-1) \quad (2)$$

4.2. Indegree and Outdegree

A shortcoming of *Degree* is that it cannot tell whether a VC firm has a leading position in an investment round syndicate or not. A possible solution to this problem is to use two other directed social network measures: *Indegree* and *Outdegree*, which also consider the direction of ties. *Indegree* calculate the number of ties in which the VC firm is invited to co-invest in an investment round syndicate. *Outdegree* calculates the number of ties in which the VC firm, serving as lead investor,[9] chooses and invites other VC firms to join the syndicate. A VC firm with a high level of *Outdegree* initiates connections and decides which other VC firms are more suitable to join the syndicates. Therefore, a VC firm with high *Outdegree* can choose other VC firms based on the type of resources and expertise that can be used to help the private companies that it is about to invest. On the contrary, a VC firm with a high level of *Indegree* is often regarded as a desirable co-investor and has more access to valuable resources and information.

I also use the same equation to compute *Indegree* and *Outdegree*. However, there are some changes to be made. If the VC firm i is the lead VC firm that invites the VC firm j to join the investment round syndicate, I set $V_{ij}= 1$ and $V_{ji} = 0$ to calculate the *Outdegree*, and I set the

[9] Following Hochberg, Ljungqvist, and Lu (2007), I define the VC firm that invests the highest amount in the investment round as the lead investor.

opposite to measure the *Indegree*. Similar to *Degree*, Indegree and *Outdegree* are normalized by dividing the number of maximum ties N-1.

4.3. Eigenvector

One concern of the above measures is that the number of ties a VC firm has with others does not necessary capture its importance in the VC firms' network. For example, a VC firm may have a high level of *Degree* but most of its connections to other VC firms themselves are not well-connected. Under this circumstance, the influence of this VC firm in its network may be restricted. On the contrary, if a VC firm is tied to only a few VC firms, but all of which are well-connected, then this VC firm can still be considered as influential in the network. *Eigenvector* centrality can best characterize this concept. It uses each VC firm's connectedness in the network as weights for each tie. In other words, *Eigenvector* weights each ties by its own *Degree*. Therefore, a VC firm that is tied to other VC firms that have a high level of *Degree* will generate a higher *Eigenvector* score. In particular, the *Eigenvector* (E_i) for VC firm i is calculated as:

$$E_i = \mu \sum_{j=1}^{N} V\text{ij}\ \text{Ej} \quad (3)$$

Where μ is a constant represented by the largest eigenvalue of the adjacency matrix and E is the *Eigenvector* centrality score. Therefore, the *Eigenvector* is a weighted sum of all the ties in place. I normalize the *Eigenvector* by dividing the number of maximum ties N-1.

4.4. 2-StepReach

2-StepReach counts the number of unique VC firms within two ties of a given VC firm. Therefore, this centrality measure counts the number of VC firms can be arrived by a specific VC firm within 2 steps. If a VC firm just has one connection, but the other VC firm that it is connected is very famous and well-connected, then the *Degree* does not consider this situation. Although *Eigenvector* capture this situation, it still only measures the direct connections. Assuming that VC

firms not only obtain resources and expertise from direct relations, but also from indirect connections *2-StepReach* provides a better measure of VC firm centrality. For example, a VC firm only connected to one well-connected VC firm can still benefit from the resources and expertise that the other VC firm can approach.

4.5. Betweenness

The last centrality measure, *Betweenness*, captures the ability of a venture capital firm to act as a bridge among other disconnected venture capital firms. *Betweenness* of a venture capital firm in a network is calculated by counting the number of the shortest ties passing through that venture capital firm. Intuitively, if the total number of ties between any two venture capital firms are invariant, the higher the number of times in which the shortest connection go through a given venture capital firm, the higher is that venture capital firm's *Betweenness*. Formally, *Betweenness* (B_i) for a venture capital firm i is:

$$B_i = \sum_{m<n} p_{imn}/p_{mn} \quad (3)$$

Where p_{imn} is the total number of ties between venture capital firm m and n going through venture capital firm i and p_{mn} is the total number of ties between venture capital firm m and n. In other words, *Betweenness* calculates how many times a given venture capital firm serves as the shortest ties between two other venture capital firms. If a venture capital firm is separated from the network, or each of the other venture capital firm it is connected is well-connected, then its *Betweenness* is very small. Actually, a venture capital firm with high *Betweenness* is in a position to serve as an intermediate with respect to other venture capital firms. This advantaged position could enhance the venture capital firm's ability to draw attention from other institutional investors.

4.6. Real VC firm network examples

Fig.1 and Fig.2. are real VC firm network examples. Fig.1 uses part of the VC firms' network in 1981, when the amount of connections is least and thus the graph is manageable. The arrows represent the ties established between VC firms that show up in the same syndicate in the previous five-year period. Fig.1 does not differentiate lead VC firm from other VC firms, therefore, the adjacent matrix formed is symmetric and the arrows are undirected. Take the VC firm RFE Investment Partner on the right-up corner of the Fig.1 as an example. It can be easily seen that the RFE is connected to four other VC firms, then its *Degree* is 4. It can also been seen that there two pairs of VC firm are connected by RFE, thus its *Betweenness* is 2. *2-StepReach* and *Eigenvector* can also be calculated as the definition mentioned above.

Fig.2 differentiates lead VC firm from other VC firms, therefore, the adjacent matrix formed is asymmetric and the arrows are directed. Take the VC firm BRYAN&EDWARDS as an example. There are 11 arrows originating from it, meaning that it had been served as 11 other VC firms' lead investor over the past 5 years. Thus, its *Outdegree* is 11. There is only one arrow pointing to it, thus its *Indegree* is 1.

Normally, a venture capital backed IPO company is invested by several VC firms, and they put the capital into the company in different times and in different rounds. The VC firm network is dynamic. To capture these process, I construct a new network for each year t, using the data on syndications from the previous 5 years ending in t. Therefore, in each year t, I calculate each VC firm's centrality measure. I use the following concrete example to illustrate the calculation. Assume that company P went public in 2004, and it had been invested by three VC firms A, B and C. Firm A, B, and C invested in company P in year 2001, 2002, and 2003 repectively. Then I calculate firm A's yearly mean centrality measures from 2001 to 2004, firm B's yearly mean

centrality measures from 2002 to 2004, and firm C's yearly mean centrality measures from 2003 to 2004. Thus, each VC firm's yearly mean centrality is a comprehensive reflection of the position of the VC firm in the network during company P's nurture period. Because this yearly mean centrality measures are constructed by the VC firm's social network before it invested in company P, the reverse causality issue, which assumes that it is the venture capitalists' original skills that improve their portfolio companies, and such skills also enable VC firms to improve their network positions, can be largely solved. Then, I average again three firms' yearly mean measure for company P to proxy for the comprehensive centrality of company P's three VC firms. As mentioned above, the centrality measures are based on the VC firms' previous syndication. A VC firm will have a tie with another VC firm only if these two firms have co-invested in the same company-round during the past five calendar years. A VC firm will become more central in the network as the number of such ties increases. Thus, the VC firm centrality is unrelated to the characteristics of companies that it is about to invest.

There are still some concerns about endogeneity issues. Although the VC firm network measures are calculated at the time after a VC firm has invested in the given portfolio company, it could still be the case that a well-connected VC firm have been well connected even before it invests the company. Therefore, it is the ex ante connectedness that enables a VC firm to choose a private company that are quite likely to have better post-IPO performance. Admittedly, the endogeneity problems cannot be totally resolved. However, all of my sample portfolio companies have gone public in the end. In other words, all of them are very successful companies. As a VC firm's primary goal is to push their portfolio companies to go public and then cash out, I assume that these portfolio companies look no different ex ante in the eye of VC firms and that VC firms generally do not take the post-IPO performance into account when they choose which private

company to invest. Therefore, the endogeneity issues are to large degree alleviated in my sample, although not totally resolved.

5. Empirical tests and results

5.1. Data and summary statistics

I collect US venture capital backed IPOs in 1981-2011 from Thomson one. Following the IPO literature, I exclude real estate investment trusts, closed-end funds, unit IPOs, unit investment trusts, and financial firms. IPO companies invested by VC firms outside United States are also excluded. Thus, my final sample is made up of 1926 VC firm backed IPOs. Information about venture capital firms, IPO underwriters and various IPO characteristic is also taken from Thomson one. Data on institutional investors comes from Institutional Shareholder Services (ISS). Financial data and stock price data are obtained from Compustat and CRSP, respectively. Investment bank ranking data comes from Jay Ritter's website.

Table 1 reports the summary statistics of all variables. Table 1 shows that on average, a venture capital firm in my sample are connected to 5.3% of other venture capital firms in a certain year. About 4% of the shortest ties between venture capital firms went through another venture capital firm in my sample. The average ROA for IPO companies is negative, consistent with the previous literature that most IPO companies will underperform in their first few post IPO years. On average, there will be about 35 institutional investors that hold the shares of an IPO company and 4 analysts that follow an IPO companies. The underpricing of these venture capital backed IPO companies are very high, consistent with prior study that venture capital firms are willing to bear the cost of underpricing for grandstanding.

(Insert table 1)

One argument is that better-connected VC firms will also have higher reputation. Therefore, in order to defend their reputation, better-connected VC firms may be more strict and harsh on their portfolio companies, extending their portfolio companies' rearing period and allowing their

portfolio companies to go public only if they indeed perform well. Thus, it is not surprise to see that IPO companies backed by well-connected VC firms will have higher ROA than their peers. Hoch erg, Lyungqvist, and Lu (2007) show that better-connected VC firms will have higher IPO rates of their portfolio companies. Nahata (2008) also show that companies backed by better-connected VC firms are more likely to access public markets faster. Therefore, the concern that better-connected VC firms hold on their portfolio companies to go public does not make sense, as they always have higher IPO rates, and their nurturing periods are shorter. Therefore, the better post-IPO performance of companies backed by more central VC firms is just because these companies have received more value adding service during their rearing stage.

5.2. VC firm centrality, ROA and R&D spending

I study the relation between venture capital firm centrality and portfolio companies' post-IPO return of assets (ROA) and R&D spending. I run regression of *ROA*, which is the net income divided by the book value of total assets, and *R&D spending*, which is the ratio of research and development capital expenditures plus capital expenditures to total assets, as the dependent variables. These two measures are measured over 3 years after a company goes public.

The independent variables of interests are six VC firm centrality measure. I use Jay Ritter's underwriter ranking to measure a underwriter's reputation. If an IPO company have more than one underwriter, I average the ranking score. *Underwriter reputation* is always regarded as an important factor in determining IPO outcomes. I use the natural logarithm of IPO total proceeds (*OfferSize*) to control for IPO offer size. According to Bajo, Chemmanur, Simonyan, and Tehranian (2016), this variable is highly correlated with centrality measures. Therefore, I first regress *OfferSize* on the six VC firm centrality measures. Then, I take the residual from the above regression and them into the main regression in my setting. Besides, I also control for *Underpricing*,

and whether the company is a high technology (*HitechDummy*) company. Finally, I also control for year and industry fix effects to allow for the differences in IPO characteristics across companies in different industries and time periods..

Table 2 report the main results for the hypothesis H1. Consistent with Krishnan, Ivanov, Masulis, and Singh (2011), all six VC firm centrality measures have positive and statistically significant coefficient estimates, suggesting that more central VC firms are associated with better post-IPO performance of their portfolio companies. This finding is consistent with my hypothesis H1. The result indicates that for the portfolio companies that are invested by better connected venture capital firms, they will receive more value adding service during their rearing stage, and such advantage will be reflected in their post-IPO performance.

Table 3 report the regression results for the hypothesis H2. Four of the six centrality measures have positive and statistically significant coefficient estimates. The results are consistent with hypothesis H2, suggesting that well connected venture capital firms may cultivate their portfolio companies' habit of innovation, thus these companies are more willing to spend money on R&D in the future.

(Insert Table 2 and Table 3)

5.3. VC firm centrality and the earnings management

In this section, I study the effect of VC firm centrality and private companies' levels of earnings management for several years before IPO date. As better-connected VC firms have stronger bargain power over entrepreneurs, I expect that companies invested by more central VC firms have lower levels of earnings management in the several years prior to their IPO. I use the modified Jones (1991) model to separate the nondiscretionary component of accruals from the discretionary

component (*Dis-accr*) to examine the relationship between a VC firm's centrality and the amount of discretionary accruals of its portfolio companies.

The main results are presented in table 4. All of the coefficients are negative and three of them are statistically significant, indicating that the venture capital firm centrality and the levels of discretional accruals of the companies in its portfolio are negatively associated. Therefore, better-connected VC firms have stronger bargain power over entrepreneurs and thus the companies invested by more central VC firms have lower levels of earnings management in the several years prior to their IPO.

(Insert Table 4)

5.4. VC firm centrality and the absolute value of IPO offer price revision

In this section, I study the effect of VC firm centrality on IPO offer price revision, which is the absolute value of the difference of the IPO offer price and the middle price, divided by the offer price. In the same way, I control for *Underwriter reputation*, *OfferSize*, and VC firms' age. What is more, the offer price is more likely to be modified if people are unsure about IPO company's valu. I use a dummy for hi-tech companies (*Hitech*), for these companies tend to be younger and have higher growth rates, all of which indicating high degree of uncertainty. Thirdly, the degree of uncertainty about the value of IPO shares is also associated with the filing range. Therefore, I add a dummy for companies filing width[10] of 20% or more (*FilingWidth20Dummy*). Next, I also control for *Reversemidpoint* and *AbsMarket*. *Reversemidpoint* is the reciprocal of initial filing range midpoint, which is used to control for the effect of price level choice. *AbsMarket* is the absolute return on the CRSP value-weighted index between the filing date and the IPO issue date.

[10] Filing range is calculated as the difference between the high filing price and the low filing price in the initial filing range divided by the high filing price.

Prior literature shows that the offer price revision is positively associated with the stock market movement between the filing date and the IPO issue date. Finally, I also control for year and industry fix effects to allow for the differences in IPO characteristics across companies in different industries and time periods.

The results are represented in table 5. Except for *Betweenness*, the coefficients of all the other five centrality measures are positive and statistically significant, consistent with the hypothesis H4 that VC firms' centrality and the absolute value of offer price revision of IPO companies invested by them are positively associated. The results indicate that a more central VC firm is able to be in a better position to obtain information about investors' interest on his portfolio companies. All of such information will be useful for valuing the IPO companies' shares. Besides, the regression also shows that the absolute value of IPO offer price revision increases with the underwriter reputation and filing width, consistent with Bajo, Chemmanur, Simonyan, and Tehranian (2016)'s findings.

(Insert Table 5)

5.5. VC firm centrality and IPO market valuation

In this section, I study how the VC firm centrality will affect the market values of IPO companies invested by them. I use the *Tobin's Q* to proxy for the IPO market valuation. *Tobin's Q* is measured as the asset's ratio of market value to book value, where the market value of assets equals to the book value of assets minus the book value of common equity plus the number of shares outstanding times the offer price. The book value of asset and the book value of equity for IPO companies are taken from the first available post-IPO fiscal year end in Compustat. In the same vein, I control for *Underwriter reputation*, *OfferSize*, and *VC age*. I control for *Hitech* in my

regression because high tech companies are expected to have larger growth option, and therefore higher valuation. Finally, I use *Reversemidpoint* to control for the effect of price level choice.

The results are represented in table 6. Except for *Betweenness*, the coefficients of all the other five centrality measures are positive and statistically significant, consistent with the hypothesis H5 that VC firms' centrality and the market valuation of IPO companies invested by them are positively associated. The results indicate that the demand for shares will be higher for IPO companies invested by better connected VC firms.

(Insert Table 6)

5.6. VC firm centrality and financial market players

In this section, I study the effect of VC firm centrality on institution investors and analysts. I use three variable: the number of institutional investors holding IPO companies shares one year after IPO (*InstN*), the percentage of shares held by institutional investors one year after IPO (*InstP*), and the number of sell side analysts who cover the company in year of IPO (*NumAn*). I control for *Underwriter reputation* and *OfferSize*. Previous literature finds that analysts and institutional investors are more interested in IPOs underwritten by famous investment banks. Besides, IPO companies making larger offers are more likely to draw attention of analysts and institutional investors. Finally, I include *Reversemidpoint*, *Hitech*, and *Underpricing* as control variables. Bradley, Jordan, and Ritter (2003) find that analysts are interested in IPO companies that have larger amount of underpricing.

The results of institutional investors are reported in table 6 and table 7. As can be seen, the VC firm centrality measures are positive associated with the number of institutional investors and the percentage of shares held by them. The results indicate that a well-connected VC firm is able to draw a larger number of institutional investors' attention to its portfolio companies that are about

to go public. In table 8, I report the results of how the VC firm centrality affects the number of analysts covering the company at the end of the fiscal year of the IPO. The results are consistent with hypothesis H7. In particular, one percentage increase in *Degree* will increase about six analysts following the IPO firm. Besides, I also find that institutional investors are more likely to hold shares of companies underwritten by famous underwriters, and analysts are more willing to follow IPOs that are more underpriced.

(Insert Table 6, Table 7, and Table 8)

5.7. VC firm centrality and the secondary market liquidity

In this section, I explore how VC firm centrality influences the secondary market liquidity of the IPO companies it has invested. I use *Lnturnover,* which is the natural logarithm of the ratio of average monthly shares trade to total shares outstanding over the one year after the company goes public. Liu, Sherman, and Zhang (2014) find that a firm's market turnover is associated with firm age and the reputation of underwriters. I control for *Underwriter reputation*, *OfferSize*, *VC Age*, and so on.

The results are listed in Table9. As can be seen, the coefficients of all VC firm centrality measures are statistically significant. These results indicate that the institutional investors will consistent pay attention to these IPO companies for a long period of time after IPO. Thus, IPO companies invested by well-connected VC firms to have greater secondary market liquidity. This finding is consistent with Liu, Sherman, and Zhang (2014), who find that companies draw more investor attention will have greater market turnover after going public. I also find that hi-tech firms, as well as firms with larger offer size and more underpricing, will have more liquidity stocks.

5.8. VC firm centrality and the post-IPO stock return performance

In this section, I study how the VC firm centrality affects the post-IPO stock performance. I regress *1YearHPRAdj*, which is a company's one-year post-IPO monthly market adjusted return on VC firm centrality measures. The results are present in Table 11. Three out of the six VC firm centrality measures have positive and statistically significant estimates. This means that well connected VC firms will positively influence the post-IPO stock return performance of their portfolio companies. I then estimate my regression using three-year and five-year stock return performance. However, there are no results for three-year or five-year period. Thus, my findings suggest that VC firms' connectedness will only positively influence stock performance of their portfolio companies within one year after IPO. However, such positive influence will not exist any longer one year later. The results still provides certain degree of support for my hypothesis H9.

5.9. Robust test

As mentioned above, an alternative explanation for the value-adding role of venture capital firm network is that well connected VC firms are always old aged, thus it is the experience that help the portfolio companies perform better, not the network itself (e.g., Kaplan, Martel, and Stromberg (2003)). Krishnan, Ivanow, Masulis, and Singh (2011) also document that VC firms' reputation has significant positive association with long-run firm performance and corporate governance measures. To rule out the possibility that my measures of network centrality merely proxy for VC experience and reputation, I use four variables to proxy for experience and reputation: *VC Age*, *VC Experience Dummy*, *NumRound* and *CumInvest*. *VC Age* is the number of years between the IPO companies' issue date and VC firms founding dates, or January 1, 1980 if the founding date is earlier. Krishnan, Ivanov, Masulis, and Singh (2011) regard the *VC Age* as VC firms' reputable. *VC Experience Dummy* is a dummy that equals to one if a VC firm is larger than six, and zero otherwise. Lerner (1996) consider a venture capital firm to be more experience if it is aged over

six. *NumRound* is the number of rounds that a VC firm has participate in, and *CumAmount* is the cumulative amount that it has invested. Hochberg, Lyungqvist, and Lu (2007) use these two variables to proxy for venture capital firms' experience.

To save space, I only report the results of one centrality measure: *Degree.* The results are report from Table 12 to Table 16. It can be seen that all of the previous results still hold when I use different measures of VC firm experience and reputation. In particular, *NumRound* and *CumInvest* generally have no effects on the dependent variables I examine. Thus, it is the position of VC firms in the network that helps to provide more value-adding service to their portfolio companies, to improve the corporate governance of their portfolio companies, and to draw greater market attention to their portfolio companies.

(Insert Table 12 to Table16)

6. Conclusion

In this paper, I assume that the VC firm centrality will affect the IPO companies invested by them in three ways. First, VC firms that have connections to many other venture capital firms may have access to a wider range of knowledge, technology, and poor of capital, and are thus expected to add more value to their portfolio companies. Then, for the portfolio companies that are invested by better connected venture capital firms, they will receive more value adding service during their rearing stage, and such advantage will be reflected in their post-IPO performance. Secondly, well-connected VC firms can have a better disciplining effect on the companies they invest, forcing the private companies to regulate their corporate governance. Thirdly, a more central venture capital firm will be connected to a greater number of institutions, allowing it induce a larger number of institutions to pay attention to the companies in its portfolio.

Hochberg, Lyungqvist, and Lu (2007) show that better-connected VC firms will add value to their portfolio companies. Thus, IPO companies invested by more central venture capital firms are associated with higher rate of return on assets, and will spend higher R&D in the post-IPO years. Well-connected VC firms can have a better disciplining effect on the companies they invest, forcing the private companies to regulate their corporate governance. One feature of poor corporate governance is the presence of earnings management. Earnings management will generate substantial costs to investors. Companies with higher levels of earnings management will have significantly less annual returns than firms with lower levels of earnings management. Motivated by getting another round of funding or reaching public market, entrepreneurs may engage in earnings management to boost their accounting income. However, such earnings are quite likely to reverse in the future. As most VC firms still need to hold shares of IPO companies for a period, they will suffer from the drop of stock price caused by the reverse of earnings. As better-connected

VC firms have stronger bargain power over entrepreneurs, companies invested by more central VC firms have lower levels of earnings management in the several years prior to their IPO.

A more central ventral capital firm is able to be in a better position to obtain information about investors' interest on his portfolio companies. All of these information will be useful for valuing the IPO companies' shares. Under such circumstances, the IPO offer price will be revised for larger amounts. Well-connected VC firms will be able to draw more institutional investors' attention to their portfolio companies. When they are going to take their portfolio companies public, they can easily use their network to disseminate the information of these companies to the institutional investors. This will lead to higher demand of shares of the IPO companies. Consistent with this, I find that the market value of IPO companies invested by more central venture firms will be higher. Shares purchased by institutional investors will be greater for IPO companies invested by more central VC firms. Considering that sell-side analysts are committed to collecting information about IPO companies for the buy-side institutional investors, there will be greater analyst coverage for IPO companies invested by more central VC firms Merton (1987) assumes that a necessary condition for an investor to buy a stock is he pays attention to it. Bajo, Chemmanur, Simonyan, and Tehrania (2016) assume that the cost is low when the information about a particular IPO is brought to investors' attention by an investment bank with which it has had previously interacted with. I also make a similar assumption that an institutional investors' cost of obtaining information from private companies will be low if the institutional investor obtains such information from the VC firms with which it has interacted during the previous IPO process. This assumption implies that an institutional investor is more likely to pay attention to information about a particular private company (that is about to go public) if it receives this information from a VC firm with which it has interacted during the previous IPO process. From the above discussion, institutional investors

will pay attention to well-connected venture capital backed IPOs. As these institutional investors usually have a long run relationship with VC firms, they will consistent pay attention to these IPO companies for a long period of time after IPO. Thus, the stocks of IPO companies invested by more central VC firms enjoy higher market turnover and better one year post-IPO performance.

An alternative explanation for the value-adding role of VC firm network is that well connected VC firms are always old age, thus it is the experience that help the portfolio companies perform better, not the network itself. To rule out the possibility that my measure of network centrality merely proxy for VC experience and reputation, I control for a variety of measures that proxy for VC age, experience, and reputation in the robust check table and the results still remain significant.

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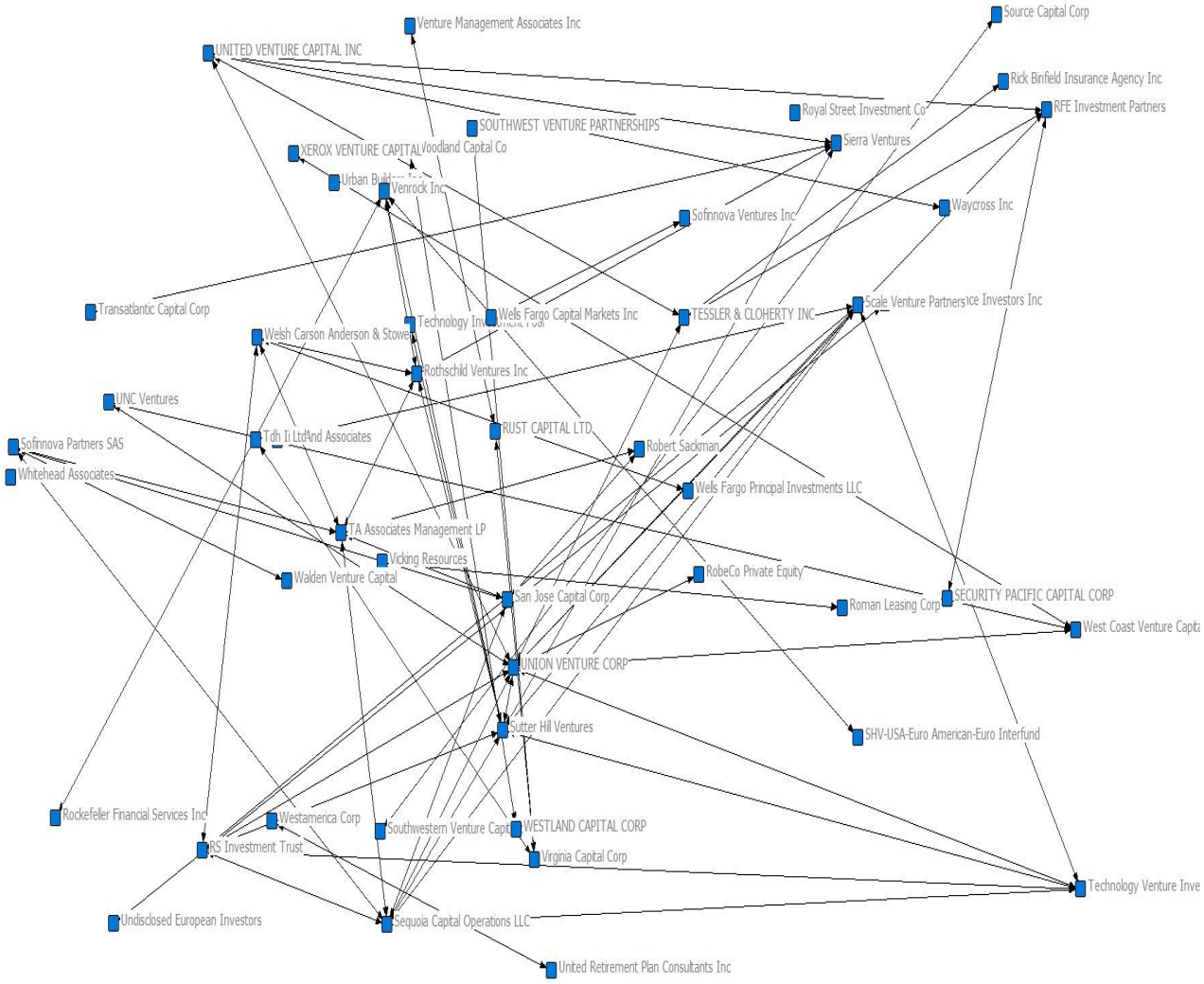

Fig. 1 Part of the VC firms' network in 1981 (undirected)

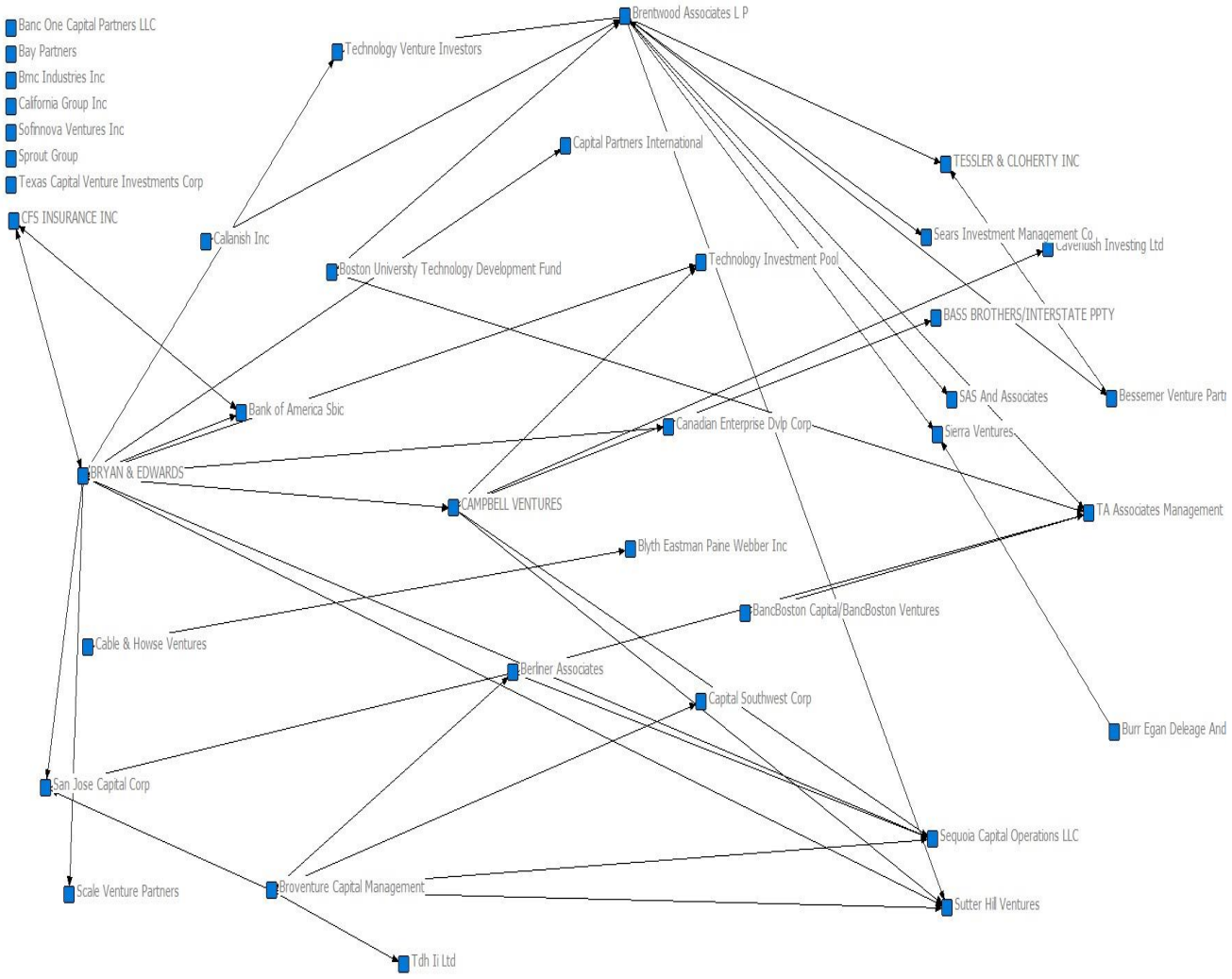

Fig. 2 Part of the VC firms' network in 1981 (directed)

Table 1 Descriptive Statistics

The sample consists of venture capital backed IPO in 1981 to 2011. VC firm centrality are defined in section 4. *ROA* is the net income divided by the book value of total asset. *R&D spending* is the ratio of research and development capital expenditures plus capital expenditures to total assets. Both variables are measured over 3 years after a company goes public. *Dis-accr* is the discretional accruals calculated by the modified Jones model. *AbsRevision* is the absolute value of the difference of the IPO offer price and the middle price, divided by the offer price. *Tobin's Q* is measured as the asset's ratio of market value to book value. *InsN* is the number of institutional investors holding IPO companies shares one year after IPO. *InsP* measures the percentage of institutional holdings in a company one year after IPO. *NumAn* counts the number of sell side analysts who cover the company in year of IPO. *Lnturnover* is the natural logarithm of the ratio of average monthly shares trade to total shares outstanding over the one year after the company goes public. *1YearHPRAj* is a company's one-year monthly market adjusted return after the company goes public. *Underwriter reputation* is defined as Jay Ritter's underwriter ranking *OfferSize* is the natural logarithm of IPO total proceeds. *Underpricing* is the ratio of the difference of the first trading day closing price and the IPO offer price to the IPO offer price. *VC Age* is natural logarithm of one plus the difference number of years between the IPO companies' issue date and venture capital firms founding dates, or January 1, 1980 if the founding date is earlier. *Hitech* is dummy that equals to 1 if the IPO company is a high tech company, and 0 otherwise. *ExperienceVC* is a dummy that equals to 1 if the age of VC is over 6 years, and 0 otherwise. *NumRound* is the total cumulated number of rounds a VC has participated. *Cuminvest* is the cumulated amount a VC has invested. *Revision* is the difference of the IPO offer price and the middle price, divided by the offer price. *AbsMarket* is the absolute return on CRSP value-weighted index between the filing date and the IPO issue date. *Reversemidpoint* is 1 divided by middle price. *FilingWidth20Dummy* is a dummy equal to one for IPOs with filing width of 20% or more.

VARIABLES	N	Minimum	Mean	Median	Maximum	Standard deviation
Centrality measures						
Degree	2595	0	0.0530	0.0390	0.330	0.0470
Indegree	2595	0	0.0210	0.0150	0.217	0.0220
Outdegree	2595	0	0.0180	0.0120	0.138	0.0190
Betweenness	2595	0	0.471	0.303	5.838	0.584
Eigenvector	2595	0	0.0430	0.0410	0.211	0.0310
2-Stepreach	2187	0	0.473	0.495	0.891	0.224
IPO characteristics						
ROA	2287	-7.703	-0.181	-0.0360	0.412	0.417
R&D	1681	0	0.222	0.184	1.673	0.177
Dis-accr	1632	0	0.732	0.196	134.9	3.767
Absrevision	2205	0	0.111	0.0830	1	0.109
Tobin's Q	1682	0.744	3.219	2.861	15.11	1.651
InstN	1774	1	35.26	25	628	36.37
InstP	1729	0	0.315	0.280	1.574	0.209
NumAn	1735	1	4.038	3	39	3.269
Lnturnover	1691	-6.963	-2.094	-2.029	0.343	0.795
1YearHPRAj	2186	-1.164	-0.0410	-0.227	9.175	0.860

Table 1 Descriptive Statistics (Continued)

VARIABLES	N	Minimum	Mean	Median	Maximum	Standard deviation
Control variables						
VC Age	2595	0	2.198	2.417	3.497	0.760
Underwriter reputation	2242	0	7.335	8.001	9.001	2.066
Underpricing	2184	-1	0.284	0.111	11.83	0.680
Revision	2471	-0.813	0.00300	0	1	0.157
OfferSize	2595	-0.799	3.492	3.561	9.681	1.116
Reversemidpoint	2471	0.0110	0.136	0.0830	40	0.900
FilingWidth20Dummy	2595	0	0.154	0	1	0.361
AbsMktret	2595	0	0.0530	0.0390	1.982	0.0670
PriorMktret	2595	-0.281	0.0190	0.0200	0.253	0.0440
Hitech	2595	0	0.741	1	1	0.438
ExperienceVC	2595	0	0.684	1	1	0.465
NumRound	2408	1	266.1	192.4	2815	274.1
Cuminvest	2371	0	505.2	202.7	17000	1045

Table 2 VC firms' centrality and ROA

The sample consists of venture capital backed IPO in 1981 to 2011. VC firm centrality are defined in section 4. *ROA* is the net income divided by the book value of total asset. It is measured over 3 years after a company goes public. *Underwriter reputation* is defined as Jay Ritter's underwriter ranking *OfferSize* is the natural logarithm of IPO total proceeds. *Underpricing* is the ratio of the difference of the first trading day closing price and the IPO offer price to the IPO offer price. *VC Age* is natural logarithm of one plus the difference number of years between the IPO companies' issue date and venture capital firms founding dates, or January 1, 1980 if the founding date is earlier. *Hitech* is dummy that equals to 1 if the IPO company is a high tech company, and 0 otherwise. *Revision* is the difference of the IPO offer price and the middle price, divided by the offer price.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	*ROA*	*ROA*	*ROA*	*ROA*	*ROA*	*ROA*
Degree	11.113***					
	(5.241)					
Indegree		33.583***				
		(5.241)				
Outdegree			29.948***			
			(5.325)			
Betweenness				1.075***		
				(5.364)		
Eigenvector					14.028***	
					(5.271)	
2-StepReach						3.410***
						(5.035)
VC Age	-0.008	-0.007	-0.011	-0.014	-0.012	0.003
	(-0.400)	(-0.393)	(-0.591)	(-0.769)	(-0.612)	(0.115)
Underwriter Reputation	0.045***	0.045***	0.044***	0.044***	0.044***	0.046***
	(6.287)	(6.325)	(6.236)	(6.198)	(6.211)	(5.904)
OfferSize	-11.416***	-34.303***	-30.431***	-1.084***	-14.279***	-3.511***
	(-5.424)	(-5.382)	(-5.432)	(-5.427)	(-5.420)	(-5.200)
Underpricing	-0.014	-0.014	-0.014	-0.014	-0.014	-0.022
	(-0.857)	(-0.826)	(-0.840)	(-0.852)	(-0.829)	(-1.263)
Hitech	-0.052	-0.052	-0.052	-0.054*	-0.052	-0.012
	(-1.593)	(-1.597)	(-1.604)	(-1.657)	(-1.598)	(-0.311)
Revision	-0.226***	-0.223***	-0.227***	-0.230***	-0.227***	-0.267***
	(-3.224)	(-3.170)	(-3.234)	(-3.276)	(-3.236)	(-3.520)
Constant	-0.700*	-0.705*	-0.484	-0.581	-0.823**	-1.863***
	(-1.907)	(-1.921)	(-1.330)	(-1.594)	(-2.218)	(-3.541)
Observations	1,649	1,649	1,649	1,649	1,649	1,438
R-squared	0.233	0.233	0.233	0.232	0.233	0.236
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes

t-statistics in parentheses

*** p<0.01,**p<0.05,*p<0.1

Table 3 VC firms' centrality and R&D

The sample consists of venture capital backed IPO in 1981 to 2011. VC firm centrality are defined in section 4. *R&D spending* is the ratio of research and development capital expenditures plus capital expenditures to total assets. It is measured over 3 years after a company goes public. *Underwriter reputation* is defined as Jay Ritter's underwriter ranking *OfferSize* is the natural logarithm of IPO total proceeds. *Underpricing* is the ratio of the difference of the first trading day closing price and the IPO offer price to the IPO offer price. *VC Age* is natural logarithm of one plus the difference number of years between the IPO companies' issue date and venture capital firms founding dates, or January 1, 1980 if the founding date is earlier. *Hitech* is dummy that equals to 1 if the IPO company is a high tech company, and 0 otherwise *Revision* is the difference of the IPO offer price and the middle price, divided by the offer price.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	*R&D*	*R&D*	*R&D*	*R&D*	*R&D*	*R&D*
Degree	0.321**					
	(2.324)					
Indegree		0.796***				
		(3.159)				
Outdegree			0.353			
			(1.250)			
Betweenness				0.009		
				(0.857)		
Eigenvector					0.339*	
					(1.798)	
2-StepReach						0.090***
						(2.720)
VC Age	0.011	0.009	0.015	0.016	0.010	0.011
	(1.022)	(0.827)	(1.407)	(1.559)	(0.891)	(0.908)
Underwriter Reputation	-0.008**	-0.008**	-0.007**	-0.007**	-0.008**	-0.010***
	(-2.337)	(-2.479)	(-2.198)	(-2.162)	(-2.404)	(-2.667)
OfferSize	-0.021**	0.796***	-0.022**	-0.022**	-0.022**	-0.016
	(-2.429)	(3.159)	(-2.458)	(-2.444)	(-2.453)	(-1.584)
Underpricing	-0.005	-0.006	-0.005		-0.006	-0.006
	(-0.683)	(-0.761)	(-0.707)	(-0.688)	(-0.752)	(-0.789)
Hitech	0.043**	0.042**	0.045***	0.045***	0.042**	0.031*
	(2.571)	(2.516)	(2.646)	(2.702)	(2.505)	(1.724)
Revision	-0.039	-0.045	-0.038	-0.037	-0.041	-0.043
	(-1.206)	(-1.359)	(-1.173)	(-1.132)	(-1.245)	(-1.249)
Constant	0.032	0.043	0.026	0.021	0.035	-0.021
	(0.243)	(0.327)	(0.194)	(0.160)	(0.267)	(-0.111)
Observations	1,211	1,211	1,211	1,211	1,211	1,100
R-squared	0.242	0.245	0.241	0.241	0.243	0.224
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4 VC firms' centrality and discretional accruals

The sample consists of venture capital backed IPO in 1981 to 2011.VC firms' centrality measures are defined in section 4. *Dis-accr* is the discretional accruals calculated by the modified Jones model.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	*Dis-accr*	*Dis-accr*	*Dis-accr*	*Dis-accr*	*Dis-accr*	*Dis-accr*
Degree	-5.461**					
	(-2.459)					
Indegree		-7.497				
		(-1.640)				
Outdegree			-9.795*			
			(-1.795)			
Betweenness				-0.254		
				(-1.250)		
Eigenvector					-4.081	
					(-1.191)	
2-StepReach						-1.687***
						(-3.044)
Constant	0.321	0.317	0.324	0.317	0.318	0.348
	(0.120)	(0.118)	(0.121)	(0.118)	(0.118)	(0.119)
Observations	1,632	1,632	1,632	1,632	1,632	1,316
R-squared	0.015	0.012	0.013	0.012	0.012	0.019
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 5 VC firms' centrality and offer price revision

The sample consists of venture capital backed IPO in 1981 to 2011. *AbsRevision* is the absolute value of the difference of the IPO offer price and the middle price, divided by the offer price. *Underwriter reputation* is defined as Jay Ritter's underwriter ranking *OfferSize* is the natural logarithm of IPO total proceeds. *Underpricing* is the ratio of the difference of the first trading day closing price and the IPO offer price to the IPO offer price. *VC Age* is natural logarithm of one plus the difference number of years between the IPO companies' issue date and venture capital firms founding dates, or January 1, 1980 if the founding date is earlier. *Hitech* is dummy that equals to 1 if the IPO company is a high tech company, and 0 otherwise. *Revision* is the difference of the IPO offer price and the middle price, divided by the offer price. *AbsMarket* is the absolute return on CRSP value-weighted index between the filing date and the IPO issue date. *Reversemidpoint* is 1 divided by middle price. *FilingWidth20Dummy* is a dummy equal to one for IPOs with filing width of 20% or more.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	*Absrevisin*	*Absrevision*	*Absrevision*	*Absrevision*	*Absrevision*	*Absrevision*
Degree	0.237***					
	(3.534)					
Indegree		0.412***				
		(3.198)				
Outdegree			0.470***			
			(3.134)			
Betweenness				0.008		
				(1.542)		
Eigenvector					0.238***	
					(2.591)	
2-StepReach						0.044***
						(2.756)
VC Age	-0.001	0.001	0.001	0.004	0.001	0.002
	(-0.115)	(0.155)	(0.159)	(0.776)	(0.142)	(0.254)
Underwriter Reputation	0.013***	0.013***	0.013***	0.013***	0.013***	0.013***
	(7.039)	(7.118)	(7.187)	(7.407)	(7.069)	(6.729)
OfferSize	-0.009**	-0.008*	-0.009**	-0.009**	-0.009**	-0.008
	(-2.041)	(-1.941)	(-2.041)	(-1.994)	(-2.050)	(-1.559)
Hitech	0.001	0.001	0.000	0.002	0.000	-0.001
	(0.088)	(0.118)	(0.054)	(0.231)	(0.015)	(-0.076)
AbsMktret	-0.028	-0.028	-0.029	-0.029	-0.026	-0.013
	(-0.726)	(-0.717)	(-0.738)	(-0.728)	(-0.653)	(-0.317)
Reversemidpoint	-0.008	-0.008	-0.008	-0.008	-0.008	-0.006
	(-1.339)	(-1.308)	(-1.327)	(-1.222)	(-1.276)	(-0.976)
FilingWidth20Dummy	0.044***	0.044***	0.045***	0.044***	0.045***	0.040***
	(5.550)	(5.556)	(5.638)	(5.549)	(5.588)	(4.754)
Constant	0.085	0.083	0.086	0.073	0.082	-0.003
	(1.124)	(1.097)	(1.133)	(0.968)	(1.087)	(-0.024)
Observations	1,886	1,886	1,886	1,886	1,886	1,617
R-squared	0.124	0.123	0.123	0.120	0.123	0.129
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 6 VC firms' centrality and Tobin's Q

The sample consists of venture capital backed IPO in 1981 to 2011. VC firm centrality are defined in section 4. *Tobin's Q* is measured as the asset's ratio of market value to book value. *Underwriter reputation* is defined as Jay Ritter's underwriter ranking *OfferSize* is the natural logarithm of IPO total proceeds. *VC Age* is natural logarithm of one plus the difference number of years between the IPO companies' issue date and venture capital firms founding dates, or January 1, 1980 if the founding date is earlier. *Hitech* is dummy that equals to 1 if the IPO company is a high tech company, and 0 otherwise. *Reversemidpoint* is 1 divided by middle price.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	*Tobin's Q*	*Tobin's Q*	*Tobin's Q*	*Tobin's Q*	*Tobin's Q*	*Tobin's Q*
Degree	2.261*					
	(1.940)					
Indegree		5.939***				
		(2.634)				
Outdegree			5.432**			
			(2.182)			
Betweenness				0.078		
				(0.849)		
Eigenvector					3.814**	
					(2.355)	
2-StepReach						0.498*
						(1.780)
VC Age	-0.119	-0.135	-0.117	-0.079	-0.130	-0.079
	(-1.207)	(-1.398)	(-1.208)	(-0.832)	(-1.318)	(-0.692)
Underwriter Reputation	-0.150***	-0.153***	-0.149***	-0.145***	-0.152***	-0.141***
	(-5.043)	(-5.151)	(-5.035)	(-4.896)	(-5.100)	(-4.416)
OfferSize	0.234***	0.238***	0.230***	0.236***	0.229***	0.180**
	(3.145)	(3.200)	(3.095)	(3.166)	(3.072)	(2.139)
Hitech	0.195	0.187	0.190	0.208	0.187	0.116
	(1.342)	(1.288)	(1.307)	(1.433)	(1.287)	(0.729)
Reversemidpoint	-0.002	-0.005	-0.004	0.004	-0.001	0.002
	(-0.017)	(-0.051)	(-0.040)	(0.050)	(-0.015)	(0.017)
Constant	3.786***	3.874***	3.816***	3.657***	3.787***	4.006**
	(3.204)	(3.284)	(3.231)	(3.098)	(3.209)	(2.258)
Observations	1,380	1,380	1,380	1,380	1,380	1,225
R-squared	0.205	0.207	0.205	0.204	0.206	0.218
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 7 VC firms' centrality and InstN

The sample consists of venture capital backed IPO in 1981 to 2011. VC firm centrality are defined in section 4. *InsN* is the number of institutional investors holding IPO companies shares one year after IPO. *Underwriter reputation* is defined as Jay Ritter's underwriter ranking *OfferSize* is the natural logarithm of IPO total proceeds. *Underpricing* is the ratio of the difference of the first trading day closing price and the IPO offer price to the IPO offer price. *VC Age* is natural logarithm of one plus the difference number of years between the IPO companies' issue date and venture capital firms founding dates, or January 1, 1980 if the founding date is earlier. *Hitech* is dummy that equals to 1 if the IPO company is a high tech company, and 0 otherwise. *Reversemidpoint* is 1 divided by middle price.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	*InstN*	*InstN*	*InstN*	*InstN*	*InstN*	*InstN*
Degree	109.449***					
	(5.138)					
Indegree		218.467***				
		(5.529)				
Outdegree			187.728***			
			(4.204)			
Betweenness				7.013***		
				(4.130)		
Eigenvector					201.938***	
					(6.742)	
2-StepReach						12.055***
						(2.698)
VC Age	1.464	1.083	2.357	2.111	0.766	2.338
	(0.849)	(0.644)	(1.403)	(1.276)	(0.446)	(1.383)
Underwriter Reputation	-0.679	-0.760	-0.558	-0.604	-0.783	0.774
	(-1.246)	(-1.401)	(-1.029)	(-1.115)	(-1.440)	(1.555)
OfferSize	27.467***	27.541***	27.437***	27.487***	27.418***	19.719***
	(20.160)	(20.269)	(20.085)	(20.164)	(20.173)	(14.988)
Underpricing	10.138***	9.963***	10.143***	10.196***	9.960***	10.606***
	(8.427)	(8.293)	(8.416)	(8.472)	(8.289)	(10.005)
Hitech	1.485	1.236	1.790	1.755	1.003	0.188
	(0.564)	(0.471)	(0.678)	(0.668)	(0.381)	(0.077)
Reversemidpoint	1.954	1.930	1.973	1.991	1.911	1.461
	(0.994)	(0.984)	(1.001)	(1.012)	(0.974)	(0.850)
Constant	7.582	11.083	8.720	8.201	9.456	111.485***
	(0.374)	(0.547)	(0.428)	(0.404)	(0.467)	(4.225)
Observations	1,293	1,293	1,293	1,293	1,293	1,174
R-squared	0.553	0.555	0.551	0.552	0.555	0.517
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 8 VC firms' centrality and InstP

The sample consists of venture capital backed IPO in 1981 to 2011. VC firm centrality are defined in section 4. *InsP* measures the percentage of institutional holdings in a company one year after IPO. *Underwriter reputation* is defined as Jay Ritter's underwriter ranking *OfferSize* is the natural logarithm of IPO total proceeds. *Underpricing* is the ratio of the difference of the first trading day closing price and the IPO offer price to the IPO offer price. *VC Age* is natural logarithm of one plus the difference number of years between the IPO companies' issue date and venture capital firms founding dates, or January 1, 1980 if the founding date is earlier. *Hitech* is dummy that equals to 1 if the IPO company is a high tech company, and 0 otherwise. *Reversemidpoint* is 1 divided by middle price.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	*InstP*	*InstP*	*InstP*	*InstP*	*InstP*	*InstP*
Degree	0.262*					
	(1.755)					
Indegree		0.309				
		(1.117)				
Outdegree			-0.108			
			(-0.348)			
Betweenness				0.023*		
				(1.951)		
Eigenvector					0.373*	
					(1.775)	
2-StepReach						0.081**
						(2.343)
VC Age	0.036***	0.038***	0.045***	0.036***	0.037***	0.025*
	(2.983)	(3.218)	(3.813)	(3.092)	(3.052)	(1.917)
Underwriter Reputation	0.014***	0.014***	0.015***	0.014***	0.014***	0.013***
	(3.592)	(3.650)	(3.878)	(3.583)	(3.602)	(3.195)
OfferSize	0.068***	0.068***	0.069***	0.068***	0.068***	(2.343)
	(7.027)	(7.047)	(7.121)	(7.028)	(7.028)	0.071***
Underpricing	0.024**	0.024**	0.025**		0.024**	0.018*
	(2.457)	(2.448)	(2.530)	(2.478)	(2.430)	(1.888)
Hitech	-0.018	-0.018	-0.014	-0.019	-0.018	-0.012
	(-1.004)	(-0.960)	(-0.758)	(-1.015)	(-0.995)	(-0.653)
Reversemidpoint	-0.006	-0.006	-0.005	-0.006	-0.006	-0.005
	(-0.433)	(-0.421)	(-0.343)	(-0.442)	(-0.428)	(-0.377)
Constant	0.021	0.026	0.017	0.028	0.019	0.007
	(0.100)	(0.127)	(0.080)	(0.135)	(0.090)	(0.034)
Observations	1,264	1,264	1,264	1,264	1,264	1,146
R-squared	0.323	0.322	0.324	0.323	0.322	0.319
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 9 VC firms' centrality and NumAn

The sample consists of venture capital backed IPO in 1981 to 2011. VC firm centrality are defined in section 4. *NumAn* counts the number of sell side analysts who cover the company in year of IPO. *Underwriter reputation* is defined as Jay Ritter's underwriter ranking *OfferSize* is the natural logarithm of IPO total proceeds. *Underpricing* is the ratio of the difference of the first trading day closing price and the IPO offer price to the IPO offer price. *VC Age* is natural logarithm of one plus the difference number of years between the IPO companies' issue date and venture capital firms founding dates, or January 1, 1980 if the founding date is earlier. *Hitech* is dummy that equals to 1 if the IPO company is a high tech company, and 0 otherwise. *Reversemidpoint* is 1 divided by middle price.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	NumAn	NumAn	NumAn	NumAn	NumAn	NumAn
Degree	6.635***					
	(3.069)					
Indegree		15.756***				
		(3.957)				
Outdegree			14.430***			
			(3.201)			
Betweenness				0.388**		
				(2.288)		
Eigenvector					14.770***	
					(4.863)	
2-StepReach						0.565
						(1.119)
VC Age	-0.007	-0.067	0.017	0.050	-0.106	0.143
	(-0.037)	(-0.388)	(0.101)	(0.295)	(-0.598)	(0.749)
Underwriter Reputation	0.069	0.057	0.071	0.075	0.054	0.127**
	(1.177)	(0.990)	(1.221)	(1.292)	(0.927)	(2.183)
OfferSize	1.727***	1.731***	1.719***	1.728***	1.723***	1.345***
	(11.752)	(11.812)	(11.689)	(11.753)	(11.758)	(8.552)
Underpricing	0.299**	0.278*	0.299**	0.306**	0.272*	0.348**
	(2.044)	(1.899)	(2.041)	(2.091)	(1.856)	(2.451)
Hitech	0.382	0.351	0.382	0.406	0.329	0.298
	(1.404)	(1.295)	(1.404)	(1.498)	(1.210)	(1.082)
Reversemidpoint	1.994	1.854	2.000	2.032	1.935	1.262
	(1.564)	(1.456)	(1.569)	(1.594)	(1.522)	(1.020)
Constant	0.512	0.742	0.683	0.583	0.673	0.015
	(0.211)	(0.307)	(0.282)	(0.240)	(0.278)	(0.005)
Observations	1,261	1,261	1,261	1,261	1,261	1,145
R-squared	0.344	0.347	0.344	0.343	0.348	0.281
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 10 VC firms' centrality and turnover

The sample consists of venture capital backed IPO in 1981 to 2011. VC firm centrality are defined in section 4. *Lnturnover* is the natural logarithm of the ratio of average monthly shares trade to total shares outstanding over the one year after the company goes public. *Underwriter reputation* is defined as Jay Ritter's underwriter ranking *OfferSize* is the natural logarithm of IPO total proceeds. *Underpricing* is the ratio of the difference of the first trading day closing price and the IPO offer price to the IPO offer price. *VC Age* is natural logarithm of one plus the difference number of years between the IPO companies' issue date and venture capital firms founding dates, or January 1, 1980 if the founding date is earlier. *Hitech* is dummy that equals to 1 if the IPO company is a high tech company, and 0 otherwise. *Reversemidpoint* is 1 divided by middle price.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	*Lnturnover*	*Lnturnover*	*Lnturnover*	*Lnturnover*	*Lnturnover*	*Lnturnover*
Degree	1.033**					
	(2.077)					
Indegree		1.871**				
		(2.009)				
Outdegree			1.841*			
			(1.769)			
Betweenness				0.079**		
				(1.982)		
Eigenvector					1.372*	
					(1.941)	
2-StepReach						0.198*
						(1.674)
VC Age	0.038	0.035	0.044	0.040	0.044	0.018
	(0.936)	(0.893)	(1.104)	(1.034)	(1.085)	(0.406)
Underwriter Reputation	0.019	0.019	0.020	0.020	0.020	0.016
	(1.540)	(1.500)	(1.612)	(1.567)	(1.597)	(1.179)
OfferSize	0.271***	0.272***	0.271***	0.271***	0.271***	0.274***
	(8.561)	(8.585)	(8.544)	(8.562)	(8.554)	(7.832)
Underpricing	0.090***	0.089***	0.090***	0.090***	0.090***	0.088***
	(3.258)	(3.209)	(3.247)	(3.263)	(3.243)	(3.176)
Hitech	0.107*	0.106*	0.109*	0.108*	0.110*	0.142**
	(1.725)	(1.706)	(1.753)	(1.742)	(1.757)	(2.145)
Reversemidpoint	-0.040	-0.041	-0.040	-0.041	-0.039	-0.043
	(-1.043)	(-1.062)	(-1.030)	(-1.053)	(-1.019)	(-1.123)
Constant	-3.356***	-3.328***	-3.332***	-3.338***	-3.364***	-3.082***
	(-7.629)	(-7.563)	(-7.563)	(-7.587)	(-7.637)	(-4.514)
Observations	1,219	1,219	1,219	1,219	1,219	1,108
R-squared	0.463	0.463	0.462	0.463	0.462	0.468
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 11 VC firms' centrality and 1YearHPRAj

The sample consists of venture capital backed IPO in 1981 to 2011. VC firm centrality are defined in section 4. *1YearHPRAj* is a company's one-year monthly market adjusted return after the company goes public. *Underwriter reputation* is defined as Jay Ritter's underwriter ranking *OfferSize* is the natural logarithm of IPO total proceeds. *Underpricing* is the ratio of the difference of the first trading day closing price and the IPO offer price to the IPO offer price. *VC Age* is natural logarithm of one plus the difference number of years between the IPO companies' issue date and venture capital firms founding dates, or January 1, 1980 if the founding date is earlier. *Hitech* is dummy that equals to 1 if the IPO company is a high tech company, and 0 otherwise. *Reversemidpoint* is 1 divided by middle price.

VARIABLES	(1) *1YearHPRAj*	(2) *1YearHPRAj*	(3) *1YearHPRAj*	(4) *1YearHPRAj*	(5) *1YearHPRAj*	(6) *1YearHPRAj*
Degree	2.319**					
	(2.357)					
Indegree		3.979				
		(1.607)				
Outdegree			5.483*			
			(1.841)			
Betweenness				0.128		
				(0.975)		
Eigenvector					-0.791	
					(-0.351)	
2-StepReach						0.524***
						(2.633)
VC Age	-0.021	-0.034	-0.027	-0.028	-0.049	0.014
	(-0.543)	(-0.913)	(-0.725)	(-0.762)	(-1.330)	(0.292)
Underwriter Reputation	0.039***	0.039***	0.039***	0.039***	0.041***	0.042***
	(3.119)	(3.138)	(3.098)	(3.093)	(3.188)	(3.024)
OfferSize	-1.876	-2.651	-4.705	-0.111	1.894	-0.596**
	(-1.593)	(-0.959)	(-1.420)	(-0.804)	(0.794)	(-2.382)
Underpricing	-0.029	-0.036	-0.034	-0.037	-0.038	-0.022
	(-0.881)	(-1.071)	(-1.012)	(-1.110)	(-1.130)	(-0.614)
Reversemidpoint	-0.037	-0.036	-0.035	-0.036	-0.038	-0.036
	(-0.618)	(-0.602)	(-0.587)	(-0.594)	(-0.628)	(-0.580)
Constant	-0.403***	-0.334**	-0.360***	-0.315**	-0.185	-0.624***
	(-2.898)	(-2.468)	(-2.720)	(-2.415)	(-1.283)	(-3.404)
Observations	1,591	1,591	1,591	1,591	1,591	1,401
R-squared	0.012	0.011	0.011	0.009	0.009	0.013

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 12 Robust tests: ROA and R&D

The sample consists of venture capital backed IPO in 1981 to 2011. VC firm centrality are defined in section 4. *ROA* is the net income divided by the book value of total asset. *R&D spending* is the ratio of research and development capital expenditures plus capital expenditures to total assets. Both variables are measured over 3 years after a company goes public. *ExperienceVC* is a dummy that equals to 1 if the age of VC is over 6 years, and 0 otherwise. *NumRound* is the total cumulated number of rounds a VC has participated. *Cuminvest* is the cumulated amount a VC has invested. *Revision* is the difference of the IPO offer price and the middle price, divided by the offer price. Other variables are defined in the same way.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	*ROA*	*ROA*	*ROA*	*R&D*	*R&D*	*R&D*
Degree	11.090***	11.564***	11.193***	0.321**	0.475***	0.404***
	(5.231)	(5.019)	(4.835)	(2.370)	(2.789)	(3.022)
ExperienceVC	0.033			0.018		
	(1.115)			(1.204)		
NumRound		0.000			-0.000	
		(0.816)			(-1.206)	
Cuminvest			0.000			-0.000
			(0.945)			(-1.640)
Underwriter Reputation	0.044***	0.048***	0.049***	-0.008**	-0.009**	-0.008**
	(6.220)	(6.410)	(6.429)	(-2.324)	(-2.518)	(-2.278)
OfferSize	-11.523***	-11.968***	-11.506***	-0.021**	-0.019**	-0.017*
	(-5.478)	(-5.281)	(-5.017)	(-2.392)	(-2.168)	(-1.932)
Underpricing	-0.014	-0.016	-0.018	-0.005	-0.005	-0.004
	(-0.841)	(-0.921)	(-1.048)	(-0.697)	(-0.668)	(-0.593)
Revision	-0.223***	-0.245***	-0.230***	-0.039	-0.039	-0.050
	(-3.187)	(-3.337)	(-3.156)	(-1.202)	(-1.178)	(-1.521)
Hitech	-0.053	-0.053	-0.050	0.042**	0.043**	0.039**
	(-1.625)	(-1.490)	(-1.410)	(2.520)	(2.459)	(2.265)
Constant	-0.735**	-0.748**	-0.731**	0.049	-0.008	0.082
	(-2.020)	(-2.229)	(-2.198)	(0.382)	(-0.062)	(0.645)
Observations	1,649	1,546	1,522	1,211	1,183	1,172
R-squared	0.234	0.236	0.241	0.243	0.244	0.252
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes

t-statistics in parentheses

**** p<0.01, ** p<0.05, * p<0.1*

Table 13 Robust tests: offer price revision

The sample consists of venture capital backed IPO in 1981 to 2011. VC firm centrality are defined in section 4. *AbsRevision* is the absolute value of the difference of the IPO offer price and the middle price, divided by the offer price. *ExperienceVC* is a dummy that equals to 1 if the age of VC is over 6 years, and 0 otherwise. *NumRound* is the total cumulated number of rounds a VC has participated. *Cuminvest* is the cumulated amount a VC has invested. *Revision* is the difference of the IPO offer price and the middle price, divided by the offer price. Other variables are defined in the same way.

VARIABLES	(1) *AbsRevision*	(2) *AbsRevision*	(3) *AbsRevision*
Degree	0.231***	0.266***	0.225***
	(3.531)	(3.263)	(3.283)
ExperienceVC	0.001		
	(0.164)		
NumRound		-0.000	
		(-0.744)	
Cuminvest			-0.000
			(-0.348)
Underwriter Reputation	0.013***	0.012***	0.012***
	(7.041)	(6.575)	(6.328)
OfferSize	-0.009**	-0.008*	-0.008
	(-2.029)	(-1.777)	(-1.630)
Hitech	0.001	0.003	0.002
	(0.083)	(0.312)	(0.256)
AbsMktret	-0.028	-0.022	-0.021
	(-0.726)	(-0.562)	(-0.528)
Reversemidpoint	-0.008	-0.007	-0.008
	(-1.338)	(-1.160)	(-1.169)
FilingWidth20Dummy	0.044***	0.043***	0.042***
	(5.550)	(5.260)	(5.088)
Constant	0.083	-0.079	-0.080
	(1.108)	(-0.898)	(-0.907)
Observations	1,886	1,762	1,735
R-squared	0.124	0.123	0.121
Year dummy	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 14 Robust tests: InstN and InstP

The sample consists of venture capital backed IPO in 1981 to 2011. VC firm centrality are defined in section 4. *InsN* is the number of institutional investors holding IPO companies shares one year after IPO. *InsP* measures the percentage of institutional holdings in a company one year after IPO. *ExperienceVC* is a dummy that equals to 1 if the age of VC is over 6 years, and 0 otherwise. *NumRound* is the total cumulated number of rounds a VC has participated. *Cuminvest* is the cumulated amount a VC has invested. *Revision* is the difference of the IPO offer price and the middle price, divided by the offer price. Other variables are defined in the same way.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	*InstN*	*InstN*	*InstN*	*InstP*	*InstP*	*InstP*
Degree	109.072***	88.937***	119.447***	0.285*	0.441**	0.456***
	(5.261)	(3.251)	(5.592)	(1.959)	(2.290)	(3.064)
ExperienceVC	2.688			0.053***		
	(1.120)			(3.173)		
NumRound		0.007			-0.000	
		(1.489)			(-0.466)	
Cuminvest			-0.001			-0.000
			(-0.597)			(-1.504)
Underwriter Reputation	-0.672	-0.617	-0.639	0.014***	0.014***	0.015***
	(-1.234)	(-1.110)	(-1.134)	(3.618)	(3.526)	(3.680)
OfferSize	27.503***	27.898***	28.495***	0.068***	0.068***	0.070***
	(20.185)	(20.023)	(20.090)	(7.095)	(6.858)	(6.946)
Underpricing	10.142***	9.993***	9.964***	0.025**	0.024**	0.024**
	(8.433)	(8.230)	(8.154)	(2.517)	(2.445)	(2.408)
Hitech	1.361	1.357	1.164	-0.021	-0.019	-0.022
	(0.517)	(0.502)	(0.424)	(-1.131)	(-1.025)	(-1.174)
Reversemidpoint	2.000	1.989	2.101	-0.005	-0.006	-0.005
	(1.017)	(1.004)	(1.055)	(-0.378)	(-0.433)	(-0.390)
Constant	10.018	51.943**	10.182	0.076	0.121	0.065
	(0.497)	(2.426)	(0.499)	(0.368)	(0.732)	(0.314)
Observations	1,293	1,259	1,246	1,264	1,231	1,218
R-squared	0.553	0.555	0.555	0.323	0.313	0.317
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 15 Robust tests: NumAn

The sample consists of venture capital backed IPO in 1981 to 2011. VC firm centrality are defined in section 4. *NumAn* counts the number of sell side analysts who cover the company in year of IPO. *ExperienceVC* is a dummy that equals to 1 if the age of VC is over 6 years, and 0 otherwise. *NumRound* is the total cumulated number of rounds a VC has participated. *Cuminvest* is the cumulated amount a VC has invested. *Revision* is the difference of the IPO offer price and the middle price, divided by the offer price. Other variables are defined in the same way.

	(1)	(2)	(3)
VARIABLES	NumAn	NumAn	NumAn
Degree	5.261**	5.556**	7.288***
	(2.493)	(1.975)	(3.345)
ExperienceVC	0.500**		
	(2.047)		
NumRound		0.000	
		(0.408)	
Cuminvest			-0.000
			(-0.815)
Underwriter Reputation	0.067	0.068	0.075
	(1.153)	(1.144)	(1.241)
OfferSize	1.735***	1.754***	1.800***
	(11.826)	(11.663)	(11.770)
Underpricing	0.305**	0.280*	0.265*
	(2.087)	(1.888)	(1.777)
Hitech	0.349	0.393	0.324
	(1.284)	(1.403)	(1.144)
Reversemidpoint	2.051	1.975	2.106
	(1.613)	(1.530)	(1.628)
Constant	0.525	0.159	3.639
	(0.218)	(0.060)	(1.507)
Observations	1,261	1,229	1,216
R-squared	0.346	0.343	0.347
Year dummy	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 16 Robust tests: Turnover and 1YearHPRAj

The sample consists of venture capital backed IPO in 1981 to 2011. VC firm centrality are defined in section 4. . *Lnturnover* is the natural logarithm of the ratio of average monthly shares trade to total shares outstanding over the one year after the company goes public. *1YearHPRAj* is a company's one-year monthly market adjusted return after the company goes public. *ExperienceVC* is a dummy that equals to 1 if the age of VC is over 6 years, and 0 otherwise. *NumRound* is the total cumulated number of rounds a VC has participated. *Cuminvest* is the cumulated amount a VC has invested. *Revision* is the difference of the IPO offer price and the middle price, divided by the offer price. Other variables are defined in the same way.

VARIABLES	(1) *Lnturnover*	(2) *Lnturnover*	(3) *Lnturnover*	(1) *1YearHPRAj*	(2) *1YearHPRAj*	(3) *1YearHPRAj*
Degree	0.940*	1.490**	1.516***	2.476***	2.257**	1.797*
	(1.935)	(2.369)	(3.077)	(2.588)	(2.229)	(1.724)
ExperienceVC	0.103*			0.007		
	(1.812)			(0.129)		
NumRound		-0.000			-0.000	
		(-0.696)			(-0.619)	
Cuminvest			-0.000**			-0.000
			(-2.466)			(-1.026)
Underwriter Reputation	0.020	0.018	0.017	0.037***	0.041***	0.043***
	(1.547)	(1.410)	(1.309)	(3.032)	(3.053)	(3.122)
OfferSize	0.273***	0.267***	0.281***	-2.156*	-1.619	-1.197
	(8.630)	(8.308)	(8.647)	(-1.922)	(-1.250)	(-0.968)
Underpricing	0.089***	0.092***	0.090***	-0.030	-0.034	-0.036
	(3.205)	(3.321)	(3.225)	(-0.887)	(-0.984)	(-1.031)
Reversemidpoint	-0.039	-0.042	-0.040	-0.036	-0.036	-0.035
	(-1.007)	(-1.092)	(-1.038)	(-0.593)	(-0.591)	(-0.575)
Constant	-3.288***	-4.267***	-4.260***	-0.453***	-0.446***	-0.443***
	(-7.522)	(-8.979)	(-8.976)	(-3.877)	(-3.613)	(-3.575)
Observations	1,219	1,191	1,179	1,591	1,491	1,467
R-squared	0.464	0.448	0.454	0.012	0.012	0.012
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1