A Social Network Analysis of Corporate Venture Capital Syndication

By

Ju Kimberly Zheng

A thesis

presented to the University of Waterloo

in fulfilment of the

thesis requirement for the degree of

Master of Applied Science

in

Management Sciences

Waterloo, Ontario, Canada, 2004

Author's declaration for electronic submission of a thesis

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

A Social Network Analysis of Corporate Venture Capital Syndication

By Ju Kimberly Zheng

The importance of social capital can be characterized by a well-known quote: “it's not just what you know, but whom you know". Firms with rich social capital are more informed, more capable, and more competitive, because networks of resources are within their reach. Social capital is embedded in social networks, and social network analysis is the chief topic of this research. The network being examined contains 1126 venture capital (VC) programs, 206 of them being corporate venture programs, and the rest consisting of independent venture capital firms. Venture programs co-invest in portfolio firms following an identifiable pattern. This research attempts to explain this co-investment pattern using social network analysis. Four attributes of social networks are explored during this analysis: prominence, range, brokerage, and cohesion. The findings of the corporate venture capital network provide a number of implications for the theory of social capital.

The objective of the thesis is *using social capital to examine the syndication patterns in a corporate VC network.* The analysis of the corporate VC co-investment pattern supports four hypotheses. First, the corporate VC network is not cohesive. Second, most relationships in the network are indirect. Third, most prominent VCs are also the most powerful resource brokers in the network. Lastly, prominent VCs are likely to syndicate with other prominent VCs.

Acknowledgements

First and foremost, I would like to express my sincerest gratitude to my supervisor, Dr. Rod McNaughton for guiding me through this fantastic research with his valuable insights, recommendations, and encouragements. Without him, I could not have completed this thesis in such a short timeframe. Next, I would like to thank my readers, Dr. Scott Jeffrey and Dr. Cliff Blake for taking their time to read my thesis and provide constructive comments for improvements. Thanks to Dr. Brian Cozzarin for supplying the Corporate Venturing Directory necessary for this research.

In addition, I would like to thank Smitha Varghese for her emotional support throughout the time of this thesis development. Also, I would like to thank Mike Bobinski for being a fun friend always.

Furthermore, I would like to thank Dr. Frank Safayeni and Lynne Wight for their academic guidance during the time of my graduate studies. They have made Management Sciences department an enjoyable place to be.

Last, but not least, I would like to thank Gavin Tholl who proofread my thesis carefully under a very tight schedule, and for his understanding and encouragements throughout my thesis development.

Dedication

This thesis is dedicated to my loving parents, Shao Guang Zheng and Shao Ming Liu, who continue to give me unconditional love and support for the best and worst times of my life. It is also dedicated to my best friend, Gavin Tholl, who has been the true inspiration for who I am and who I want to become.

Table of Contents

List of Tables

List of Figures

1. Introduction

1.1 Background of Research

The venture capital industry has grown radically in the past few decades, even during the slow-down of the high-technology industry in the late 1990's. In the United States, venture capital investments grew from $3.3 billion in 1990 to $40 billion in 2001; and in Europe, such investments grew from $6.4 billion in 1998 to more than $10 billion in 1999 (Casamatta and Haritchabalet, 2003). One striking feature of venture capital activities is the large amount of co-operation involved in an investment process. Many researchers (e.g. Bygrave 1987, 1988; Lerner 1994, Lockett and Wright, 2001) have examined these cooperative activities. Brander, Amit and Antweiler (2002) found that in Canada, venture capital co-investments yield higher returns on investment (average of 35% - 39%) compared to standalone investments (average of 15% - 20%) between the years 1991 and 1997.

The formation of social networks characterizes the pattern of venture capital co-investments, with the ultimate goal of creating social capital within the networks. Social capital, like any other capital, is a valuable asset to venture capitalist firms (VCs) [1]. Social capital is productive, making possible the achievement of certain goals that in its absence would not be possible (Coleman, 1988). Light and Karageorgis (1994) argue that social capital is a compensation mechanism to human capital. They propose that highly developed social networks can compensate deficient intellectual capital. If their claim is true, the VC co-investment activities are the act of seeking social capital. VCs collaborate

[1] For simplicity, venture capital firms will be referred to as VCs.

to benefit from each other's experience, expertise, and information when seeking promising target firms to invest. Without co-investing with others, a VC may never achieve its desired investment objectives. Furthermore, social capital is trust-based. A VC offers favours to another VC and expects favours returned in the future, because favour reciprocation is an implicit obligation in a social network (Coleman, 1988; Putnam, 1995).

The objective of the thesis is *using social capital to examine the syndication patterns in a corporate VC network.* The analysis of the corporate VC co-investment pattern supports four hypotheses. First, the corporate VC network is not cohesive. Second, most relationships in the network are indirect. Third, most prominent VCs are also the most powerful resource brokers in the network. Lastly, prominent VCs are likely to syndicate with other prominent VCs.

1.2 Definition of Syndication

Syndication is a synonym for co-investment. Syndication is not exclusive to VCs. It occurs with other types of investments such as pension funds, insurance funds, and investment funds of banks. An economist, Robert Wilson (1968, p.119), gives the following general definition of syndication: "…a group of individual decision-makers who must make a common decision under uncertainty, and who, as a result, will receive jointly a payoff to be shared among them." The key term is uncertainty, and the literature recognizes it as the most important rationale of syndication (e.g. Bygrave 1987, 1988). Ten years after Wilson's paper, Pfeffer and Salancik (1978) agreed that syndication is an act to reduce uncertainty. They expressed that when situations are uncertain and

problematic, organizations attempt to establish relationships to access resources and exert control in the environment. There are recent definitions of syndication specific to venture capital. Jo (2000) defined syndication of venture capital investments as co-operation among VCs in funding a potentially promising firm. Brander, Amit, and Antweiler (2002) further defined venture capital syndication as *either* two or more VCs sharing a particular round of financing, *or* different VCs investing in a given project at different times.

1.3 Corporate Venture Capitalists

This research places emphasis on the co-investment activities of corporate venture capitalists (corporate VCs). Corporate venturing involves creating venture funds by a parent corporation to invest in new venture opportunities. In contrast to traditional venture capital, corporate venturing is a strategic process of commercializing new products or services that may potentially benefit the parent firm.

There are three justifications for why corporate VCs are chosen as the unit of analysis for this thesis. First, corporate VCs are present for decades. The history traces as far back as the mid-1960s, about two decades after the first formal venture capital funds (Gompers and Lerner, the Directory, p.27). During the late 1960s and the early 1970s, over 25 percent of the Fortune 500 companies attempted corporate venture programs (Gompers and Lerner, the Directory, p.27). While corporate VCs form a small portion of the market for venture capital investing, the trend began to pick up significantly in the late 1990's (Kambil and Dickman, the Directory, p.9). Secondly, corporate VCs are important contributors of the venture capital industry. Corporate VC investments have been increasing in both the dollar amount and the number of new startups (called

portfolio firms) financed, totaling almost $16 billion in 2000 invested in more than 1,900 portfolio firms (Ernst & Young, 2001). Lastly, despite their long-lasting presence and economical significance in the venture capital industry, corporate VCs have not received much attention in the VC literature. Most empirical studies are primarily on traditional VCs (Gompers and Lerner, 2001). This research aims to contribute a wider field of knowledge on corporate VCs to existing literature, specifically in the area of VC syndication.

1.3.1 Differences between Corporate VCs and Traditional VCs

Corporate VCs differ from traditional VCs in a number of ways. The first difference is their organizational structure. A corporate VC is normally an individual unit of a parent corporation with some degree of autonomy or a functional unit serving as part of the parent corporation's research and development group. Unlike the traditional VCs that are usually limited partners, corporate VCs are an important influence on the performance of portfolio firms. The second difference is the lifespan of an investment. Corporate venture programs have considerably shorter duration compared to traditional VC investments (Gompers and Lerner, 2002). A typical corporate venture program terminates in four years while a traditional VC investment lasts up to fifteen years (Gompers and Lerner, 2001, 2002). The last difference, which is also the most important difference, is the investment motive. Corporate VCs invest in portfolio firms for strategic reasons as opposed to financial reasons. The corporate VCs, especially ones from research and development groups of the parent corporation, strive to exploit industry knowledge to develop products or services that can potentially provide competitive advantage for the

parent corporation. The portfolio firm may be a prospective supplier of the corporate VC parent, or a cash-hungry startup that has the potential to penetrate new markets for the parent. In contrast, the primary investment motive of traditional VCs is financial return.

1.3.2 Different Corporate VC Structures

Corporate VCs employ a variety of structures in the management of their corporate venturing activities. Paul, Zivian and Fieweger (2002, p.16-17) from Baker & McKenzie[2], describe four structures of corporate VCs.

1. Investments in Externally Managed Funds

An equivalent expression of this type of fund structure is "fund of funds", that is a venture capital fund investing in other venture capital funds or other securities. This type of structure is suitable for a corporate VC if its sole motive of investment is financial return. Fund of funds does not support strategic collaboration between the portfolio firm and the corporate VC.

It is important to note that this research does not consider this type of corporate VC structure. When referring to corporate VC investments, this thesis exclusively implies the following three corporate VC structures.

2. Separate Corporate Venture Funds

The corporate VC is setup as a separate unit of the parent corporation with an independently defined budget. Internal fund managers usually carry interests in the fund to produce financial returns. Because the corporate VC receives some degree of

[2] M. Paul, B. Zivian and M. Fieweger are the contributing authors to the article, "Structuring a Result Oriented Coporate Venturing Program" in the 2002 Corporate Venturing Directory and Yearbook. More details of the four structures the authors illustrated can be found in the Directory on pages 16 and 17.

autonomy from the parent corporation, there are less internal pressures to invest in startups where the prospects for a financial return are secondary to other corporate interests. Therefore, the financial and strategic goals of investment coexist.

3. In-house Venture Groups

The in-house venture groups are very closely involved with internal corporate units such as research and development, marketing, executive offices, or a combination of many units. Corporate VCs with this type of structure primarily pursue the parent corporation's strategic goals other than or in addition to financial return.

4. Incubators

In contrast to the in-house venture groups, the incubators are the friends of startups. They provide portfolio firms a collection of services, particularly industry expertise, that help a portfolio firm commercialize their products successfully. Through frequent interactions with entrepreneurs, incubators learn entrepreneurial lessons that in turn benefit the parent corporation.

1.4 Overview of Research Method

Social network analysis is a study of the relations of actors in a network, and is employed to find the patterns of corporate VC syndication. It strives to derive social structure empirically based on observed relationships between members or actors of a network. A relation is a social tie between actors. The three dimensions of social relations are direction, strength, and content (Wasserman and Faust, 1994). Direction indicates which actor sends or receives the relation; strength defines frequency of interaction between two actors; and content defines a specific substantive connection among actors. The four

attributes of the VC network are prominence, range, brokerage, and cohesion. Prominence measures "who is in charge"; range measures "how far" an actor can reach other actors; brokerage measures the extent of bridging connections; and cohesion describes the cohesiveness of the whole network. The three social relations and four network attributes of the corporate VC network are examined and discussed throughout the body of the thesis, and finally some important findings of the network are reported.

The data used to examine the patterns are coded from the 2002 Corporate Venturing Directory and Yearbook published by Asset Alternatives and VentureOne. The syndication information from the Directory is coded using Microsoft Excel 2002. UCINET 6.0 is the software used to compute various measurements of the VC social network. UCINET 6.0 is chosen because of its user friendliness, data processing capabilities, and its ability to work with Excel data files.

1.5 Outline of the Thesis

This thesis consists of five chapters. Chapter 1 prepares the building blocks for the thesis. It presents the readers with some background information necessary for this research. Chapter 2 reviews literature on social capital, social network analysis and venture capital syndication. It interweaves the seemingly two independent areas of research, social capital and venture capital, and brings them to a common ground for discussion. Chapter 3 explains the research method and process of data coding. Chapter 4 reports key findings from analyses of corporate VC network data utilizing UCINET 6.0. Finally, Chapter 5 presents the implications of key findings and draws four conclusions about the corporate VC network. It also discusses limitations and future research opportunities.

1.6 Delimitations

Delimitations determine the scope of research. First, this research attempts to find patterns of VC syndication on a macro level, and does not make any conclusions on VC attributes on a micro level. The individual VC attributes include industry, geography, and funding stages preferences. Second, syndication data from only one year does not allow analysis on the evolution of the network. Instead, only a snapshot of the network is available. In fact, the network is constantly changing, and the snapshot does not provide any information on how the same network behaves at present time. Lastly, this research chooses social capital as the explanation of network patterns. Plausible explanations from other competitive theories, such as the transactions cost theory, are not shown.

2. Literature Review

2.1 Introduction

This literature review explores two separate yet related literatures, social capital and venture capital syndication, and establishes a link between the two areas of research. The chapter provides an overview of social capital from two different approaches. It shows how social networks may serve as a proxy to social capital, and how venture capital networks are equivalent to social networks. Several rationales of venture capital co-investments as well as timing patterns of co-investments are discussed. Next, the chapter describes transactions cost economics, an alternative theory that could explain the patterns of venture capital co-investments. Finally, it ends with some expectations of findings derived from the literature review.

2.2 Social Capital

The concept of social capital has gained popularity in the study of organizations in the 1990's, and is seen as a productive outcome of social networks (Gabbay & Leenders, 2001). Coleman (1990), Burt (1992) and Putnam (1993) have done influential work on social capital. Despite its popularity, the definition of social capital is not consistently defined (Burt, 2000, Gabbay & Leenders, 2001). Coleman (1990, p.302) defines social capital as "some aspect of a social structure, facilitating certain actions in individuals who are within the structure…" Bourdieu (1997, p.49) states that "social capital is the sum of the resources, actual or virtual, that accrue to an individual or a group by virtue of possessing a durable network of more or less institutionalized relationships of mutual

acquaintance and recognition." Putnam (1995, p.67) defines social capital as "the features of social organization, such as networks, norms and social trust that facilitate coordination and cooperation for mutual benefit". Gabbay & Leenders (1999, p.3) extends social capital to the corporate level and defines *corporate* social capital as "the set of resources, tangible or virtual, that accrue to a corporate player through the player's social relationships, facilitating the attainment of goals." Gabbay & Leenders (2001) argue that social capital created by the relationships of individuals should apply to the organizational level because individuals play out and mediate relationships in their organizations in the first place. They also express that most important business deals rely on interpersonal trust, and "this does not mean that these transactions should be categorized as a function of the network at the individual level (p.9)."

Gabbay & Leender (2001) also propose two views on the creation of social capital, one is natural creation, and the other is purposeful creation. The natural creation is a result of normal social interactions, where members leave and enter a network of relationships over time. The more commonly adopted understanding is that members of a network create social capital for their own benefit (Coleman, 1990; Burt, 1992; Gabbay & Leenders, 1999). Within the second point of view, social capital is a creation of strategic behaviour of members, rather than a by-product of normal social interaction.

All the definitions include three common elements: relationships, members that together form the relationships, and networks as a result of members and relationships. Members can be individuals or organizations. In addition, despite the different understanding of social capital creation, both views by Gabbay and Leender (2001) stress the importance of social capital because it creates value to the members involved.

Whenever the social capital is lost the income from it also disappears, and may never return unless new social capital is slowly accumulated (Jacobs, 1961). Therefore, the formation and retention of social capital is significant, and social networks are an important source of social capital.

2.2.1 Instrumental Approach to Social Capital

Not only is social capital vaguely defined, but also there are two conflicting understandings of the concept that Johanson (2001) calls the instrumental view and the expressive view. The instrumental view focuses on the benefits of *structural hole*, a theory first developed by Ronald Burt. He defines a structural hole as "a relationship of non-redundancy between two contacts" (Burt, 1992, p.18). In Burt's view, sparse networks are beneficial because each contact serves as a bridge to non-redundant sources of information and they help network members gain control in a competitive environment. Burt (1992) found that non-redundant networks lead to faster career promotion. A similar study by Higgins (2001) reveals that more non-redundant contacts lead to higher ability to switch careers. A structural hole is a path to control and information benefits, and is equivalent to the liaison positions in organizational analysis (Johanson, 2001). Liaison positions may be introduced to enable direct communication between formally separate units and functions (Mintzberg, 1979, p.162). In a broader scale, liaison positions can be used to provide integration to formally differentiated organizations (Lawrence & Lorsch, 1967). In Burt's (1992)'s language, structural hole acts as the only bridging connection between two otherwise disconnected networks. Because of its advantageous position,

structural holes offer attractive opportunities for exploitation in a competitive environment (Johanson, 2001).

2.2.2 Expressive Approach to Social Capital

In contrast to the instrumental view, the expressive view promotes cohesive networks because they enable the construction of trust and an obligation to cooperate among the members in the network (Coleman, 1988; Putnam, 1995). The greater the number of reciprocal associations between members in a network, the more social capital the network can offer (Coleman, 1990a). Coleman (1988) used the analogy of credit slips to describe the flow of financial capital based on trust. A quote from Coleman illustrates his idea, "if A does something for B and trusts B to reciprocate in the future, this establishes an expectation in A and an obligation on the part of B. This obligation can be conceived as a credit slip held by A (Coleman, 1988, p.S102)." Therefore, a cohesive social network facilitates economic transactions by circulating Coleman's credit slips (Johanson, 2001).

Trust is an important part of social capital (Nooteboom, 2001, p.196). Trust reduces transactions cost (Nooteboom, 2001; Johanson, 2001) because legal contracts and monitoring costs can be prevented. Moreover, trust cannot be purchased, installed, or forced upon anyone, and without trust relationships cannot arise (Nooteboom, 2001). Trust emerges because obligations are enforceable through the power of the community to impose implicit rules on its members should they fail to comply with the established norms (Portes, 1998). Consequently, there is no need to be cautious about other partners'

agendas, because any unethical behaviour will result in rejection from the social network (Ferrary, 2002).

2.2.3 The Balance of Social Capital

Johanson (2001) stresses the need to balance social capital between the two approaches. While each approach, instrumental or expressive, has its own scope of analysis, they are not mutually exclusive. Johanson (2001) explains that the instrumental approach takes a restricted position by analyzing ego networks, that is, networks consisting of a focal individual and his/her direct contacts and contacts among of his/her contacts. On the other hand, the expressive approach does not limit its analysis to such restricted networks, but rather looks at networks as a whole. Therefore, the boundaries of ego networks may easily cross those of whole networks, making ego networks a special case in the analysis of expressive benefits.

There are shortcomings associated with each approach, thus achieving a fine balance between the two extreme ends is the ideal approach to understanding social capital (Johanson, 2001). After studying the garment (1997) and banking (1999) industries, Uzzi suggests that when organizations perform tasks to succeed in market competition, influential bonds may provide the most social capital. In contrast, strong community bonds may hurt a firm financially, limiting its options and its access to information about the market. Gargiulo and Bernassi (1999) found that cohesive social networks severely limit the flow of information into a firm, preventing managers from grasping their organization's fit with the competitive environment. Conversely, if every member in an organization tried to maximize his/her structural holes, the organization may be in danger

of falling apart (Gabbay & Zuckerman, 1998). All the before mentioned shortcomings of each approach are generalized as *social liability* by Gabbay and Leenders (1999, 2001).

The most distinguishing difference between the two approaches is found in the "beneficiary of social interaction" (Johanson, 2001, p.235). While the individual members of a network enjoy the power of control and information benefits (Burt, 1992), the trust and obligation to cooperate stemming out of the expressive approach benefit every participant in the network and thus the social capital becomes a public good (Coleman, 1990).

Table 2.1 provides a comparison between the two approaches. The table was assembled by Jan-Erik Johanson (2001, p.234) in her work of comparing the characteristics of structural hole theory and social capital theory.

Table 2.1 Some characteristics of structural hole theory and social capital theory

	Structural Hole Theory (Instrumental Approach)	**Social Capital Theory** (Expressive Approach)
Network	Sparse	Cohesive
Benefits	Instrumental	Expressive
Social Environment	Competitive	Cooperative
Scope of Analysis	Ego networks	Ego/total networks
Beneficiary	Actor	Group

Source: Johanson (2001, p. 234)

2.3 Social Networks as Social Capital

In their definitions of social capital, many researchers (e.g. Coleman, 1990, Burt, 1992, Gabbay & Leenders, 2001) used "social capital" and "social network" interchangeably. White (2002) explicitly claims that social network is a proxy to social capital. The networks are constructed through "linkages and practices between individuals and

organizations, within and between communities (p.260).” He explains that social capital is embedded in an intelligent social structure, where members (or actors) use it to achieve their goals through the networks they belong to for social support. Flap (1991) brings a similar notion. He argues that social capital is related to social networks in terms of size, strength and resources enjoyed by those members in the network. Lin (1986) asserts that relationships are sources of material, informational and emotional aid. Lin’s claim implies that those sources of aid are equivalent to social capital generated by an individual’s relationships. Social capital is difficult to measure because of its intangibility and its ambiguous definition. Nevertheless, principles for measuring it have existed for over fifty years (Scott, 1992), and social network is merely another mechanism to conceptualize and measure social capital (White, 2002).

Social capital theory is chosen for this research instead of an alternative theory, the transactions cost theory for many reasons. The rest of this section discusses the transactions cost theory and offers some justifications for why it is not adopted.

Oliver Williamson (1975, 1985, 1993, 1996) has done seminal work on opportunism in transactions cost economics. In short, he argues against the notion of trust. Instead, he emphasizes opportunism, the monitoring of performance, and sanction of punishment (Nooteboom, 2001). Williamson (1993) subjects trust as unnecessary and misleading. He asks the question whether trust goes beyond calculative self-interest. If it does not, trust adds no value to one’s existing actions and is thus deemed unnecessary; but if it does, trust is blind, which is unwise and should be avoided. Therefore, according to Williamson, trust should be discarded either way. The replacement for trust is the idea of “hostages” (Williamson, 1996; Kuan, 2003). He defines “mutual reliance relation” in

which each party depends on the other parties for something valuable. In venture capital co-investments, the involved parties alternate roles as lead investor and passive partner, which are the informed and the uninformed. If one party attempts to misrepresent information, the other party takes possession of its hostage, in this case its share of investment.

There are three justifications for not adopting the transactions cost theory in this research. First, the theory disregards the reputation effect on organizations. It assumes the possibility of syndication opportunities even after an investing partner cheats. In reality, if a firm is convicted of unethical behaviour, it is unlikely that others in the firm's network will be willing to cooperate with it in the future. Secondly, this theory neglects inter-firm learning (Nooteboom, 2001). Firms collaborate not just to seek opportunism now, but also to learn the other party's core competence for long-run benefits. Finally, trust *can* go beyond calculative self-interest without being irrational (Nooteboom, 2001). Social norms are built on a rational foundation in the sense that they are based on successful performance in the past. When a community deems observed behaviour unacceptable, action will be automatically triggered (Ferrary, 2003; Nooteboom, 2001).

2.4 Venture Capital Network as a Social Network

A *social network* consists of a finite set of actors and the relations defined on them (Wasserman and Faust, 1994, p.17). In the context of venture capital syndication, the actors are the VCs, and the relations are co-investment activities amongst the VCs.

Wasserman and Faust (1994) define three dimensions of social relations as direction, strength, and content. Direction indicates which actor sends or receives the relation;

strength defines frequency of interaction between two actors; and content defines the kind of resources being exchanged, whether information or financial capital, both of which are common in venture capital syndication. The details of these three dimensions will be discussed in the next chapter.

There are five characteristics of social network analysis: prominence, cohesion, range, brokerage, and structural equivalence. The first four characteristics are more applicable to venture capital networks, and shall be discussed in further detail. *Prominence* indicates who has power in the network; c*ohesion* describes attributes of the whole network, showing the presence of strong socializing relationships among actors, and cohesion concerns direct ties (Burt, 1992, p. 19); *range* indicates the extent of an actor's network (Haythornthwaite, 1996); and *brokerage*, indicates bridging connections to other networks (Burt, 1992b; Nohria, 1992). Finally, *structural equivalence* shows "identical ties to and from all other actors in the network" (Wasserman & Faust, 1994, p.356). The first four characteristics of social network analysis and the three dimensions of social relations will be discussed in the following sections.

2.5 Corporate Venturing and Syndication Rationales

Corporate venturing is an activity whereby established companies stimulate innovations within their own company or in outside organizations. Many independent venture capital groups seek strategic partnerships with corporations as a source of competitive advantage in technical knowledge and experience (Gompers and Lerner, 2001). The reasons for corporations to invest in entrepreneurial start-ups are more strategic than financial with a justified explanation: if an investment is not likely to yield strategic benefits but only

attractive financial benefits, the parent firm is in threat of creating a potential rival (Gompers and Lerner, 2001, 2002). In a study of corporate and independent venture investment comparisons, Gompers and Lerner (2001) found that corporate programs without a close strategic fit with their investments are much less stable than those of independent funds with a close strategic fit. In this section, three rationales of syndication applied on corporate VCs are derived from Gomper and Lerner's work, of which one stems from the advantages of the client firm, while the other two stem from the objectives of the investing corporations.

2.5.1 Increased Investment Lifespan

Gompers and Lerner (2002) found that the corporate venture programs have a significantly shorter duration compared to independent venture capital investments. A typical corporate venture capital program terminates within four years of its launch, whereas independent venture capital investments last approximately ten to fifteen years (Gomper and Lerner, 2001, 2002). What is the reason behind such a significant difference? Gomper and Lerner (2002) provided two explanations. First, they argue that dissolving the investment effort is a response to technological change. New entrants often exploit technological breakthroughs more aggressively than the established parent firms, and often product leaders have rapidly lost their leading market position after many years of dominance. Corporate venture capital programs may be a response to these short-run periods of technological discontinuity. Secondly, they point out that the short-term nature of corporate venture programs is a result of defections of their most successful investors, who become frustrated at their low level of compensation. It is not difficult to understand

why client firms are reluctant to seek funding solely from a corporate venture capital program. In contrast, independent venture funds normally make long-term investments, and do not "pull the plug" in a matter of few years because they commit to the investment duration in partnership agreements, whereas corporate VCs withdraw investments whenever they see fit. From a client firm's perspective, it is most optimal to obtain long-term financial support from an independent venture capital firm while still acquiring the technical experience and expertise from a corporation leading in their field of interest. Therefore, the best choice for a client firm is seeking syndication from both parties.

2.5.2 Acquiring Investment Expertise

New venture creation is not a core competence of most corporations. Managers of corporate venture units mostly come from the parent company who are considered naïve investors compared to independent venture capitalists who do new venture investments for a living. Gompers and Lerner (2001) presented a couple of key results to support this observation. First, corporations are unable to recruit investment talents from the venture industry, who are used to the attractive "20 percent profit-sharing rule", which corporations are reluctant to compensate. Secondly, key personnel, frustrated at not receiving their share of profits, leave the corporation. Corporate venturing units are left with few choices. They can either follow the 20 percent profit-sharing rule to attract investment talents, or become passive investors only (Gompers and Lerner, 2001). If neither seems appropriate, syndication with an independent venture capital firm becomes an appealing choice.

From a corporate VC's point of view, the ideal syndication partner would be an independent VC having the investment expertise. Thus, independent VCs that have influence or power in the corporate VC's network, and who is "in demand" (Nohria, 1992) tend to be the first candidates corporate VCs approach.

2.5.3 Strengthening the Corporate Venturing Brand Name

It is tough enough for corporations to attract investment experts, but to make the problem worse, new corporate venturing programs also have a hard time attracting "sweet" deals. Many corporations launch venture programs with a mindset that their core business brand name will earn them respect and make them deals. They then discover that their venture program is not successful without conference presentations, and press releases to publicize the company activities (Gompers and Lerner, 2001). The venture capital community is close-knit; many leading firms have syndicated with one another for decades. Therefore, tapping into the network of this community, i.e. having a high degree of range in corporate VC's network is a shortcut to potentially rewarding investments. Gompers and Lerner (2001) suggest several strategies to strengthen the corporate venturing brand name, and many of them involve syndication with a knowledgeable VC. Their recommended strategies include recruiting the fund's investment professionals from the venture capital community; simultaneously invest in venture capital partnerships specializing in similar technologies; and/or joint ventures with one or more VCs who have prominent presence in their network.

2.6 General Rationales of Syndication

Syndication does not only apply to corporate VCs, but is a common practice in the venture capital industry. Why do VCs syndicate in general? The rationales cover a wide spectrum of viewpoints. Some VCs syndicate to benefit from each other's knowledge and from the higher returns of the investments (Bygrave, 1987, 1988; Lockett and Wright, 2001), while and others syndicate to prevent hazards such as asymmetric information and competition (Bygrave, 1987; Brander, Amit, and Antweiler, 2002; Casamatta and Haritchabalet, 2003).

The following seven rationales of syndication generally explain why VCs syndicate. The first five rationales come from gaining benefits, while the last two rationales come from preventing hazards.

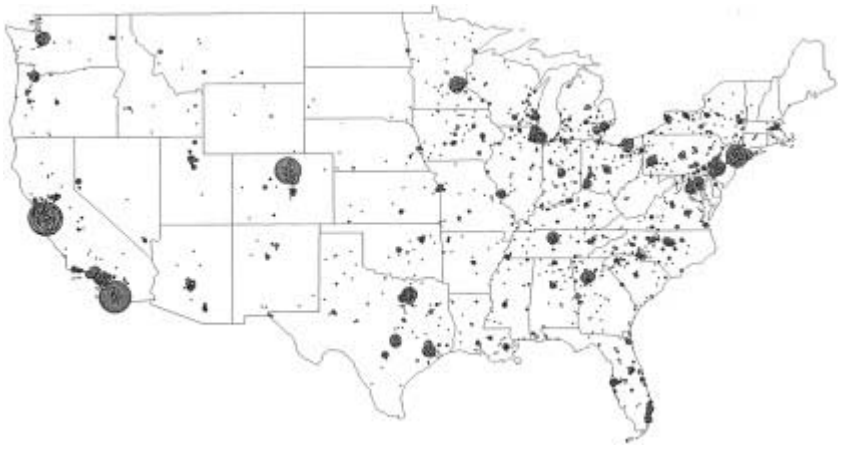
2.6.1 Exchange of Resources

Pfeffer and Salancik (1978) pioneer the resource exchange model. They claim that the reasons for organizations to cooperate are to gather information, to transmit information, to obtain commitment and support, and to legitimate the organization. They also propose that the degree of interconnectedness between two organizations is a function of uncertainty[3], concentration[4], and munificence[5] of the industry that the firms reside. Bygrave (1988) applies the resource exchange model to the venture capital industry, and obtains empirical evidence to validate his model. Bygrave (1987) claims that by

[3] Uncertainty is the degree to which the outcome of an event cannot be predicted (Bygrave, 1988).
[4] Concentration is the number of competing firms in an industry (Bygrave 1988).
[5] Munificence is the degree to which the resources that a firm needs to gather from its environment are abundant or scarce (Bygrave, 1988).

syndicating investment deals, VCs obtain support and commitment from one another, and by participating in syndications, especially with industry leaders, they increase their reputation. In his study of U.S. venture capital industry, he found that in the state of California, there is not only greater connectedness among VCs, but also greater intensity in their connections. This result is particularly true with the VCs that specialize in new high-technology venture investments. His finding confirms the prediction of the resource exchange model because California has the highest concentration of VCs in the U.S. (See Figure 2.1), and VCs specializing in high-tech investments bear more uncertainty in their investments. Such high concentration and high connectedness of VCs imply high cohesiveness in the network. Actors in the California venture capital network have similar attributes. They are in the same geographic region, and they are mostly interested in including high-technology firms in their portfolios. Information transmissions between firms consist of technical data, work advice, political opinions, and office rumors (Knoke, 2001). Resources exchanged can also be tangibles such as goods, services, and money (Haythornthwaite, 1996). Patterns of exchange show how information and goods move in an environment, as well how actors in the network are positioned to exercise control of the resource flow (Haythornthwaite, 1996).

Figure 2.1 Geographic distributions of venture capital investments
Larger circles (proportionate to the square root of the number of target companies in a zip code) indicate the presence of more portfolio firms.



Source: Sorenson, O. and Toby E. Stuart (2001): "Syndication Networks and the Spatial Distribution of Venture Capital Investments", *American Journal of Sociology*, Vol. 106, No. 6, pp. 1546-1588.

Lockett and Wright (2001) subdivides resources into financial and non-financial resources, the latter being largely market information. They assert that by sharing resources, all partners involved are able to reduce uncertainty and increase confidence in investments in both *ex*-ante and *ex*-post stages. The *ex*-ante stage involves selecting the optimal investment from a list of potential investments, with information being the most important resource, because it reduces the probability of selecting a "lemon". The *ex*-post stage involves subsequent management of investments with cash being the most important resource, because later-stage ventures demand more cash to expand operations. By pooling financial and non-financial resources, all partners benefit from comparatively greater results. Therefore, by strategically bonding together, all actors in the network benefit from less risks and better quality deals. The strength of bonds is considered strong because resource exchange is a two-way relationship, and the frequency of exchange is high, particularly in the California region where VCs exhibit high interconnectedness.

2.6.2 Diversification of Financial Risk

The risk-sharing hypothesis originates from finance. Wilson (1968), Lerner (1994), Lockett and Wright (2001) believe that VCs undertake syndication in order to diversify their portfolios and reduce overall risk. Because of the lack of information in the *ex*-ante stage, a VC does not always realize the actual risk associated with an investment until he goes forward. However, he/she cannot liquidate investment immediately after realizing his/her mistake; in other words he/she cannot divest the "lemon" right way. Syndication thus provides an attractive means of sharing risk on a deal-by-deal basis that may help to reduce overall portfolio risk (Lockett and Wright, 2001). Furthermore, the scope for both syndicating out deals as well as syndicating into deals provides more freedom and more diversity of investments. Brander, Amit, and Antweiler (2002) discover higher variability, i.e. higher risk in syndicated investments, suggesting that by syndicating VCs can achieve diversification. In addition, Lerner (1994) suggests that VCs constantly try not to under-perform their peers, hence investing in many syndicated investments, a venture fund can achieve the effect of diversification. The ability to diversify risk by syndication shows a VC's high degree of brokerage in its network, which is its ability to tap into resources in other industries or geographic locations. For example, if firm A has no experience in investing in the semiconductor industry, syndicating with firm B that has the expertise in the semiconductor industry greatly reduces A's investment risks. The ability of A to syndicate with B shows A's resource access. Furthermore, having the power to convince B to syndicate with A shows A's influence on B. A's influence translates to high degree of range in its VC network.

In spite of the benefits of diversification mentioned above, the main drawback resides in the transaction costs each time a firm syndicates. It is possible that transaction costs exceed the gains of portfolio diversification. Thus, VCs must be aware of the trade-off between risk reduction and transaction costs associated with any addition to the portfolio or reduction of deals from the portfolio (Lockett and Wright, 2001).

2.6.3 Superior Selection of Investments

Sah and Stiglitz (1986) suggested the idea of superior investment selection by syndication. They show that in hierarchical organizations, investments proceed only if a number of independent observers agree, and that decisions made by many parties are superior to ones made by a single party. The same logic applies to venture capital investments. Two or more independent VCs screen projects more effectively than one VC would because they bring in different perspectives, and each learns something from the others' evaluation (Brander, Amit, and Antweiler, 2002). Ultimately, another VC's willingness to invest in a potentially promising firm may serve as confirmation for the lead venture capitalist's decision to invest (Pence, 1982). A quote from Lerner (1994, p.17) provides further illustration: "Venture capitalists prefer syndicating most deals for a simple reason – it means that they have a chance to check out their own thinking against other knowledgeable sources." In the study of 271 pre-IPO biotechnology firms in the U.S., Lerner (1994) found that lead VCs prefer investing with other VCs with similar levels of experience, especially in early stages. This fact confirms his hypothesis, because the lead prefers to ask other experienced VC for confirmation during the most uncertain stage of investment. From a network perspective, if actors seek each other to bond because of

similar experience, then their network displays a high degree of cohesion, which means actors that have common relationships tend to syndicate on deals.

2.6.4 Reciprocation of Deal Flow

An important intangible resource for a VC is deal flow, which is the available list of potentially promising investments. It is clear that VCs want to be in a position to gain as many deals as possible so they can make their investment selections from a wide supply of deals. Deal flow becomes even more important in times when "too much money is chasing too few deals". VCs share the pool of available investments by syndicating in and out deals with one another, and hence their relationship is two-way. By syndicating out deals to another VC, the lead VC expects the other party to syndicate future deals with him. As a result, its deal flow is increased (Lockett and Wright, 2001). In the social capital literature, Coleman (1988) relates reciprocation closely to trustworthiness, and describes such favour swapping as "people are always doing things for each other." The reciprocation of deal flow strengthens the tie between two actors in the network. Clearly, the more deal flows incur between two actors, the greater the strength of their relationship.

If reciprocation of deal flow is the sole reason for venture capitalists to syndicate, then they do not add as much value to the portfolio firms as they could or should. From the standpoint of the client firms, they should avoid approaching VCs with the only intent of deal reciprocation. Such a biased objective is difficult to spot, and is often out of control of the portfolio firms.

2.6.5 Act of "Window-dressing"

Lakeonishok, Shleifer, Thaler, and Vishny (1991) claim that pension funds "window dress". Money managers adjust their portfolios at the end of the quarter by buying firms whose shares have appreciated and selling "losers" in order to impress sponsors. Lerner (1994) argues that venture capital funds behave the same way. VCs often try to prove their quality by entering successful investments on later stages to earn publicity. To be able to join these "sweet" investments, they must syndicate with other experienced or reputable VCs. For instance, a corporation with no prior investment experience chooses to syndicate with a well-known independent VC for the purpose of being known even if the corporation only plays as a limited partner in the investment. Another example would be a newly established telecommunications company trying to co-invest with AOL in a start-up firm, with the intention of using the reputation of AOL to strengthen its brand name into the telecommunications industry.

Experienced VCs tend to occupy central positions in the VC network. They are actors in the network with high degree of prominence and range, both features are important for identifying opportunities (Haythornthwaite, 1996). Hence, these experienced VCs possess power to retain "sweet" deals, and are often approached by young VCs that try to "window-dress". The relationship is one-way, as the experienced VC has no advantage, thus no intention to initiate syndication with a young VC unless the young VC has considerable financial resources (Lerner, 1994). Because the sole purpose of syndication is for the young VC to obtain the brand name or reputation of the experienced VC, the relationship between the syndicating parties is considered weak

A related notion to "window dressing" is "grandstanding" suggested by Gomper (1996). He states that young VCs have incentives to grandstand, which is taking actions to signal their ability to potential investors, either by taking the client firm public prematurely or by trying to syndicate with other well-known venture capitalists in later stages.

2.6.6 Mitigation of Asymmetric Information

Unlike the other rationales presented previously, this rationale of syndication stems from hazard prevention. The hazard in question is asymmetric information. Syndication normally involves a lead VC and one or more passive partners. The lead VC is involved in the client firm's day-to-day operations, and thus has a better understanding of the firm and holds an informational advantage over the other passive partners. The firm-specific information that the lead obtains during his monitoring activities can give him considerable bargaining power in subsequent rounds of financing (Admati and Pfleiderer, 1994). The lead also has the incentive to conceal the true value of a private sale, and deceive the passive partners, taking their rightful share (Kuan 2003). In order to mitigate the problems associated with asymmetric information, Admati and Pfleiderer (1994) propose an instrument called "fixed-fraction contract". With this contract in effect, the lead holds a constant stake of equity in the client firm, and finances that same fraction of any future investment. This implies that later-round financings must be syndicated. The VC's payoff is independent of the future security prices, and therefore it has no incentive to misrepresent the value of the client firm. The relationship between the lead and the limited partner is two-way, since the lead and the limited partner must swap positions in

later rounds. The relationship is built upon lack of trust and is considered strong because it is bound by a "fixed-fraction contract" and the VCs collaborate for a long period.

2.6.7 Prevention of Competition

VCs are competitors as well as suppliers of information and financial resources to each other (Bygrave, 1987). Banding together as opposed to competing, VCs may improve their bargaining power with entrepreneurs (Brander, Amit, and Antweiler, 2002). Banding is especially beneficial when attractive deals are scarce. Casamatta and Haritchabalet (2003) speculate that asking another VC for information is potentially dangerous for the initiator, because it is in effect revealing the very existence of an investment opportunity. There is a possibility that it is creating a rival who might later obtain exclusive financing of that hot deal. Therefore, they suggest that the two VCs should syndicate to share the rent in order to prevent harmful competition. They then conclude that syndication is a result of information gathering as well as competition prevention.

2.7 Timing of Syndication

Brander, Amit, and Antweiler (2002) used data from the Canadian venture capital industry and found that syndication normally occurred soon after the first venture capital investment. More specifically, of those new ventures that received syndicated investments from multiple VCs, approximately 70 percent received financing from a

second VC within the same calendar year. They generalized the following three major patterns of syndication:

1) First investment from a VC occurs in the early growth stage[6] or later, with syndication occurring simultaneously or shortly after (*Most Common*).
2) The lead VC makes a seed investment[7] or a startup investment[8], followed by syndication at a later stage.
3) Syndication occurs at the seed or startup stage (*Least Common*).

The most common pattern of syndication is most risk-averse, and the least common pattern is most risky, since the seed stage bears the most uncertainty, and late stages bear the least uncertainty in comparison.

Lerner (1994)'s findings from the U.S. biotechnology industry generally agree with the Canadian results. He found that established VCs syndicate with peers who have similar levels of experience for the first-round investments. The reason is that early-stage investments involve more uncertainty, so the need for quality information is greater, and only more experienced VCs can provide such quality information. They syndicate with less experienced VCs only in the later rounds because younger VCs are seldom invited to syndicate, thus they provide inexpensive capital in return. The growing venture on the other hand desperately needs cash to expand operations; therefore, it is a win-win situation to syndicate with younger VCs in later stages. Furthermore, having already decided to provide capital to a new venture, the lead VC is less concerned about confirming his judgment.

---

[6] The authors define early growth stage as the period after the initial sales but before sales becomes a major source for ongoing operations.
[7] Seed investment is an investment based on the entrepreneur's idea and expertise.
[8] Startup investment is an investment made after the firm exists but before any sales occur.

2.8 Conclusion

The contribution of VCs in the development of new technologies and businesses is undeniable. They are active gatherers and suppliers of information (Pfeffer and Salancik, 1978); they invest for the suppliers of capital and benefit the users of capital by providing equity on a confidential basis and non-financial resources, such as industry expertise (Fried and Hisrich, 1994).

More importantly, the significance of social network is evident in the patterns of venture capital syndication, where social capital is embedded in the relationships within the VC networks. Social capital encompasses trust, community and reciprocity (White, 2002), which allow members of the close-knit venture capital community get to enjoy the benefits of attractive investment deals. Why VCs syndicate have much to do with their aim to seek social support. Researchers of the social capital theory provide the fundamentals of social network analysis while researchers of the venture capital industry conduct empirical research on VC co-investment activities and conclude the importance of social networks. Both branches of research have served the building blocks of this thesis. Table 2.2 at the end of the chapter summarizes the literature review for both theories. The row elements are the ten rationales of syndication resulting from both the corporate VC syndication and VC syndication in general. The column elements are the three dimensions and four principles of social networks. The names of representative authors that have done work in each area are listed at the end of each row or column.

2.9 Expectations of Corporate VC Syndication Patterns

The literature review provides theoretical means of explaining the syndication patterns in corporate VCs. Before the empirical analysis conducted on the corporate VC syndication data, the following expected patterns are hypothesized based on the review of literature.

1. The corporate venture capital network is not cohesive.

There are three reasons for this hypothesis. First, a common view of social capital is that social capital is a creation of strategic behaviour of network members, rather than a byproduct of normal social interaction (Coleman, 1990; Burt, 1992; Gabbay & Leenders, 1999). Unless corporate VCs have some motive of obtaining certain benefits from forming relationships with other corporate VCs, network ties would not form automatically. Second, strong bonds can potentially hurt a firm financially (Uzzi, 1997, 1999), unless corporate VCs do not emphasize financial return, they would prefer weak, but useful bonds. Since weaker bonds do not exist in cohesive networks (Burt, 1992), the corporate VC network is thought to be non-cohesive. Finally, cohesive social networks severely limit the flow of information into a firm, preventing managers grasping their organization's fit with the competitive environment (Gargiulo & Bernassi, 1999), yet information exchange is a key motive of syndication (Bygrave, 1987, 1988), the corporate VC network cannot be cohesive.

2. Most relationships in the network are indirect.

This hypothesis is a corollary of the first hypothesis. The word cohesion implies direct tie. If the network is not cohesive, the number of direct ties is small. Since a tie can only be direct or indirect, most relationships are assumed indirect.

3. VCs in prominent positions are likely to hold "structural hole" positions in the network.

Recall that a structural hole is "a relationship of non-redundancy between two contacts" (Burt, 1992, p.18). Each structural hole serves as a bridge connecting otherwise disconnected networks (Burt, 1992); and like liaisons, they enable direct communication between formally separate units and functions (Mintzberg, 1979, p.162). Since structural hole is a measure for brokerage, an actor holding in a structural hole position can be thought as a broker as well.

Why do the VCs in most prominent positions also hold strongest brokerage power? The answer lies in the implications of prominence and brokerage. Prominence measures "who is in charge" (Haythornthwaite, 1996) in the whole network, and structural hole is a path to control and information benefits (Johanson, 2001, Burt, 1992) for the ego being considered. Although the two characteristics come from different viewpoints, they lead to the same conclusion, which is the level of resource control. Bygrave (1987, 1988) empirically validated the existence of resource exchange in the VC industry. Resources can be tangibles like goods, services, and money (Haythornthwaite, 1996) or intangibles like technical data, work advice, political opinions, and office rumors (Knoke, 2001). The mere access to the resources is a valuable asset to an organization. Hence, it follows that gaining control of the before mentioned resources grants competitive advantage to a VC in its network. Since only the prominent VCs have the power to control resources, prominent and brokering VCs are the same group of actors.

4. Prominent VCs are likely to co-invest with other prominent VCs.

VCs enjoy co-investing with prominent VCs because they have confidence in their partners' reputation, experience and resources. Prominent VCs co-invest among one another for three potential benefits. First benefit is strategic alignment. Most corporate VCs invest in startups are more strategic than financial. Often, their purpose of investment is exploiting technological breakthroughs in young startups (Gompers and Lerner, 2001, 2002). Making technological breakthroughs require industry experience and technical expertise, and prominent VCs hold both qualities. In order to support their strategic agenda, prominent VCs seek other VCs alike. The second benefit is extended resource accessibility. Prominent VCs have access to a wide range of financial and non-financial resources such as market information (Lockett and Wright, 2001). By sharing resources, all partners reduce uncertainty and increase confidence in an investment (Lockett and Wright, 2001). The benefit of resource sharing increases if the partnering VCs are prominent in the network because more resources are accessible for all involved parties. The last benefit is superior investment selection (Sah and Stiglitz, 1986). Lead VCs prefer investing with other VCs with similar levels of experience, especially in early stages (Lerner, 1994) because the lead prefers asking its experienced partners for confirmation during the most uncertain stage of investment. Therefore, if a lead VC is prominent in the network, it most likely co-invests with another prominent VC in the same network.

Table 2.2 Summary of Literature Review

	Prominence	Range	Brokerage	Cohesion	Direction	Strength	Content	Representative Authors
Resource Exchange	+	–	–	+	Two-way	Strong	Goods, Money, Info.	Bygrave (1987, 1988) Pfeffer & Salancik
Risk Diversification	–	+	+	–	–	–	–	Lerner (1994), Brander, Amit & Antweiler
Superior Selection	–	–	–	+	–	–	Opinion, Information	Sah & Stiglitz (1986), Lerner (1994)
Reciprocation of Deal Flow	–	–	–	–	Two-way	Strong	Deals	Lockett & Wright (2001) Coleman (1988)
"Window-dressing"	+	+	–	–	One-way	Weak	Brand name, Reputation	Lakeonishok, Shleifer, Thaler, and Vishny
Mitigate Asymmetric Info.	–	–	–	–	Two-way	Strong	–	Admati & Pfleiderer (1994), Kuan (2003)
Competition Prevention	–	–	–	–	–	–	Similar roles, i.e. structural equivalence	Casamatta and Haritchabalet (2003), Bygrave (1987)
Increased Investment Life	–	–	–	–	–	–	Client firm's interest	Gompers & Lerner (2001, 2002)
Investment Expertise Acquisition	+	–	–	–	One-way	–	Expertise, Influence	Gompers & Lerner (2001, 2002)
Brand Name Acquisition	+	+	–	–	One-way	–	Brand name, Reputation, Influence	Gompers & Lerner (2001, 2002)
Representative Authors	Haythornth-waite (1996)	Haythornth-waite (1996)	Burt (1992b), Nohria (1992)	Haythornth-waite (1996)	Coleman (1988), Bygrave (1987)	Coleman (1988)	Wasserman & Faust (1994), Lin (1986)	

Notes: a "+" sign represents that an attribute is present; a " − " sign means that an attribute is absent

3. Method

3.1 Introduction

Social networks exist in different levels of society. On a macro level there is the network of European Union; on a micro level there are professional associations and family ties. The venture capital network is also a social network, in which venture capital firms co-invest in promising projects. The patterns of co-investments are examined using social network analysis.

The method of social network analysis is employed to find the patterns of syndication. The data used to examine the patterns are coded from the 2002 Corporate Venturing Directory and Yearbook published by Asset Alternatives and VentureOne. The process of data collection and analysis are described.

This chapter consists of three sections following the introduction. Section 3.2 introduces the notion of social network analysis; section 3.3 describes how data is coded from the Directory; and section 3.4 explains various data processes used to compute the findings.

3.2 Social Network Analysis

Social network analysis is a study of relations of the actors in the network. It strives to derive social structure empirically based on observed relationships between actors, rather than labelling them as a group arbitrarily like teachers, constructors, students, investors, and so on (Haythornthwaite, 1996). As a social network analyst stated, "The world is composed of networks, not groups." (Wellman, 1988, p.37) An *actor* is an individual or an

organization in the network, a *relation* is a social tie between actors. The relations are established by the act of resource exchange. Resources shared between actors can be tangibles like supplies of goods, or intangibles like services and information.

3.2.1 Three Dimensions of Social Relations

Wasserman and Faust (1994) define three dimensions of social relations as direction, strength, and content. *Direction* indicates which actor sends or receives the relation. For instance, direction shows which VC initiates the intention to co-invest in a target firm, and which VC agrees to the syndication proposal. Direction also shows who sends information to whom. A social relation can also be undirected. An *undirected* relation provides no information on who is the sender and who is the receiver because the direction of resource flow is irrelevant.

Strength defines frequency of interaction between two actors. In venture capital syndication, strength is how often two VCs syndicate on deals. A couple of VCs syndicating in five portfolio firms are assumed to have a stronger relation than another couple that only syndicated in one portfolio firm.

Finally, *content* defines a specific substantive connection among actors, in other words, the kind of resources being exchanged, whether information or financial capital, both of which are common in venture capital syndication.

3.2.2 Measurements of the Four Attributes of Social Network

The four attributes of Social network, prominence, range, brokerage, and cohesion were defined in Chapter 2. The attributes measure different characteristics of a social network.

Recall that prominence measures "who is in charge", range measures "how far" an actor can reach other actors, brokerage measures the extent of bridging connections, and cohesion describes the cohesiveness of the whole network. Although these attributes effectively characterize a social network, they are not quantitative. Further tools are needed to quantify the four attributes, thus two metrics are utilized to quantify each attribute. Degree and closeness determine prominence. *Degree* is the number of direct connections an actor has with other actors in the network. An actor with high degree is said to be "in the thick of things". *Closeness* calculates the frequency an actor falls on the shortest path between two other actors. High closeness index is analogous to high efficiency in information transmission, because short distances mean fewer message transmissions, shorter times and lower costs (Hakimi, 1965). Therefore, the higher the degree and closeness, the more central an actor is in its network.

Reachability and geodesic distance compute range levels. *Reachability* indicates how many times a connection is established between two actors. In VC syndication, the reachability is a record of how many times two VCs co-invest in the same portfolio firm. *Geodesic distance* is the length of shortest path between two actors. The path can be direct or indirect. A *direct* path indicates a direct relation or tie, where no intermediaries are involved in establishing the relation. On the other hand, an *indirect* path indicates an indirect relation, where one or more intermediaries must be involved to make the relation possible. Small reachability and geodesic distance indices indicate cheaper cost of cooperation between actors.

Brokerage is measured by betweenness and structural hole. *Betweenness* is the extent to which an actor sits between two other actors. When an actor is located strategically on

the communication path between two others, it holds the power to influence information transmission, whether distorting the information or withholding it (Bavelas, 1948 and Shaw, 1954). A *structural hole* is a connection of non-redundant contacts (Burt, 1992). A strong relation signals the absence of structural hole. For example, a husband-wife relation is not a structural hole, but a newly established relationship between a manager of a powerful industrial association and the CEO of a manufacturing firm that seeks clients who are members of the association is a structural hole. The manager of the association essentially acts as a broker for the manufacturing firm to gain access to a vast customer base. Thus, high betweenness and structural hole indices mean higher brokerage power of an actor.

Density and clique measure the cohesiveness of the whole network. *Density* determines how extensively actors in the network interact among each other. While density is an index, clique provides qualitative information on the structure of a network on a micro level. A *clique* is defined as a fully connected sub-network. A clique containing more actors is more cohesive than one containing fewer actors. Table 3.1 summarizes the metrics that measure the four attributes.

Table 3.1 Metrics for network attributes and their descriptions

Attribute	*Metrics to measure the attribute*	*Metric Descriptions*
1. Prominence	Degree	number of direct ties to an actor
	Closeness	frequency an actor falls on the shortest path between two other actors
2. Range	Reachability	how many times a connection is established between two actors
	Geodesic distance	length of shortest path between two actors
3. Brokerage	Betweenness	the extent to which an actor sits between two other actors
	Structural hole	connection of non-redundant ties
4. Cohesion	Density	how extensively actors in the network interact among each other
	Cliques	fully-connected sub-network

3.3 Data Collection

3.3.1 The 2002 Corporate Venturing Directory & Yearbook

Data used for this research comes from the 2002 edition of Corporate Venturing Directory & Yearbook, which is part of The Venture Capital Analyst product line. The Directory is published by Asset Alternatives and VentureOne. The publishing firms gathered data from survey forms, telephone calls, e-mails, venture firm websites and news releases to produce 206 entries of corporate venture programs. The Directory lists the profiles of 206 corporate venture programs. Each profile contains the parent company name, the program name(s), office location, names of key personnel, program details such as start year, fund allocation, total number of staff, goals of program, and investment activity and criteria, which include investment size range, funding stage, industry, and geographic preferences. Table 3.2 shows a partial description of sample entries from the Directory. The sample entries have

the highest count of syndicated deals. In the context of social network, they are actors with the highest degree centrality.

Aside from the corporate venture program profiles, the Directory includes two other important pieces of information – profiles of portfolio firms and the names of independent venture capital firms that syndicated with the corporate venture program. However, these two pieces of information lack detail, and are summarized under the category of "Recent Investments" of each corporate venture program. Each record of the "Recent Investments" includes the portfolio firm name, its web address, business type, other co-investor names, and finally, the total amount of investment.

Table 3.2 Partial description of Directory data

Program Name	Year started	Amount of funds managed	# offices world wide	# staff world wide	# synd. deals	Proportion of links the firm accounts for
1. Intel Capital	1997	-	23	-	268	0.038
2. GE Equity	1995	$1,800M	13	155	221	0.031
3. Cisco Systems Inc.	1996	-	1	-	141	0.020
4. Vertex Management Inc.	1988	$900M	8	31	124	0.017
5. Comdisco Ventures	1987	$1,700M	1	-	101	0.014
6. Mitsubishi International Corp.	-	-	1	-	94	0.013
7. Sun Microsystems Inc.	1999	$400M	1	10	85	0.012
8. Johnson & Johnson Development Corp.	1973	$100M Annual	5	-	84	0.012
9. TI Ventures L.P.	1996	$100M	2	-	79	0.011
10. Siemens Venture Capital	1999	€500M	3	13	77	0.011
11. Innovacom S.A.	1988	$400M	4	14	72	0.010
12. Accenture Technology Ventures	1999	$1,000M	13	-	69	0.010
13. Dell Ventures	1999	$1200M	1	20	68	0.010
14. Qualcomm Ventures	2000	$500M	1	-	58	0.008
15. Oracle Venture Fund	1999	$500M	1	-	57	0.008
16. AOL Time Warner Investment	2001	-	1	-	51	0.007

Table 3.2 Partial description of Directory data (Continued)

Program Name	Year started	Amount of funds managed	# offices world wide	# staff world wide	# synd. deals	Proportion of total links the firm accounts for
17. Lucent Venture Partners LLC	-	-	1	-	51	0.007
18. Corning Innovation Ventures	2000	$50M	1	-	50	0.007
19. Motorola Ventures	1999	$100M	3	-	46	0.006
20. 3i Group plc	1997	$250M	1	-	42	0.006
21. VeriSign Inc.	-	-	1	-	41	0.006
22. Mitsui & Co. Venture Partners	2001	$200M	2	-	41	0.006
23. Intel Communications Fund	1999	$500M	1	-	38	0.005
24. Infineon Ventures GmbH	1998	€95M	3	14	38	0.005
25. Philips Corporate Strategy, Venturing	1998	-	3	10	38	0.005
26. Sony Strategic Venture Investment	-	-	2	-	37	0.005
27. Adobe Ventures L.P.	1994	$240M	2	-	37	0.005
28. Juniper Networks Inc.	-	-	1	-	36	0.005
29. Kodak Ventures Group	1982	$100M	3	6	35	0.005
30. Hitachi Corporate Venture Capital Fund	2000	$95M	2	-	34	0.005

Note: the symbol "-" means data unavailable.

Three reasons justify the use of The Corporate Venturing Directory and Yearbook. First of all, it focuses on the corporate venturing activities. As discussed in the previous chapter, the significance of corporate venturing is undeniable. David Barry, Vice President of venture capital at Asset Alternatives expresses that entrepreneurs and independent venture capitalists recognize the importance of ties to corporations. They learn that those corporations have the resources to make or break a company with their technology expertise, relationships, and due diligence (The Directory, 2002, p.5). This Directory provides an avenue to examine the influence of many established corporations through their corporate venture programs.

Secondly, data from this Directory offers ease of data processing and statistical analysis. There are 206 entries corporate venture programs and 920 references of independent venture capital firms in the Directory. Together, they account for 1126 data entries. The amount of data is within the computation limits of the social network analysis software, UCINET 6.0, thus data sampling and statistical inferences are not needed.

Furthermore, UCINET 6.0 takes a master matrix of size 1126 by 1126 as the input data. This master matrix contains entries of zeros and ones, and is very sparse. Of the total 1,266,750 entries (1126x1126-1126 diagonal row), only 2,789 or 0.22 percent of them are ones.

Lastly, data from this Directory is a record of 2001 venturing activities, and is the most up-to-date information on venture capital syndication. Furthermore, most prominent corporate venture programs are established after the year 1998, as can be seen from Table 3.1 above. Hence, the venture capital network being examined is relatively new, and the results found from it are therefore current as well.

Although many benefits accompany the Directory, it has three limitations. To begin with, not all corporate venture programs are listed in this Directory. Unless a corporation is willing to participate in the surveys conducted by the publishing firms, even the most influential corporate venture programs cannot enter the study population of this research. Even though there is no need for data sampling from the Directory, study error cannot be avoided. Secondly, 2001 was a dreadful year for new high technology ventures. Following the burst of high tech bubbles, the economic plunge after the September 11 attack discouraged much investment activities in the United States. Some corporations, including the distinguished AT&T and Lucent Technologies decided to stop investing in start-ups

(The Directory, p.5). A considerable number of venture programs halted in 2001. The 2001 edition has over 300 listings, containing over a hundred more listings than the 2002 edition. Therefore, the 2002 edition of the Directory may not offer the most representative picture of the corporate venture capital world. Lastly, according to data compiled by Asset Alternatives and VentureOne, the Directory is intended to be global (The Directory, p.5). However, the majority (161 out of 206, or 78 percent) of venturing programs listed in the Directory are from the United States, making the Directory data geographically biased. Table 3.3 offers the breakdown of the number of corporate venture programs by country. Unfortunately, there is no data available on the true number of corporate venturing programs in the world.

Table 3.3 Breakdown of the number of corporate venture programs by country

Country	# of Programs
United States	161
Canada	8
Germany	7
United Kingdom	6
France	4
Japan	3
Finland	2
Israel	2
Singapore	2
Sweden	2
Switzerland	2
Ireland	1
China	1
Netherlands	1
Philippines	1
South Korea	1
Taiwan	1
Brazil	1

3.3.2 Data Coding

The syndication information from the Directory is coded using Microsoft Excel 2002 in three stages. The results of the three-stage coding are three datasets recorded in separate Excel worksheets. Stage one involves converting corporate venture programs into numeric values. Since the Directory lists the programs in alphabetical order, they are converted into ID numbers in the same order. Dataset I is organized after stage one coding, as illustrated in Table 3.4.

Table 3.4 Snapshot of Dataset I

Program Name	Assigned ID #
ABB New Ventures Ltd.	1
Accenture Technology Ventures	2
Acer Technology Ventures	3
…	…
Scientific-Atlanta Inc.	206

Stage two coding involves converting the referenced names of co-investors into numeric values. The co-investors can be another corporate venture program or an independent venture capital firm, but only the independent VC firms are coded in this stage. Because the co-investor names appear under the "Recent Investments" section of each entry of corporate venture program, the same 206 entries are examined again, except in more detail. The co-investor names are coded starting with the ID #207. The result of stage two coding is organized in Dataset II, which is shown in Table 3.5.

Table 3.5 Snapshot of Dataset II

Co-investor Name	Assigned ID #
A-LIVE Holdings II Inc.	207
Abingworth Management Inc.	208
ABN AMRO Capital (USA) Inc.	209
…	…
Zurich Scudder Investments Inc.	1126

Stage three combines the results of Datasets I and II. It couples the IDs of venture programs that syndicated in common portfolio firms. The result of paired data is organized in Dataset III. It is shown in Table 3.6.

Table 3.6 Snapshot of Dataset III

Program ID#	Co-investor ID#
1	240
1	488
1	574
…	...
206	1118

Finally, the paired data in Dataset III becomes the input data for social network analysis. UCINET 6.0 is the software used to compute various measurements of the venture capital social network.

3.4 Data Processing

3.4.1 UCINET 6.0

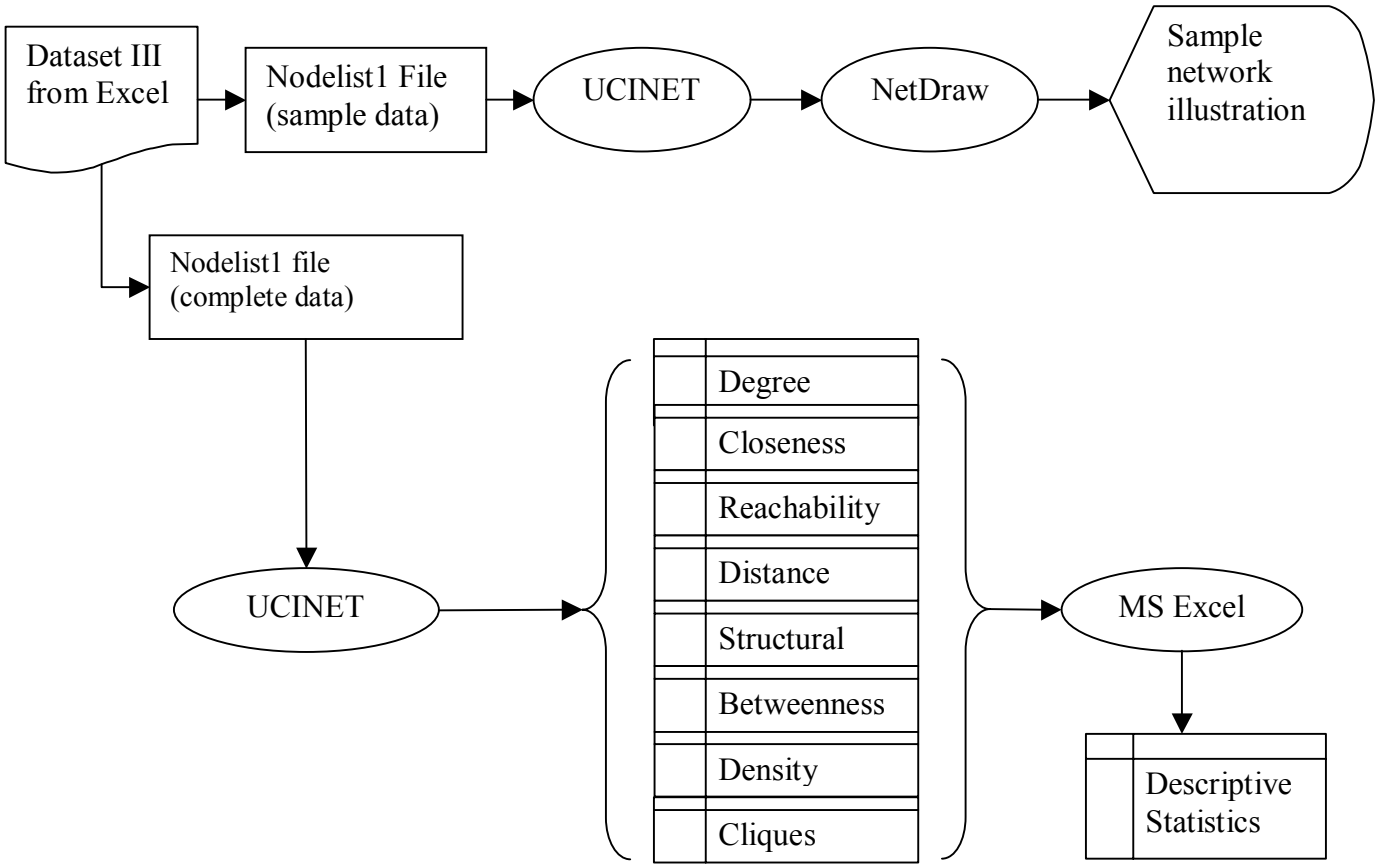
UCINET is a comprehensive program for the analysis of social networks (Borgatti, Everett, and Freeman, 2002). The program allows file import from Excel. As well, it is able to convert paired data into matrices for further analysis. The program contains numerous network analytic routines. The routines enable the measurements of all four network attributes mentioned earlier. NetDraw is a subprogram of UCINET. It provides visual representations of networks in 2D or 3D space. Once a network is graphed, NetDraw can also reorient and manipulate the graph by simply clicking and dragging the cursor with a mouse. The version 6.0 of UCINET is used. The program is menu-based, user friendly and is easy to learn. It can accommodate all 1126 entries of Directory data at a reasonable computing speed.

Other competing programs of social network analysis include STRUCTURE, Egonet, Pajek, MetSight, and dozens more. UCINET 6.0 is chosen because of its user friendliness, data processing capabilities, and its ability to work with Excel data files.

3.4.2 Data Processing Procedures

The data processing procedures are summarized in Figure 3.1 as a flowchart.

Figure 3.1 Data processing flowchart



The first step in data processing was converting the Excel file where Dataset III resided into a file called *nodelist1*, which UCINET can read. The data contained in nodelist1 file looked exactly the same as the paired data in the Excel file, except with a special header. The header can simply be added on top of the Excel data or in a separate text editor. Next, UCINET read the nodelist1 file, and then converted the paired data into a matrix. Thus, the 1126 pairs of co-investments became an 1126 by 1126 matrix. UCINET stored the matrix, and was ready for data analysis.

Degree centrality was computed on the whole dataset. The output was all entries sorted by degree. Because it was not possible to graph 1126 programs and co-investors as nodes and their thousands of connections as edges, a sample was selected for ease of visualization. The sampling criterion was the degree centrality index. A subset of entries with the most degree indices was selected. The sample data was stored in another nodelist1 file. The eight measurements of network attributes were degree, closeness, reachability, distance, betweenness, structural hole, density, and cliques. UCINET computed them one by one, first on the sample data, then on the entire dataset.

Lastly, the results of the measurements on the sample data were summarized into tables, and some figures were illustrated with NetDraw. The results on the entire dataset were sent to the Excel worksheets to be stored. Descriptive statistics were computed by Excel Data Analysis tools and were summarized in tables.

4. Findings

4.1 Introduction

Chapter 3 provided information on data coding and data processing using MS Excel and UCINET 6.0. This chapter encapsulates the results of the data processes into diagrams and tables. More detailed discussions of the findings will be given in chapter 5. This chapter begins describing some observations of a network sample, followed by the findings on the entire dataset. The sample consists of 22 venture capital programs selected from the dataset of 1126 programs. These 22 programs (or actors of the whole network) were sampled because they accounted for more than 0.5 percent of total links or degree centralities. The other rationale behind choosing them is the ease of drawing. Because of their positions in the network, these 22 nodes nicely compose a sample network diagram. Recall that *degree* is the number of connections an actor has with all the other actors in the network. Since actors with high degrees are central in their network (Freeman, 1979), these 22 actors were therefore regarded as good candidates to illustrate the findings. The word "actor" is equivalent to "node" in the network, and these two words will be used interchangeably during the discussion.

The findings are categorized into four attributes of networks: prominence, range, brokerage, and cohesion. Specific metrics are used to measure each attribute. Table 4.1 provides an overview of the attributes and metrics. Two metrics are chosen for each attribute for two reasons. The first reason comes from the act of reassurance. No one measurement can provide a complete picture of a network attribute, thus using two metrics enhances the level of understanding of the attribute in question. The second reason is the

possibility of substitution. In the event of one metric being impossible to compute due to the nature of the data, the other metric can serve the same function without too much compromise. For instance, closeness is a measure of prominence of a network, but it cannot accurately measure the prominence of the whole network because the whole network is not connected, and the closeness values would converge to zero. Therefore, degree is the other option that measures prominence.

Table 4.1 Overview of attributes and metrics

Attribute	*Metrics to measure the attribute*
1. Prominence	degree, closeness
2. Range	reachability, geodesic distance
3. Brokerage	betweenness, structural hole
4. Cohesion	density, cliques

4.2 The Network Sample

Table 4.2 presents the program IDs and the program names of the actors selected for the sample. Intel Capital, program #0095 scores the highest degree centrality in the whole network, which means Intel Capital has initiated and successfully co-invested with 268 other programs. It is important to note that this 22-node sample is in no way predicting or representing the findings of the entire dataset. It merely provides an intuitive means of explaining the concepts of the findings. It also makes the visualization of a network possible, since it is unrealistic to graph 1126 nodes and thousands of ties among them. Figure 4.1 is a visual representation of the sample network. Each directed edge (or arc) represents the intention of syndication from the actor of origin to the actor of destination. One other important fact to note is that the sample network completely ignores the

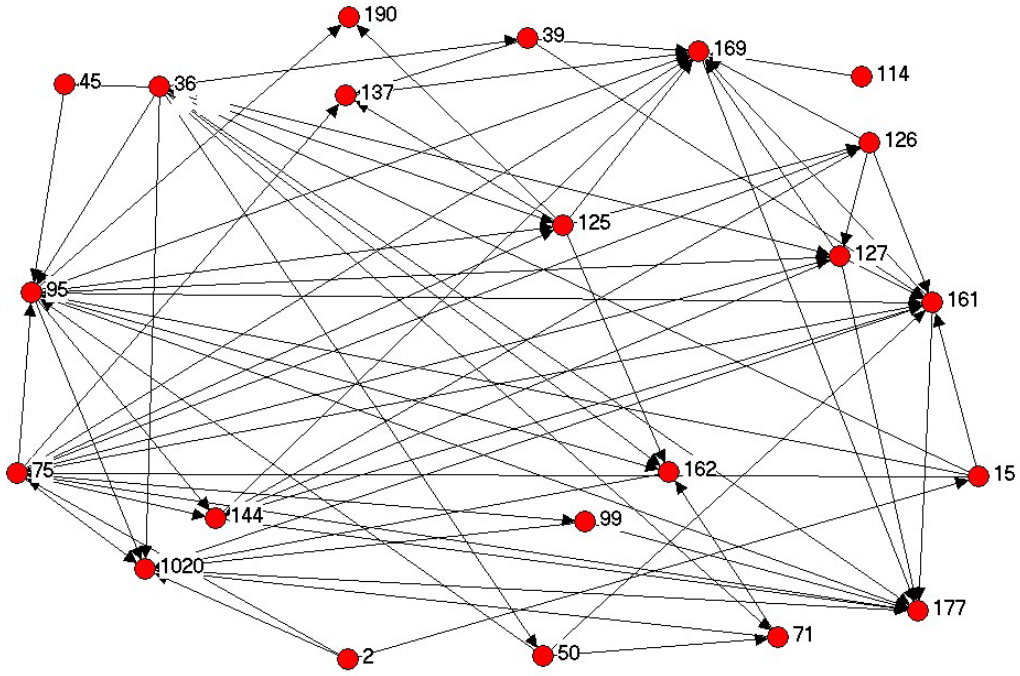
connections that the sample nodes have with other nodes outside the sample. The results of the findings are calculated and presented on the whole dataset later in the chapter.

Table 4.2 Venture programs in the sample – firms accounting for more than 0.5% of total links (exclusive)

Venture Program Name	Program ID#	Degree centrality in the whole network	Proportion of total links the firm accounts for
Intel Capital	#0095	268	0.038
GE Equity	#0075	221	0.031
Cisco Systems Inc.	#0036	141	0.020
Vertex Management Inc. (Singapore Technologies Group)	#0162	124	0.017
Comdisco Ventures	#0039	101	0.014
Mitsubishi International Corp.	#0125	94	0.013
Sun Microsystems Inc.	#0169	85	0.012
IDG Technology Venture Investment Inc. (International Data Group)	#0099	84	0.012
TI Ventures, L.P. (Texas Instruments)	#0177	79	0.011
Siemens Venture Capital	#0161	77	0.011
Innovacom S.A. (France Telecom)	#0071	72	0.010
Accenture Technology Ventures (Accenture Ltd.)	#0002	69	0.010
Dell Ventures	#0050	68	0.010
Qualcomm Ventures	#0144	58	0.008
Oracle Venture Fund	#0137	57	0.008
AOL Time Warner Investment Corp.	#0015	51	0.007
Lucent Venture Partners LLC	#0114	51	0.007
Corning Innovation Ventures	#0045	50	0.007
Motorola Ventures	#0127	46	0.006
3i Group plc	#1020	42	0.006
VeriSign Inc.	#0190	41	0.006
Mitsui & Co. Venture Partners	#0126	41	0.006

Note: the firm names in parentheses are parent corporation names

Figure 4.1 Sample network diagram



The network sample shown in Figure 4.1 is a miniature version of the whole network. It consists of nodes and links, where nodes represent the corporate or independent VCs and the links represent the number of syndications between two VCs. Before UCINET computes indices characterizing the network, some observations can be made from the picture above. The two obvious observations are prominence and cohesion. GE Equity (#0075) and Intel Capital (#0095) have the most links in the sample, whereas Lucent Venture Partners (#0114) has the lowest degree centrality. Since Lucent only has one link with Sun Microsystems (#0169), it is the least prominent actor in the sample network. A special name for the least prominent node is *isolate*. Although the isolate does not play a central role in this particular sample network, it may have numerous connections with

actors in other networks. The other observation about the sample network is its cohesiveness. Cohesion describes the level of interaction among the actors in a network. As can be seen from the sample network diagram, the degree of interconnectedness is high among actors. Thus, this sample network is highly cohesive.

4.3 Findings on the Whole Dataset

This section presents findings on the whole dataset. The section first introduces each attribute and its metrics, and then presents the numeric network indices on the sample 22 programs. Lastly, it shows the summary statistics and explains them in the context of syndication on the whole dataset.

4.3.1 Prominence

Prominence indicates who is central or who is "in charge" in the network. Table 4.3 shows the degree centrality and the closeness centrality of the sample 22 firms. The third column of Table 4.3 summarizes degree centralities of the 22 actors in the whole network. Intel Capital, the actor holding the most links is in the most prominent position. The second prominent firm is GE Equity, and the third is Cisco Systems. The fourth column of the table lists the normalized degree centrality, which is calculated as the degree divided by the maximum possible degree as a percentage. For example, of all the possible 1125 ties Intel Capital could establish, it actually established 268 ties, which is 23.8 percent of total possible ties. Nodes with high degree centralities play a more central role than the ones with low degree centralities. The fifth column of Table 4.3 gives the *share* of ties, which is

the proportion of ties an actor holds in the network. For instance, Mitsui & Co. Venture Partners holds 0.6 percent of all possible ties.

A second measure of prominence is closeness centrality. *Closeness* is calculated as the *inverse* of farness, which is the sum of shortest distance between a node and every other node in the same network. The node with the lowest sum of all distances is the central node because it does not depend on many intermediaries to relay messages (Bavelas, 1950 and Leavitt, 1951). The second half of Table 4.3 illustrates closeness information of the 22 sample firms with two specific measures: in-closeness and out-closeness. Because the edges are directed, UCINET calculates two directions separately as "in" and "out". Closeness centrality can only be calculated on connected graphs, because distance can be infinite if two nodes are not mutually reachable.

Table 4.3 Degree centrality and closeness centrality of the sample 22 firms

Program Name	ID#	Degree	NrmDegree	Share	inClose	outClose
Intel Capital	#0095	268	23.822	0.038	0.091	0.162
GE Equity	#0075	221	19.644	0.031	0.089	0.2
Cisco Systems Inc.	#0036	141	12.533	0.02	0.089	0.21
Vertex Management Inc.	#0162	124	11.022	0.017	0.092	0.108
Comdisco Ventures	#0039	101	8.978	0.014	0.089	0.178
Mitsubishi International Corp.	#0125	94	8.356	0.013	0.092	0.137
Sun Microsystems Inc.	#0169	85	7.556	0.012	0.094	0.098
IDG Technology Venture Investment	#0099	84	7.467	0.012	0.09	0.1
TI Ventures, L.P.	#0177	79	7.022	0.011	0.095	0.094
Siemens Venture Capital	#0161	77	6.844	0.011	0.093	0.102
Innovacom S.A.	#0071	72	6.4	0.01	0.09	0.117
Accenture Technology Ventures	#0002	69	6.133	0.01	0.089	0.291
Dell Ventures	#0050	68	6.044	0.01	0.089	0.176
Qualcomm Ventures	#0144	58	5.156	0.008	0.093	0.109
Oracle Venture Fund	#0137	57	5.067	0.008	0.092	0.101
AOL Time Warner Investment Corp.	#0015	51	4.533	0.007	0.089	0.267
Lucent Venture Partners LLC	#0114	51	4.533	0.007	0.09	0.102
Corning Innovation Ventures	#0045	50	4.444	0.007	0.089	0.172
Motorola Ventures	#0127	46	4.089	0.006	0.092	0.111
3i Group plc	#1020	42	3.733	0.006	0.096	0.089
VeriSign Inc.	#0190	41	3.644	0.006	0.093	0.091

Mitsui & Co. Venture Partners	#0126	41	3.644	0.006	0.092	0.113

UCINET calculates degree centrality on each of the 1126 actors in the network. The total degree centrality is 7096, which is equivalent to 7096 direct ties in the dataset. Table 4.4 summarizes the degree statistics. The mean degree centrality is 6, which means that on average, each venture program co-invests with six other programs. Some actors are significantly more prominent than others, which can be observed from the large variance. The maximum number of ties is 268, which is held by Intel Capital, whereas the minimum number of ties is 0, which applies to 131 least prominent actors. A very small number of actors enjoy a prominent position in the network. Table 4.5 shows that only two actors, Intel Capital and GE Equity have more than 200 direct ties, and the majority of actors have less than 10 direct ties.

Table 4.4 Degree summary statistics

Mean	6.3
Median	2
Mode	1
Standard Deviation	15.4
Sample Variance	236.4
Minimum	0
Maximum	268
Sum	7096
Count	1126

Table 4.5 Degree data

Degree Range	# Actors in the degree range
0	131
1	299
2	164
3	121
4	79
5	49
6	31
7	37
8	24
9	21
10	13
11-20	83
21-30	36
31-40	16
41-50	5
51-100	12
101-150	3
151-200	0
201-250	1
251-300	1

Although UCINET computes closeness indices for all actors and those indices for 22 actors are listed in Table 4.3, they cannot accurately measure the prominence of the whole network. Because the whole network is not connected, many geodesic distances (farness) are infinite. Since closeness is an inverse of farness, the closeness values would converge to zero. Thus, degree centrality remains the only metric available to measure prominence.

The large variance in prominence levels leads to some speculations. Prominent VCs have the reputation, industry expertise and financial powers to attract other VCs in the Network. By participating in syndicated deals, especially with industry leaders, less well-known VCs increase their reputation (Bygrave, 1987). For example, the most prominent VC program, Intel Capital is backed by the longstanding reputation of Intel

Corporation. The Corporation has the reputation of the world's largest chipmaker. The goal of Intel Capital is to support the Corporation's mission of being the preeminent building block supplier to the worldwide Internet economy (The Directory, p.188). The fund has no geographic preferences, as its 23 worldwide branches can virtually cover all opportunities around the globe where the fund's preferred industries reside. Because of Intel Capital's reputation, many junior VCs try to syndicate this powerful player. As long as Intel Capital sees a fit to its corporate strategy, other VCs, whether being the initiator or the receiver of a syndication proposal, are very unlikely to decline a syndication opportunity with Intel Capital. A similar argument applies to the second most prominent VC, GE Equity, owned by General Electric Company, a worldwide manufacturing leader.

4.3.2 Range

Range indicates the extensiveness of an actor's access to social capital in its network, both directly and indirectly. Consider three actors, X, Y, and Z. X has direct access to Y if X and Y have co-invested in a deal. If X can only interact with Z through Y, then X is said to have *indirect* access to Z. Reachability is one quantitative measure of range, and is expressed with zeros and ones or other numeric values a symmetric matrix. The numeric value "1" is placed in position (i,j) of the matrix if node j has a connection with i; otherwise the value "0" is placed. In the context of syndication, the reachability value can be "2", "3" or "4" and so on, These numbers mean that the two programs have co-invested in deals two, three or four times. The larger the value, the stronger the tie is because of more frequent interaction between two actors.

The other quantitative measure of range is geodesic distance. *Geodesic distance* is the shortest distance between any two nodes. It can also be interpreted as the distance of the optimal path between two actors. The result of geodesic distances is stored in a symmetric matrix of size 1126 by 1126. A blank entry indicates the absence of a path between two nodes. The value "1" shows the shortest path possible, and it is an indication of a direct tie, whereas values "2" and "3" indicate indirect ties and longer paths.

While UCINET successfully computed the results of reachability and geodesic distance, it was only able to express them in the form of symmetric matrices. Since the matrix size of 1126 by 1126 is too enormous to present, MATLAB 6.1 was used to manipulate the two matrices, and some information were obtained. Table 4.6 summarizes the reachability findings. All entries of the reachability matrix contain one of three values, 1, 2 and 3. The value "1" means a pair of actors co-invested in one portfolio firm, "2" means two portfolio firms, and "3" means three portfolio firms. Intuitively, the more portfolio firms a pair of actors co-invest, the stronger the strength of their tie. Therefore, the three values can be interpreted as the weights of a tie, with "3" being the strongest. The result shows that only three pairs of actors have the strongest tie of weight "3"; fourteen pairs have a tie of weight "2"; and the majority 2752 pairs of actors have a tie of weight "1".

Table 4.6 Reachability information obtained using MATLAB

There are 2752 pairs of actors that co-invested in one portfolio firm.	
Actors that co-invested in 2 portfolio firms:	Actors that co-invested in 3 portfolio firms:
(#0002, #0014) (#0093, #0114) (#0011, #0095) (#0095, #0193) (#0035, #0075) (#0115, #0168) (#0036, #0050) (#0152, #0177) (#0042, #0084) (#0169, #0191) (#0071, #0162) (#0205, #0214) (#0083, #0095) (#0084, #0095)	(#0036, #0039) (#0036, #0045) (#0060, #0095)

The results show that 2752 pairs of VCs invested in one portfolio firm, 14 pairs of invested in two portfolio firms, and only three pairs invested in three portfolio firms. Furthermore, no pairs invested in more than three portfolio firms. Based on the reachability data alone, most ties in the Network appear weak. However, one year of data is not sufficient to conclude whether most relationships are indeed weak because reciprocation of deal flow happens over time, and don't necessarily happen within the same year. Since reciprocation of deal flow is found to strengthen a relationship (Coleman, 1988), data from a longer period is needed for a more accurate conclusion.

Similarly, all entries of the geodesic distance matrix contained one of six values, and the values are simply 1 through 6. If there is an absence of a tie between two actors, an empty entry is shown in the matrix. Recall that geodesic distance is the optimal length of a path between two actors. The value "1" symbolizes a direct tie between a pair of actors. In other words, there is only one edge connecting two nodes. The value "2" symbolizes an indirect tie because it takes two edges to go from one node to another. Therefore, the larger the number, the longer the distance between two actors, and the more indirect their tie is.

Within the whole network, six is the longest optimal route connecting any two actors. Table 4.7 summarizes the geodesic information provided by MATLAB.

Table 4.7 Geodesic distance information obtained using MATLAB

Geodesic Distance between two actors	# of Pairs connected by that distance
1	667
2	2029
3	1873
4	524
5	70
6	5

As seen from the above table, most pairs of actors (2029 pairs) are connected with a geodesic distance of two, which means that they are only mutually reachable through a third party. The second common distance is two, and a distance of six is least common.

The shortest geodesic distance in the Network is one, signaling a direct relationship, and the longest geodesic distance is six, signaling the most indirect relationship. Clearly, the more intermediaries two VCs have to go through, the more indirect their relationship is. The findings show that most pairs of VCs (39 percent) connect with one intermediary. The majority (81 percent) of relationships are indirect, leaving just 19 percent of relationships direct.

4.3.3 Brokerage

Brokerage is defined as the bridging connections to other networks. A broker node can act as a liaison, a representative, a gatekeeper, or a coordinator of information

(Haythornthwaite, 1996). The most common measure of brokerage is betweenness. *Betweenness* is the extent to which an actor sits between two other actors. The betweenness of node X is the sum of proportions of all geodesic passing through node X, where a geodesic is the shortest path between two nodes. The normalized betweenness is the betweenness divided by the maximum possible betweenness expressed as a percentage (UCINET 6.0). The third and fourth columns of Table 4.8 summarize betweenness and normalized betweenness of all sample nodes. Intel Capital has the highest betweenness in the whole network, which implies its high potential of information filtering and control. Actors with zero betweenness, such as Accenture Technology Ventures and 3i Group plc, although prominent, do not play a role of gatekeeper in the network, and have relatively less control of information flow.

Another means of measuring brokerage is structural hole. Burt (1992, p.18) defines structural hole as "a relationship of non-redundancy between two contacts." According to Burt, maximum yield in structural hole co-exists with maximum number of non-redundant ties an actor has with other actors. One measure of structural hole Burt came up with is effective size of an ego's network. It is calculated as the number of alters minus the average degree of alters within the ego network, not counting ties to ego (UCINET 6.0). An *ego* is a node being considered in an egocentric network; an *alter* is any node other than the ego in the same network. The result is an index of non-redundancy. The higher this index, the more non-redundant ties an ego has with other alters. The last column of Table 4.8 shows the effective sizes of all nodes in the network. Intel Capital has the most non-redundant ties, and therefore has the most brokerage power. This result is in line with the betweenness measure.

Table 4.8 Betweenness and effective size of the sample 22 firms

Program Name	ID#	Betweenness	nBetweenness	EffSize
Intel Capital	#0095	8400.087	0.664	203.035
GE Equity	#0075	3649.913	0.289	180.173
Cisco Systems Inc.	#0036	1014.835	0.08	121.299
Vertex Management Inc.	#0162	2455.366	0.194	109.902
Comdisco Ventures	#0039	173.384	0.014	78.507
Mitsubishi International Corp.	#0125	2651.537	0.21	80.967
Sun Microsystems Inc.	#0169	2664.192	0.211	70.963
IDG Technology Venture Investment	#0099	459.58	0.036	70.088
TI Ventures, L.P.	#0177	2132.948	0.169	57.954
Siemens Venture Capital	#0161	2098.326	0.166	65.485
Innovacom S.A.	#0071	555.545	0.044	50.188
Accenture Technology Ventures	#0002	0.00	0.00	61.418
Dell Ventures	#0050	867.055	0.069	56.481
Qualcomm Ventures	#0144	1528.9	0.121	47.948
Oracle Venture Fund	#0137	1064.433	0.084	49.73
AOL Time Warner Investment Corp.	#0015	197.018	0.016	45.958
Lucent Venture Partners LLC	#0114	303.108	0.024	43.763
Corning Innovation Ventures	#0045	117.828	0.009	42.185
Motorola Ventures	#0127	805.42	0.064	35.99
3i Group plc	#1020	0.00	0.00	24.328
VeriSign Inc.	#0190	708.062	0.056	38.382
Mitsui & Co. Venture Partners	#0126	1124.04	0.089	32.331

The maximum betweenness is 8400 and is by Intel Capital. On the opposite of the spectrum, the lowest betweenness is zero, which is held by over 90 percent (1032 out of 1126) of the actors. Table 4.9 shows betweenness summary statistic, and Table 4.10 gives the detail of the betweenness range breakdown. Such a large variance shows the uneven distribution of betweenness among actors.

Table 4.9 Betweenness summary statistics

Mean	39.3
Median	0
Mode	0
Standard Deviation	334.3
Sample Variance	111758.6
Minimum	0
Maximum	8400.1
Sum	44196.0
Count	1126

Table 4.10 Betweenness data

Betweenness Range	# of Actors in the range
0	1032
1-100	49
101-200	13
201-300	3
301-400	5
401-500	1
501-600	4
601-700	1
701-800	3
801-900	3
901-1000	0
1001-1500	4
1501-2000	1
2001-5000	6
5001-9000	1

Parallel to betweenness, structural hole measures an actor's brokerage power in the network. Table 4.11 gives the summary statistics of structural hole measures, and Table 4.12 shows the breakdown of ranges. The maximum structural hole is held Intel Capital also, which agrees with the result in betweenness. The mean structural hole index is approximately 5, but the mode is 1. The large variance and the distribution of the structural

hole indices provide the same information as betweenness, that is, a handful of actors hold the strongest brokerage power in the network.

Table 4.11 Structural hole summary statistics

Mean	5.2
Median	2
Mode	1
Standard Deviation	12.5
Sample Variance	156.3
Minimum	0
Maximum	203.0
Sum	5830.4
Count	1126

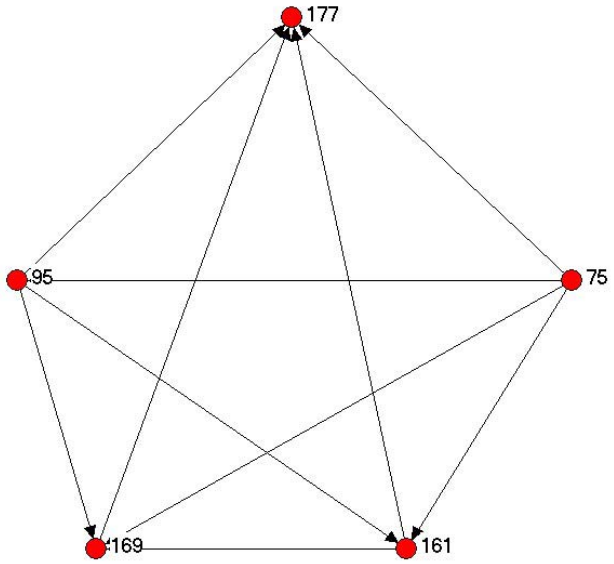
Table 4.12 Structural hole data

Structural Hole Range	# of Actors in the range
0	131
1	317
2	184
3	126
4	67
5	47
6	34
7	29
8	29
9	13
10	19
11-20	70
21-30	32
31-40	10
41-50	5
51-60	3
61-70	2
71-80	3
81-90	1
91-100	0
101-200	3
201-300	1

4.3.4 Cohesion

Contrary to the attributes of egocentric network, the final attribute, cohesion, describes the trait of a network as a whole. One measure of cohesion is the number of cliques in the network. A *clique* is a fully connected sub-graph. Within a clique, all actors interact with each other directly, and their social bonds are considered strong. Figure 4.2 is an example of a clique.

Figure 4.2 Clique Example



Another measure of cohesion is network *density*, which describe the extent to which actors in the network interact with each other. Density is a ratio of the number of actual ties to the number of potential ties in the network. The higher the density, the more interactions actors have within the network.

Clique and density measure the cohesion of a network. There are 1218 cliques present in the network. About 65 percent of them contain three or less actors and only five cliques (less than 1 percent) of cliques involve ten or more actors. Table 4.13 gives a detailed count

of cliques and their sizes. The overall portrait of cliques shows that the whole network is not cohesive.

Table 4.13 Size and number of cliques

Size of Clique (# of nodes involved)	**Count**
11	4
10	1
7	4
6	19
5	93
4	297
3	619
2	181
Total Cliques	**1218**

To confirm the conclusion of low cohesiveness, density is measured. The density of the network is only 2.8 percent. This percentage explains that of all possible ties actors can establish, on average, only 2.8 percent of ties are actually established.

5. Discussions and Conclusions

5.1 Discussion and Conclusions about the VC Network

The literature on social capital suggests many benefits of social networks. The benefits arise from trust (Nooteboom, 2001; Ferrary, 2002; Portes, 1998), resource exchange (Coleman, 1988; Putnam, 1995), mutual coordination and cooperation (Putnam, 1995), and liaison positions of control (Burt, 1992; Johanson, 2001; Higgins, 2001). Despite the two opposing approaches on the understanding of social capital, both the instrumental and the expressive views agree on the importance of social capital because it brings values to the members involved in a common social network.

The recognition of the importance of social capital leads to research on the characteristics of social networks where the social capital is embedded (Lin, 1986; Flap, 1991; White, 2002). The study of social networks involves social network analysis, which is a study of relations of the actors in the network. It empirically derives relationships between actors and characterizes a social network as a whole (Haythornthwaite, 1996).

This thesis utilizes social network analysis to describe the patterns of syndication in the corporate venture capital network. Data of the corporate venture network comes from the 2002 edition of Corporate Venturing Directory & Yearbook published by Asset Alternatives and VentureOne. The four key characteristics of the venture capital network studied are prominence, range, brokerage, and cohesion. The first half of this chapter presents the implications of findings from Chapter 4 with respect to the four hypotheses at the end of Chapter 2. The second half of this chapter discusses some implications of VC syndication on entrepreneurs, limitations of this research, and future research possibilities.

5.1.1 Non-cohesive Network

The VC network was non-cohesive. There are a large number of cliques in the network. The 1126 actors in the network form 1218 cliques, so on average, each clique contains approximately two actors, which makes the network sparse. In addition, about 65 percent of cliques contain three or less actors. The large amount of cliques relative to the size of network suggests lack of cohesion in the network, which supports *Hypothesis 1: the corporate venture capital network is not cohesive.*

The lack of cohesion has three implications. First, VCs do not establish direct ties without a reason. A parallel, but more obvious implication is that VCs do not syndicate without any motives. Because creating and maintaining syndicating relationships cost time and energy, VCs initiate and mediate them only if they believe they can extract social capital from those relationships (Coleman, 1990; Burt, 1992; Gabbay & Leenders, 1999). Secondly, strong and direct ties harm VCs financially because the co-dependent bonds limit their investment options to only the ones they are familiar with (Uzzi, 1997, 1999). Because corporate venturing is an activity of seeking technological breakthroughs, VCs do not wish to limit their investment options with many direct ties. Lastly, cohesive networks limit the flow of information because often VCs receive the same information from different direct sources. Therefore, having access to non-redundant sources of information is crucial (Burt, 1992). Since information exchange is a key motive of syndication (Bygrave, 1987, 1988), VCs would avoid establishing many direct ties, and consequently the network is not cohesive.

5.1.2 Indirect Ties

The second finding supports *Hypothesis 2: Most relationships in the network are indirect*. The findings on range show that most actors are connected with a geodesic distance of two, indicating they are only mutually reachable through a third party. The shortest geodesic distance is one, signaling a direct relationship, and the longest geodesic distance is six, signaling the most indirect relationship. The result shows approximately 13 percent of direct, leaving the majority of ties indirect. This finding is a consequence of the previous finding, because direct ties are the building blocks of a cohesive network. Since the network is not cohesive, most ties must be indirect. The implications of indirect ties are equivalent to those for non-cohesiveness.

5.1.3 Prominence and Brokerage Relation

The third important finding is the connection between prominence and brokerage. Most prominent actors are the same as actors in structural hole positions. Since structural hole measures brokerage power, the higher the efficient size of the structural hole, the more brokering power an actor holds. Appendix I provides a parallel comparison of the two attributes. The first column of the table lists the names of the most prominent firms in the network, and the third column of the table lists the names of the firms with the most brokerage power in the network. It is interesting to note that all but four firms without bolded names in the table are the most prominent actors as well as the most powerful brokers. Furthermore, the top eight firms follow the same order in terms of their level of prominence and brokerage. Most of the firms are within one or two positions of difference on the two scales.

Appendix I implies an obvious relation between the two attributes. The observations from the table support *Hypothesis 3: VCs in prominent positions are likely to hold brokerage power in the network.*

A more important question is why do prominent VCs also hold strong brokerage power? The answer is the commonality of these two attributes, and the commonality is the power to control resources. Prominent VCs are in control by definition. For example, Intel Capital, a reputable and experienced VC, does not just attract sweet deals; it has access to valuable information and financial resources because of its central position in the network. Brokers, by definition, have the advantage of firsthand information from different non-redundant sources. Prominent actors and brokers enjoy the same sense of competitive advantage in the network because of their unique and profitable positions. Therefore, they tend to be the same set of firms.

5.1.4 Syndication among Prominent VCs

The last crucial finding is that prominent VCs tend to syndicate with other prominent VCs. This finding supports *Hypothesis 4: Prominent VCs are likely to co-invest with other prominent VCs.* Recall Figure 4.1, which provides a visual representation of the intensity of syndication among the 22 most prominent VCs. The diagram shows that the sub-graph of these 22 VCs is cohesive indicating the frequency of syndication among them.

Prominent VCs prefer syndicating with other VCs similar to them because three benefits arise from their similarity. The first benefit is strategic alignment. Because most VCs invest in start-ups for strategic reasons rather than financial reasons (Gompers and Lerner, 2001, 2002), syndicating with partners that possess the necessary experience and

expertise to make the strategy whole is favourable. The second benefit is resource accessibility. Prominent VCs have access to a wide range of resource. A prominent VC would like to syndicate with another prominent VC to increase the resource access. The final benefit is superior investment selection. Lead VCs prefer syndicating with partners of similar experience (Lerner, 1994). If the lead is prominent, it most likely favours other prominent VCs to be its partners.

5.2 Implications for the Entrepreneurs

While it is true that social capital is a valuable asset to the VCs involved in the Network, but how does the conclusions from this research help the entrepreneurs in obtaining funding from the VCs? Some implications for the entrepreneurs are presented in this section.

Most VC literature focuses on understanding the entrepreneurs from the perspective of the VCs. They prescribe how to select potentially promising projects, how to successfully bring a good idea to commercialization, when to invest, and who to co-invest with. However, there is not much research on what entrepreneurs should do when seeking venture capital funding. Some researchers begin to address the implications of VC syndication on entrepreneurs.

As a general note, entrepreneurs should approach VCs selectively. The VCs can either be independent VC firms or corporate VCs. There are three reasons for it. First, VCs provide more than just money. They supply information about an industry, i.e. information about competitors, suppliers, customers, and other investors. More importantly, they bring in management expertise to the entrepreneurs, especially the industry-specific knowledge on markets and technology (Bygrave, 1987). Second, VCs favour referred deals than "cold"

deals, meaning deals without any prior introduction. VCs spend much effort developing networks of referrers. Fried and Hisrich (1994) found that while VCs often receive many proposals "cold", they rarely invest in them. Most funded proposals come from referrals. The referrers are usually people who the VCs know personally, or who they have worked with in the past. Why do they prefer referred deals? Fried and Hisrich (1994) came up with two main reasons: 1) referred deals are more likely to pass the initial screening if the venture capitalist has confidence in the referrer's judgement; 2) the referrer most likely understands the type of projects the venture capitalist finds attractive. Entrepreneurs should try to tap into the network of referrals because it increases the chance of their proposal being selected. Finally, news spreads rapidly, especially in tightly-integrated VC networks. If the entrepreneur blindly approaches any venture capitalist and is denied funding, the probability of obtaining another VC funding is greatly reduced. Bygrave (1988) found that once a proposal is in the hands of one of the top 61 VC firms in the U.S., news of its existence spread swiftly. If it is turned down by one VC, others will soon find out.

It is true that a new venture's success resides in the abilities of the entrepreneur, who has to combine the talent, skill, experience, ingenuity, leadership, education, and hard work in creative ways and to deploy them to meet customer needs in a manner that could not easily be imitated (Amit, Glosten, and Müller, 1990). However, the entrepreneur's abilities do not always lead to venture success. If he/she desires to obtain VC funding, he/she must understand the behaviour of VCs, and carefully select the appropriate investors to extract the maximum benefits from them.

5.3 Limitations

A number of limitations are present with this thesis. The first limitation resides in the nature of data. Because the VC Directory contains only one year of data, many aspects of the Network are unaccounted for. For instance, the strength of VC ties cannot be validated because a study based on only one year of data does not account for changes in the Network over time. For example, some ties may be stronger than indicated because VCs may have syndicated in five or more portfolio firms over a period of three years. However, this information is not shown in the data available. Hence to discuss whether repeat co-investments exist between actors based on past investment success is beyond the scope of this research because of lack of data.

Secondly, any network is dynamic. The study of the Network can only catch a snapshot of the Network, which does not represent a true picture of the Network at another time. To compound the inaccuracy, data collected from the Directory was done over a period of time. The moment the Directory was published, data was already outdated. All the previously concluded attributes about the Network may no longer exist. Unfortunately there is no way to change the dynamic nature of the Network, therefore one should keep in mind that the findings are merely a snapshot of the network in a past time, and may not represent the truth today.

Lastly, the research assumes the 2002 Corporate Venturing Directory and Yearbook to be an adequate representation of the corporate venturing network in general. The publisher may have left out some key actors in the network because some programs fail to participate in the study. Therefore, the truth about the corporate VC network may look very different in reality.

5.4 Future Research

A larger scope of the same research methodology can be applied to several years of syndication data. For example, the Corporate Venturing Directories of years 2000 through 2003 can be explored to find a more accurate pattern of syndication in the VC Network. Since syndication is not exclusive to venture capital funds, similar research can be done on other types of investments such as pension, insurance, and bank investments. By using the social capital theory and social network analysis, different patterns of syndication can be drawn on various investments. Another possible area of research is using game theory or transactions cost theory, as opposed to social capital, to explain patterns of syndication in VC networks. Furthermore, linking the network characteristics to attributes, such as size of funds managed, funding preferences, about the corporate venture programs is another possibility of research.

REFERENCES

Admati, A. and P. Pfleiderer (1994). "Robust Financial Contracting and the Role of Venture Capitalists", *The Journal of Finance*, Vol. 49, Issue 2, pp. 371-402.

Asset Alternatives and VentureOne (2002). The Corporate Venturing Directory and Yearbook".

Borgatti, S.P., M.G. Everett, and L.C. Freeman (2002). "Ucinet for Windows: Software for Social Network Analysis", Harvard Analytic Technologies.

Brander, J., R. Amit, and W. Antweiler (2002). "Venture-capital Syndication: Improved Venture Selection vs. the Value-added Hypothesis", *Journal of Economics & Management Strategy*, Vol. 11, No. 3, Fall 2002, pp. 423-452.

Burt, R.S. (1992). "Structural Holes: The Social Structure of Competition", Cambridge, MA: Harvard University Press.

Burt, R.S. (1992b). "The Social Structure of Competition", in N. Nohria & R.G. Eccles (eds.), *Networks and organizations: Structure, form, and action* (pp. 57-91). Boston, MA: Harvard Business School Press.

Burt, R.S. (2000). "The Network Structure of Social Capital", *Research in Organizational Behaviour*, 22, Elsevier Science.

Bygrave, W. (1987). "Syndicated Investments by Venture Capital Firms: A Networking Perspective", *Journal of Business Venturing*, Vol. 2, pp. 139-154.

Bygrave, W. (1988). "The Structure of the Investment Networks of Venture Capital Firms", *Journal of Business Venturing*, Vol. 3, pp. 137-157.

Casamatta, C. and C. Haritchabalet (2003). "Learning and Syndication in Venture Capital Investments", *University of Toulouse Working Paper, No. 2003-157*, 28 pages.

Coleman, J.S. (1988). "Social Capital in the Creation of Human Capital", *American Journal of Sociology*, Vol. 94, pp. S95-S120.

Coleman, J.S. (1990a). "Foundations of Social Theory", Cambridge: Harvard University Press.

Ernst & Young (2001). Corporate Venture Capital Report 2001.

Ferrary, M. (2003). "Trust and Social Capital in the Regulation of Lending Activities", *The Journal of Socio-Economics*, Vol. 31, pp. 673-699.

Flap, H. (1991). "Social capital in the reproduction of inequality", *Comparative Sociology of Family, Health and Education*, Vol. 20, pp.6179-6202.

Fried, V. H. and R. D. Hisrich (1994). "Toward a Model of Venture Capital Investment Decision Making", *Financial Management*, Vol. 23, Issue 3, pp. 28-38.

Gabbay, S.M., and R. A.J. Leenders (2001). "Social Capital of Organizations: From Social Structure to the Management of Corporate Social Capital", in Gabbay, S.M. and Leenders, R.Th.A.J. (eds) *Research in the Sociology of Organizations*, Vol. 18, pp. 1-20. Stamford CT, JAI Press

Gabbay, S.M. and E. Zuckerman (1999). "Social Capital and Opportunity in Corporate R&D: The Contingent Effect of Contact Density on Mobility Expectations", *Social Science Research*, Vol. 27, pp. 189-217.

Gargiulo, M. and M. Bernassi (1999). "The Dark Side of Social Capital", In R. Th. A.J. Leenders & S. Gabbay (Eds), *Corporate Social Capital and Liability* (pp. 298-322), Boston: Kluwer Academic Publishers.

Gompers, P.A. (1996). Grandstanding in the Venture Capital Industry. *Journal of Financial Economics*, Vol. 42, pp. 133-156.

Gompers, P. A. and J. Lerner (2001). *The Money of Invention: How Venture Capital Creates New Wealth*, Boston, Massachusetts: Harvard Business School Press.

Gompers, P. A. and J. Lerner (2002). *The Venture Capital Cycle*, Cambridge, Massachusetts: The MIT Press.

Haythornthwaite, C. (1996). "Social Network Analysis: An Approach and Technique for the Study of Information Exchange", *Library and Information Science Research*, Vol.18, pp. 323-342.

Hakimi, S.L. (1965). "Optimum locations of switching centers and the absolute centers and medians of a graph", *Operations Research*, Vol. 12, pp. 450-459.

Higgins, M.C. (2001). "Changing Careers: The Effects of Social Context", *Journal of Organizational Behaviour*, 22, no. 6 (September 2001), p. 595-618.

Jacobs J. (1961). *The Death and Life of Great American Cities.* Penguin: Harmondsworth.

Jo, H. (2000). "Venture Capital Syndication and Firm Value: Entrepreneurial Financing of Grand Junction Networks", *University of Santa Clara, Leavey School of Business & Administration,* working paper No. 99/00-01-WP.

Johanson, J. (2001). "The Balance of Corporate Social Capital", in Gabbay, S.M. and Leenders, R.Th.A.J. (eds) *Research in the Sociology of Organizations*, Vol. 18, pp. 1-20. Stamford CT, JAI Press.

Kuan, J. (2003). "Hostage Exchange in Venture Capital Syndicates", *Working Paper*, Stanford University.

Knoke, D. (2001). Changing Organizations: Business Networks in the New Political Economy. Boulder, CO: Westview Press.

Lakonishok, J., A. Shleifer, R. Thaler, and R. Vishny (1991). "Window Dressing by Pension Fund Managers", *The American Economic Review*, Vol. 81, Issue 2, pp. 227-231.

Lawrence, P., and J. Lorsch (1967). "Organization and Environment: Managing Differentiation and Integration", Boston: Harvard Business Press.

Leenders, R.Th.A.J. (eds) *Research in the Sociology of Organizations*, Vol. 18, pp. 1-20. Stamford CT, JAI Press.

Lerner, J. (1994). "The Syndication of Venture Capital Investments", *Financial Management*, Vol. 23, Issue 3, pp. 16-27.

Light, I and S. Karageorgis (1994). "Ethnic Economy", in Neil J. Smelser and Richard Swedberg (eds.), *The handbook of Economic Sociology*, New York, NY: Princeton University Press, pp. 647-671.

Lockett, A. and M. Wright (2001). "The Syndication of Venture Capital Investments", *International Journal of Management Science*, Vol. 29, pp. 375-390.

Mintzberg, H. (1979). "The Structuring of Organization", Englewood-Cliffs, NJ: Prentice-Hall.

Nohria, N. (1992). "Introduction: Is a network perspective a useful way of studying organizations?" in N. Nohria & R.G. Eccles (eds.), *Networks and organizations: Structure, form, and action* (pp. 1-22). Boston, MA: Harvard Business School Press.

Pence, C.C. (1982). *How Venture Capitalists Make Investment Decisions,* Ann Arbor, MI, UMI Research Press.

Pfeffer, J. and Salancik, G.R. (1978). *The External Control of Organizations*, New York, N.Y.: Harper and Row.

Portes, A. (1998). "Social Capital: Its Origins and Applications in Modern Sociology", *Annual Review of Sociology*, Vol. 24, pp. 1-24.

Sah, R.K. and J.E. Stiglitz (1986). "The Architecture of Economic Systems: Hierarchies and Polyarchies", *American Economic Review*, Vol. 76, pp. 716-727.

Scott, J. (1992). *Social Network Analysis*. Sage: London.

Sorenson, O. and Toby E. Stuart (2001). "Syndication Networks and the Spatial Distribution of Venture Capital Investments", *American Journal of Sociology*, Vol. 106, No. 6, pp. 1546-1588.

Uzzi, B. (1996). "The Sources and Consequences of Embeddedness for the Economic Performance of Organizations", *American Sociological Review*, Vol. 61, pp. 674-699.

Uzzi, B. (1999). "Social Relations and Networks in the Making of Financial Capital", *American Sociological Review*, Vol. 64, pp. 481-505.

Wasserman, Stanley and Katherine Faust (1994). *Social Network Analysis: Methods and Applications*. New York: Cambridge University Press.

White, L. (2002). "Connection Matters: Exploring the Implications of Social Capital and Social Networks for Social Policy", *Systems Research and Behavioural Science*, Vol. 19, pp. 255-269.

Williamson, O. (1975). "Markets and Hierarchies: Analysis and anti-trust Implications", NewYork: The Free Press.

Wililamson, O. (1985). "The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting", New York: The Free Press.

Williamson, O. (1993). "calculative ness, Trust and Economic Organization", *Journal of Law and Economics*, Vol. 36, pp. 453-486.

Williamson, O. (1996). *The Mechanism of Governance*, New York: Oxford University Press.

Wilson, R. (1968). "The Theory of Syndicates", *Econometrica*, Vol. 36, Issue 1, pp. 119-132.

Appendix I: Prominence and brokerage comparison

Program Name	Degree	Program Name	EffSize
Intel Capital	268	**Intel Capital**	203.035
GE Equity	221	**GE Equity**	180.173
Cisco Systems Inc.	141	**Cisco Systems Inc.**	121.299
Vertex Management Inc.	124	**Vertex Management Inc.**	109.902
Comdisco Ventures	101	**Mitsubishi International Corp.**	80.967
Mitsubishi International Corp.	94	**Comdisco Ventures**	78.507
Sun Microsystems Inc.	85	**Sun Microsystems Inc.**	70.963
IDG Technology Venture Investment	84	**IDG Technology Venture Investment**	70.088
TI Ventures, L.P.	79	**Siemens Venture Capital**	65.485
Siemens Venture Capital	77	**Accenture Technology Ventures**	61.418
Innovacom S.A.	72	**TI Ventures, L.P.**	57.954
Accenture Technology Ventures	69	**Dell Ventures**	56.481
Dell Ventures	68	**Innovacom S.A.**	50.188
Qualcomm Ventures	58	**Oracle Venture Fund**	49.73
Oracle Venture Fund	57	**Qualcomm Ventures**	47.948
AOL Time Warner Investment Corp.	51	**AOL Time Warner Investment Corp.**	45.958
Lucent Venture Partners LLC	51	**Lucent Venture Partners LLC**	43.763
Corning Innovation Ventures	50	**Corning Innovation Ventures**	42.185
Motorola Ventures	46	**VeriSign Inc.**	38.382
3i Group plc	42	**Motorola Ventures**	35.99
VeriSign Inc.	41	Infineon Ventures GmbH	35.084
Mitsui & Co. Venture Partners	41	Philips Corporate Strategy	34.991