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Venture capital syndicate networks: the determinants of interconnectedness

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Venture Capital Syndicate Networks –
The Determinants of Interconnectedness

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Abstract

This paper examines the German venture capital (VC) syndicate networks and to what extent certain characteristics of VC companies determine the investors' interconnectedness. The data used contains detailed information on 300 VC investments and their investors from the years 2004 and 2005. The analysis shows that the age of the VC companies dichotomously influences the syndicate networks of the investors – a negative influence for young and very old VC firms and a positive one for those firms in which are not very old. In contrast, the fact of being privately held or under governmental influence does not affect the number of network ties of the VC firms. The analysis reveals no indication for any geographical or spatial influences on the number of syndication partners that a VC company has within its network.

JEL-classification: G24, O16, R10.

Keywords: Venture Capital, syndication, networks.

Zusammenfassung

„Venture Capital Syndizierungsnetzwerke – die Determinanten der Vernetzung von Investoren“

Dieser Artikel untersucht die Venture Capital (VC) Syndizierungsnetzwerke in Deutschland und inwieweit bestimmte Charakteristika der beteiligten VC Gesellschaften die Vernetzung der Investoren beeinflussen. Der verwendete Datensatz besteht aus 300 VC Investitionen und deren Investoren aus den Jahren 2004 und 2005. Die Analyse macht deutlich, dass das Alter der VC Gesellschaften einen dichotomen Einfluss auf die Syndizierungsnetzwerke hat – negativ für sehr junge und sehr alte Gesellschaften, ansonsten positiv. Es kann jedoch kein Unterscheid zwischen öffentlichen und privaten VC Investoren in Bezug auf die Anzahl der Netzwerkverbindungen der Financiers festgestellt werden. Die Untersuchung zeigt keine Anzeichen für geographische oder regionale Einflüsse auf die Anzahl der Syndizierungspartner einer VC Gesellschaft im Netzwerk.

JEL-Klassifikation: G24, O16, R10.

Schlagworte: Venture Capital, Syndizierung, Netzwerke.

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1. Introduction

Research examining both the networks of VC companies built through syndicated venture capital (VC) investments as well as geographical and spatial influences on the VC markets is somewhat insufficient. Most of the studies either focus on the geographical aspects (Powell, Koput, Bowie and Smith-Doerrs, 2002; Martin, Sunley and Turner, 2002; Fritsch and Schilder, 2007) or on the syndication of VC investments¹. Only a few studies combine both lines of research, including the study by Sorensen and Stuart (2001) and the work of Bygrave (1987, 1988). However, research is mainly limited to the US VC market which shows certain particularities such as large spatial distances. Furthermore, the characteristics of the key players within the networks are not completely explored, e.g., the role of public authorities within VC syndicate networks. Therefore, additional research on VC syndicate networks and the geographical and spatial influences seems to be necessary.

Accordingly, this paper focuses on the interconnectedness of VC companies within syndicate networks. Syndication means that "... two or more venture capital firms come together to take an equity stake in an investment" (Wright and Lockett, 2003, 2074). The more network ties a VC firm has in form of syndication partners, the higher its degree centrality of the network is and the larger its own syndicate network is. However, past research (see for example Sorensen and Stuart, 2001 and Bygrave, 1987, 1988) does not entirely explain to what extend different characteristics of VC companies and, especially, spatial and geographical aspects influence the network position of a VC company – in other words to what extend the VC firms are connected with other investors. The logical question raised in this context is: "What determines the number of ties to syndication partners of a VC company within a syndicate network?" The analysis of this study examines the characteristics of the VC firms that influence their

¹ Manigart, Lockett, Meuleman, Wright, Landström, Bruining, Desbrières and Hommel., 2006; Lerner, 1994; Lockett and Wright, 2001.

degree centrality within the network, which is measured by the number of different syndication partners each VC firm has. To answer this question, a dataset based on more than 300 VC investments made in Germany in the years 2004 and 2005 is used. The results of the analyses show which individual characteristics of VC investors, including their age, their geographical location or their spatial investment behavior lead to a central position within a syndicate network, i.e., a large individual network of a VC firm. The findings also indicate the role of different types of VC firms in the German VC market, e.g., by a comparison of privately held VC firms and VC companies that are under governmental influence.

The remaining sections of the paper are structured as follows. The second section contains the rationale of VC syndication. Thereafter, important assumptions regarding the influential factors of the position of VC firms within a syndicate network are hypothesized, which are based on a review of the literature (Section 3). The data are then introduced in Section 4 and the syndicate network relationships in Germany are described. Then, the empirical analysis follows (Section 5) based on the hypothesis of different determinants affecting the network position of VC companies. Section 6 concludes and discusses implications for further research.

2. Venture Capital Syndication

The venture capital (VC) business is not a lonesome activity of individual investors working separately; it is often the case that VC investments are syndicated (Lerner, 1994). Syndication in this context means that more than one VC investor is involved in the investment (Wright and Lockett, 2003). Even though all participating VC firms are taking a stake in the investment, their function within the syndicate may differ. The role of the financiers ranges between active lead investors (they do not only invest but also offer further services such as consulting) and the more or less passive co-investors (they merely give money and abstain from providing additional services). Every VC

company is incorporated in different syndicates with various syndication partners. A so-called syndicate network develops from this cooperation (Bygrave, 1988; Sorensen and Stuart, 2001). The more syndication partners in different syndicates a VC company has, the larger the specific syndication network of the individual VC firm is.

The syndication of VC investments has various reasons. Each phase of a VC investment has its own characteristics, i.e., the search for possible target companies, the act of investing itself, the monitoring and consulting of the portfolio firm during the investment and the exit of the investment (Gompers and Lerner, 2001). Hence, different reasons or rationales for syndication emerge from the phases of a VC investment (Sorensen and Stuart, 2001). In the pre-investment stage, syndication, or more precisely the possible syndication of investments, might help to find and to evaluate target companies (Manigart et al., 2006; Lockett and Wright, 2001). If one VC company identifies a possible investment, it might ask other VC companies to syndicate. For these VC firms, the invitation to syndicate eases the search for investments, i.e. the so-called deal flow.

Within the next phase of an investment, known as the investment decision, syndication might be helpful or even necessary. Firstly, one investor might not be able or willing to raise enough capital for the investment individually (DeClerq and Dimov, 2004, Brander, Amit and Antweiler, 2002); the VC company needs help from other investors. Secondly, it is an advantage to share the investment even though the investor is able to manage the investment alone. Possible reasons are risk reduction through portfolio diversification for the individual VC company and a combined evaluation of the investment (Lockett and Wright, 1999, 2001; Cumming, 2006). Additionally, due diligence done by different VC companies might be more valuable than that of a single investor (Lerner, 1994).

Once the investment is made, syndication is also advantageous for the participating investors (Brander et al., 2002). These benefits apply to the additional services that VC companies provide to their portfolio firms, such as monitoring, advising and consulting. Through syndication, the costs of these activities can be shared, whereby the resources of the individual investor are

saved. Furthermore, the syndication partners can combine their resources (DeClerq and Dimov, 2004). This is especially important if one syndication partner is located close to the investment and other investors are further away from the portfolio firm (Fritsch and Schilder, 2006, 2007; Sorensen and Stuart, 2001). In this case, the VC company that is located closest to the investment can do most of the monitoring and advising activities on site. The distantly located syndication partners benefit from this proximity, e.g., through reduced costs of monitoring and traveling (Fritsch and Schilder, 2007).

Even if the VC investment comes to an end syndication might be helpful for the VC companies. One possible example is the exit through a trade sale, which is the sale of the venture's shares to an industrial company. This is one of the most important ways of exiting a VC investment in Germany (German Private Equity and Venture Capital Association, 2006). Trade sales might be easier if more than one investor is involved. The different financiers have contact to different possible buyers for the stakes of an investment. Therefore, the search for a trade sale partner is eased. After an exit, the fact that an investment has been syndicated can still be valuable. The participating investors might remember their syndication partners when they search for future co-investors, especially, if the syndicate was successful (Manigart et al., 2006; Sorensen and Stuart, 2001). Again, this allows an easier deal flow for the VC company.

3. Syndicate Networks and the Characteristics of the Key Players

The reasoning for syndication gives evidence for the role of syndicate networks. A syndicate network is composed of a number of VC companies that have a relationship to each other through their joint investments (Bygrave, 1988; Sorensen and Stuart, 2001). Based on this definition one is able to depict the syndicate network by simply starting with one specific VC company. Its syndicate network partners are all investors that have involvement in any of the VC company's investment syndicates. As each individual network partner of the VC company is also interconnected with other investors through syndicates, an overall

VC syndicate network exists for the whole or nearly the whole market, e.g., within one country. Past research on VC syndicate networks and spatial determinants focused on the reasons of syndication and syndicate networks (Bygrave, 1987, 1988) or on the impact of syndicate networks on the spatial investment behavior of VC firms (Sorensen and Stuart, 2001). However, these studies show two main limitations. First, they are restricted to the US VC market which is said to be rather unique in regard to its development (Martin et al., 2002), its investment activity (Sapienza, Manigart and Vermeir, 1996) or its geographical structure (Martin et al., 2002). Second, they do not entirely explore which determinants turn VC investors into active network players, such as the role of governmental influence on VC syndication behavior.

The role of different actors within a syndicate network is important for VC companies. According to network analysis theory, the more ties a financier has to other VC firms through syndication, which corresponds to its individual co-investment network, the more central its position within the network is (Wassermann and Faust, 1994, 178), and the more it can benefit from the network (Bygrave, 1988). First, a large network of co-investors eases the search for further investments because the co-investors might invite the VC company to participate in deals of which they have not heard (Bygrave, 1987; Manigart et al., 2006). Second, a group of co-investors helps to find a syndication partner for various kinds of future investments. A suitable co-investor might enable the VC company to expand the provided services for the portfolio company (Brander et al., 2002), to ensure sufficient capital availability for large investments (Lerner, 1994) and to overcome the problems attached to investments that are located far away from the VC company (Fritsch and Schilder, 2006, 2007). For these reasons, it is important to understand what determines a well interconnected network position of VC firms.

One important characteristic of a VC company with regard to its position within the syndicate network is the VC firm's age (Sorensen and Stuart, 2001). First, the older the VC company is, the more experienced its management is said to be (Gompers, 1996). Experienced investment managers might possess many

different contacts, both personal links as well as through work experience. Due to these contacts, the co-investment and syndication of VC deals can emerge (Sorensen and Stuart, 2001). Second, older VC companies have a longer history of past VC syndicates than young VC firms. These co-investments might be able to help find syndication partners or be invited to syndicate themselves. The trust established during a past syndication is an important advantage for future deals (Wright and Lockett, 2003). If the earlier joint investment was successful, this cohesion might be even stronger. Finally, a good and sustainable track record strengthens the reputation of the VC firm and encourages other VC companies to participate with the successful VC company in the same syndicate (Lockett and Wright, 1999). A young VC firm does not have this track record and its management might be less experienced than older VC firms (Sorensen and Stuart, 2002). Therefore, it can be assumed that older VC firms have a central position within the syndicate network and show a variety of co-investment ties in comparison to the younger VC investors do.

H1: The older a VC company is the better it is interconnected via syndicates.

The second possible determinant of the VC firm's network position is a spatial argument. The larger the individual network of the VC company is, i.e., the higher its degree centrality within the overall network is, the more likely the investor will have investments that are located further away from its own location (Sorensen and Stuart, 2001). There are two main reasons for this assumption. Firstly, with increasing spatial distance it will become more difficult to find and to evaluate suitable investment opportunities (Manigart et al., 2006; Lockett and Wright, 2001). Making use of a large syndicate network can ease the search and evaluation of target companies. Secondly, syndication might be used to overcome the problems of investments that are located further away from the investor such as long traveling distances for the monitoring and consulting of the portfolio firm (Fritsch and Schilder, 2006). If one syndication partner is located close to the investment, it can undertake the services that need to be done on site of the financed venture; these include certain monitoring and consulting activities.

Under such circumstances the other syndication partners can be located farther away and do not have to be at the investment very often. Therefore, multiple relationships to different syndication partners might help to find, evaluate, and manage distantly located investments. In other words, a large spatial investment behavior of VC firms requires and entails many network ties to other VC investors.

H2: VC companies with a large spatial investment behavior tend to have a central role within the overall syndicate network.

As a third determinant, the geographical dispersion of the VC suppliers might influence the interconnectedness of syndicate networks. For instance, although the German VC market is less spatially clustered than the US market (Powell et al., 2002; Florida, Smith and Sechoka, 1991), it has several VC centers including Munich, Frankfurt/Main, Düsseldorf, Hamburg, Berlin and the Rhine-Ruhr area (Fritsch and Schilder, 2007; Martin et al., 2002). VC companies that are located in these core centers might have a more central position within the overall VC syndicate network (Sorensen and Stuart, 2001). The spatial proximity to many other VC firms might spur their personal contacts within the VC community which, in turn, might lead to possible contacts to syndication partners. In return, the VC companies that are located in a peripheral region might have a disadvantage with regard to their contacts to other investors and, therefore, their syndicate network. Thus, being located in one of the German VC centers might lead to a higher level of interconnectedness of a VC company within a syndicate network than that of investors in peripheral regions.

H3: VC companies that are located in financial centers have more syndication ties than investors in peripheral regions.

Finally, the background of the VC company, in this context, that means whether they are public – an investor is under governmental influence – or

privately held, might have an impact on its number of co-investors and its personal syndicate network. Many public VC companies are restricted in regard to their investments to a certain region (Doran and Bannock, 2000; Sunley, Klagge, Berndt and Martin, 2005). Their main goal is to ensure a sufficient supply of capital for entrepreneurship and innovative activity in one specific area (Schilder, 2006; McGlue, 2002). Therefore, they have to work as a magnet attracting capital from outside their resident region and multiplying their own supply of capital through syndication. Furthermore, the private syndication partners can strongly benefit from the public VC companies' access to local networks (Sunley et al., 2005), which might be advantageous for their deal flow and for the evaluation of the target company. Therefore, a public VC investor as syndication partner should be an interesting co-investor for private VC suppliers. For that reason, public VC firms might have more co-investments than their private counterparts, which is equal to a more central position within the overall syndicate network.

H4: VC companies under governmental influence are at least as interconnected as privately held financiers

4. Analysis

4.1 Data

The analysis is based on a set of data containing details about German VC investments at the micro-level. Data have been provided by *VC facts*, a company which collects information about VC investments in Germany. It contains information on 134 and 174 VC investments for the years 2004 and 2005, respectively. This equals nearly half of the early stage investments that are recorded by the German Private Equity and Venture Capital Association (2005). There is a clear investment focus in certain industries. More than 36 percent of the investments are in the biotechnology industry to be followed by investments in software related businesses (14 percent). Around six percent of the financed start-ups are active in the communication business as well as in medical technologies.

This is similar to the industry focus of the investments made by the members of the German Private Equity and Venture Capital Association (2005). One-quarter of the investors in the analysis are under public influence, and the remainder is privately held. Only slightly more than one-half of the VC companies under investigation are located in the German VC centers which is less than that of the overall market (Fritsch and Schilder, 2007). However, it still can be assumed that this sample is representative for the overall VC activity in Germany during the time period under investigation. For the objectives of this paper, the focus is on detailed information about the age and the location of the VC investors, their syndicate network and their spatial investment behavior. Based on the addresses of the VC firms and their investments, the average traveling distance between an investor and a portfolio company and between the co-investors within a syndicate was calculated. The internet-based route planner *map24.de* was used to calculate the distances.

In the sample 199 of the 308 VC investments are syndicated, i.e., there is more than one investor involved. Within these syndicates 825 pairs of investor and the respective portfolio company can be identified. Furthermore, the number of pairs of investors that are involved in n investments can be counted, e.g., if a venture has two investors there exists one pair of co-investors. The data contain 2,107 pairs of co-investors that are involved within syndicates. Due to many missing values, the analysis is only based on a considerable smaller number of observations. The missing information mainly includes the age of some VC companies and the addresses of both informal VC investors and foreign investors. These investors are excluded from the following analysis. Furthermore, the data do not contain information about passive governmental co-investors, such as the *Kreditanstalt fuer Wiederaufbau*. Due to their merely passive syndication behavior without providing any additional services, these investors might not influence the effects of VC syndicate networks that underlie this investigation.

Table 1: Descriptive statistics

	Mean	Median	Minimum	Maximum	Standard deviation
Age of portfolio company (in years)	4.84	4.00	0.00	36.00	3.84
Age of VC company (in years)	10.43	7.00	0.00	57.94	10.12
Overall amount of capital invested (in million €)	8.21	5.00	0.15	35.00	8.65
Average distance to investment (per portfolio in kilometers)	271.81	228.74	0.00	868.61	225.50
Number of investors per investment	4.17	3.00	1.00	12.00	2.59
Number of syndication ties (per VC company)	9.65	5.00	0.00	92.00	13.14
Number of different syndication partners (per VC company)	8.08	5.00	0.00	65.00	9.94

Table 1 shows descriptive statistics for the main variables of the sample. All figures refer to the point in time when the investment was made. On average, the financed companies were almost five years old whereas the VC companies already existed for more than ten years. The average amount invested per financed company and per investment amounts to slightly more than eight million Euros. On average, the number of investors for the syndicated investments is about 4.2. The average number of syndication ties per VC company is 9.65. However, this number does not show the network of the individual VC company in detail. If a VC company has two syndicates with the same syndication partner, the syndicates are counted as two ties. Such a tie between the two is stronger than that of a single syndicate (Bygrave, 1987). Therefore, the network of different syndication

partners of a single VC company is smaller than the total number of syndication ties. On average, the syndicate network of an individual VC company contains about eight different syndication partners. This relatively small difference between the overall number of ties of a VC company and the number of different co-investors of the financier might be due to the short period of time within the analysis. Serial investments, which are based on experiences of past syndicates, are not very likely within such a short period of time.

4.2 What do Venture Capital Syndicate Networks Look Like?

The syndicate network's size of the individual VC company, which indicates the network position of the investor, can either be described by its overall number of ties to co-investors, which show the frequency of network contacts or by its number of different co-investors, that provides an idea about the breadth of the network (see Section 4.1; Bygrave, 1987). In the following analysis, the syndicate networks are limited to the number of different co-investors of each VC company for two reasons. First, the correlation coefficient of both variables is approximately 0.98 and highly statistically significant. Therefore, the empirical results do not differ considerably and both variables seem to act as good proxies for each other. Second, some advantages of VC syndicate networks come from large networks – e.g., through the sharing of information (Bygrave, 1988) – and depend on the number of different syndication partners. The strength of the ties between two VC investors might not be as important for these network benefits. If a VC company has ten syndicates with only the same co-investor, it still has the smallest possible network containing only one financier. Its interconnection within the overall syndicate network is rather limited. Therefore, the number of different co-investors is a more appropriate indicator for the network of a VC company (Bygrave, 1987).

The overall syndicate network is composed of the individual networks of the single VC companies, the so-called ego-networks (Wassermann and Faust, 1994,

42). Through joint investments, the VC companies are interconnected and, therefore, their networks are also connected. However, some VC firms that either do not have syndicated investments or whose networks are isolated from other networks are not part of the main component of a VC syndicate network. Figure 1 depicts the main component for the German VC market. It is the largest interconnected syndicate network and contains more than two-thirds of all VC firms in the sample used. The rest of the VC firms are either not part of any syndicate or are interconnected in networks that do not have more than three participants. The network graph only shows German VC investors and their ties to other German VC companies. Although, the ties to foreign investors are excluded, whereby a supra-national or global network could be illustrated, the overall German syndicate network is indicated. Furthermore, more than 50 percent of the German VC investments are made solely with German syndication partners (German Private Equity and Venture Capital Association, 2006). Therefore, the exclusive German syndicate network is an important characteristic of the market with regard to domestic VC investment activity.

Each node of the network represents one VC firm (figure 1).² The size of the node stands for the age of the investor; the older the VC company is, the larger the circle is. The different shadings indicate whether the VC company is public or private; black circles indicate VC firms that are under governmental influence and gray circles indicate privately held investors. The ties between the financiers represent the cooperation within one or more syndicates and are shown by the black lines. The thicker the line is, the more joint syndicates these two VC companies have. This equals a stronger network tie between the two investors. The ties and the position of the nodes do not show any geographical or spatial characteristics of the syndicate relationships. Furthermore, the data does not enable to the two other dimension of social relationships in addition to the strength of the tie: the content and the direction of the relationship. The more lines

² The network graphic does not show any geographical or spatial characteristics of the syndicate network.

that emerge from a VC firm, the more network ties with different financiers it has. Many ties coming out of a node mean that this VC company has a central position within the overall network because the number of ties is the simplest measure of an actor-level degree centrality (Wassermann and Faust, 1994, 178).

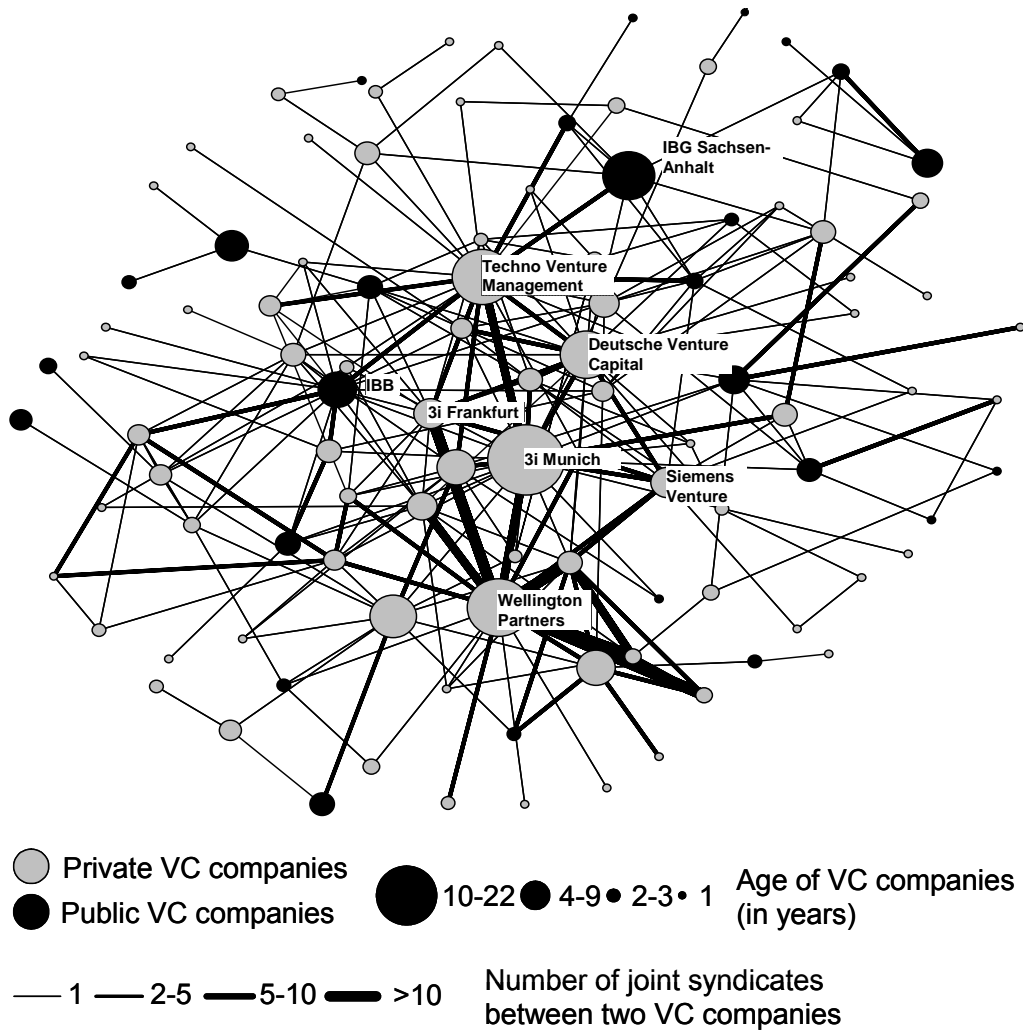


Figure 1: Main component of the German VC syndicate network

Overall, the network indicates that the VC market is very well interconnected. However, it also shows that some VC firms are more or less key network players that have many different ties and keep the large network together (figure 1). These mostly tend to be older firms such as the VC subsidiary of Siemens, 3i in Frankfurt and Munich or Techno Venture Management. Most of these key players are privately held and only few VC suppliers, which are mainly

influenced by public authorities, are also highly interconnected in the network. Among these are for example the VC subsidiary of the Merchant and Development Bank Berlin (*IBB*) and the *IBG Beteiligungsgesellschaft Sachsen-Anhalt mbH*.

The main component of the VC syndicate network shows a strong interconnection of the German VC market. Many of the investors have syndication ties with other VC firms and, in most cases, with more than one co-investor. Furthermore, there are some key players within the network that ensure such a large main component. They seem to be rather old and privately held. However, the visual interpretation of Figure 1 still leads to an important question: Which determinants turn VC companies into key players of the network? In other words, one still has to search for characteristics that enable a single VC firm to develop many different syndication ties. Furthermore, the graphical interpretation of the syndicate network does not show any regional or spatial influences that might be important determinants.

4.3 *What Determines the Actor-Level Degree Centrality of Venture Capital Firms in the Syndicate Network?*

The possible determinants of the size of the VC companies' syndicate networks measured by the number of different syndication partners per VC firm are explored in the following in-depth analysis. A negative binomial regression is employed because the distribution of the dependent variable is strongly skewed to the right. The dependent variable is the number of different syndication partners each VC investor has as indicator for degree centrality of the VC firms.³ The independent variables depict the determinants of the interconnectedness or degree centrality of the VC companies (see Section 5). First, the age of the VC company

³ Other measures from the social network analysis at a minimum such as closeness or betweenness are not part of the estimations, to keep the social network analysis on a minimum without losing track of the paper's aim.

is used because older VC firms might have larger networks than young VC companies. Second, a dummy variable, which shows whether the VC firm is privately held or under governmental influence (public dummy), is used to demonstrate the possible differences between both types of financiers. Third, two variables are added to the model to explore the influence of geographical and spatial aspects on VC syndicate networks – a dummy variable comparing the investors that are located within the German VC centers and those that are not and a variable that shows the average distance between a VC company and its portfolio firms. The analysis is based on network information about 128 German VC firms and their syndication ties, which are part of the previously introduced dataset. Private individuals and foreign VC companies are excluded from the analysis. Furthermore, the data lacks information on the age of several of the investors. Therefore, they are not included in the estimations.

The results clearly show that the age of the VC company has a statistically significant and positive impact on its number of different co-investors (Table 2, Model I). However, by adding the variable age^2 , which is the square of the age of the VC firm, it can be seen that this influence becomes smaller over time and, finally, is negative (Model II). This means that the benefits of being older in regard to the network degree centrality of a VC firm, e.g., through the experience and the track record of the investor, are only important at a certain age. Very young companies cannot benefit from these advantages. Very old VC firms also do not have an advantage of being older. One reason for this dichotomous influence of the age might be that the older VC firms begin to rest on their laurels. Overall, the analysis only partly supports hypothesis 1.

The institutional background of the VC company, i.e., whether the VC suppliers are privately held or under governmental influence, does not affect the degree centrality within VC syndicate network. The estimations do not show any statistically significant difference between both types of VC companies which is in line with hypothesis 4. Therefore, public VC companies seem to be equally interconnected and established within the German VC network, which might be rather astonishing in regard to the visual analysis of the VC syndicate network

(figure 1). However, they do not make more extensive use of syndication than their privately held counterparts to enlarge, for example, the VC supply for their resident region. Unfortunately, the data do not provide information about the current overall number of portfolio companies per investor, the amount of capital a VC firms has under management or the number of investment managers per financier. Therefore, it is not possible to control for differences in regard to the size of the VC companies, which might also influence the network activity of the investors (Bygrave, 1987). However, the age of the VC company can be regarded as a proxy for the size of the investor, because size and age of VC firms are often highly correlated (Sorensen and Stuart, 2001).

Table 2: Determinants of the number of syndication ties per VC company
(negative binomial regression)

	Number of different co-investors (per VC company)			
	I	II	III	IV
Age (VC company)	0.031* (2.43)	0.144** (5.25)	0.146** (5.26)	0.146** (5.22)
Age ² (VC company)	-	-0.003** (4.87)	-0.003** (4.88)	-0.003** (4.77)
Public VC company (dummy)	-0.181 (0.87)	-0.226 (1.15)	-0.265 (1.22)	-0.257 (1.10)
Location in VC center (dummy)	-	-	-0.090 (0.42)	-0.082 (0.42)
Average distance to investment (per portfolio in kilometers)	-	-	-	0.000 (0.08)
Constant	1.711** (10.24)	1.030** (4.94)	1.090** (4.49)	1.066** (3.64)
Pseudo R ²	0.001	0.034	0.035	0.035

** Statistically significant at the 1%-level; * Statistically significant at the 5%-level;
Number of observations: 128

The geographical and spatial influences on the number of network ties of a single VC company are less pronounced than previously assumed. First, the location of a VC company in one of the German VC centers does not have a statistical significantly effect on its syndicate network. Both VC firms in the

centers or in peripheral regions seem to have a similar degree centrality in the syndicate network (Model III). Therefore, hypothesis 3 must be rejected. This might be due to the composition of the data, which show a relatively high share of VC companies in peripheral regions. Second, the spatial investment behavior, which is measured by the average distance between a VC company and its portfolio firms, has no statistically significant influence on the number of ties of a VC company (Model IV). Contrary to the findings from a US study conducted by Sorensen and Stuart (2001) the network position of a VC investor and its spatial investment behavior are not related in Germany. There is no indication for supporting hypothesis 2 in the German VC market. This might derive from a distinct insignificance of spatial aspects for the German VC market (Fritsch and Schilder, 2007).

Furthermore, other variables such as the spatial dimension of the syndicate network, indicated by the average distance between the investor and its syndication partners or the geographical location of the investments, do not have a statistically significant influence on the network position of the VC company. These results are not reported in the estimation tables. Overall, the estimations on geographical and spatial influences of the VC investors' network position show that these determinants are less important than for the large and geographically more dispersed US VC market (Sorensen and Stuart, 2001).

5. Conclusions and Implications

VC companies are interconnected through a network of joint investments, the so-called syndicates. In this paper, the VC syndicate network structure in Germany is explored, and, possible determinants of the role of certain VC companies within the network are analyzed. This study shows to what extent certain characteristics of the investors influence their individual or ego-network of syndication partners, which equals their level of interconnectedness or degree centrality within the overall network. The empirical analysis is based on a unique dataset containing

information on more than 300 VC investments made in German during the years 2004 and 2005.

The analyses reveal that the German VC market is closely interconnected. The main component of the network shows that more than two-thirds of the VC firms within the used data are connected through syndicates. Furthermore, the visual and descriptive analyses provide evidence that some VC firms have considerably more relationships to syndication partners than others do. Therefore, a regression analysis is employed to explore the influence of several possible determinants of the network position of VC firms. The number of different co-investors per VC company, which is an indicator for the degree centrality of the network position of VC firms, mainly depends on the VC companies' age. Older VC investors seem to profit from advantages through more experience or a longer track record of investments than their younger counterparts. However, this effect diminishes over time and even turns into a negative influence. Other characteristics of the VC firm, including but not limited to the fact whether they are under governmental influence or not, do not show a statistically significant influence on the network position of the investor. Furthermore, the results indicate that the German VC syndicate network is not influenced by geographical or spatial aspects. Neither the location of the VC firms – this means a location either in one of the German VC centers or in a peripheral region – nor their spatial investment behavior affects their number of different syndication partners.

The results of this study raise some questions that enhance the analysis and should be evaluated in further research. First, the network analysis should be enhanced by additional types of closeness than mere spatial proximity; these include the social, industrial or organizational proximity, and their role in the networks of the individual VC companies. Second, the influence of VC networking on the success of the investments is an interesting topic for further research (Hochberg, Yael, Alexander Ljungqvist and Lu Yang, 2007). Finally, syndication is only one aspect of VC networking. Although, this might be the most difficult and challenging task, further network contacts, for example on an informal basis should be analyzed.

References

- Brander, James A., Raphael Amit and Werner Antweiler, 2002. Venture-Capital Syndication: Improved Venture Selection vs. the Value-Added Hypothesis. **Journal of Economics and Management Strategy**, 11(3): 423-452.
- Bygrave, William, D., 1987. Syndicated Investments by Venture Capital Firms: A Networking Perspective. **Journal of Business Venturing** 2: 139-154.
- Bygrave, William, D., 1988. The Structure of the Investment Networks of Venture Capital Firms. **Journal of Business Venturing** 3: 137-157.
- Cumming, Douglas J., 2006. The determinants of venture capital portfolio size: Empirical Evidence. **Journal of Business** 79: 1083–1126.
- DeClercq, Dirk and Dimo P. Dimov, 2004. Explaining Venture Capital Firms' Syndication Behaviour: a Longitudinal Study. **Venture Capital** 6: 143-156.
- Doran, Alan and Graham Bannock, 2000. Publicly Sponsored Regional Venture Capital: What can the UK learn from the US Experience? **Venture Capital** 2: 255-185.
- Florida, Richard L., Donald F. Smith and Elizabeth Sechoka, 1991. Regional patterns of venture capital investment. In: Green, Milford, ed., **Venture Capital: International Comparisons** (Routledge, London and New York) pp 102-133.
- Fritsch, Michael and Dirk Schilder, 2006. **Is Venture Capital a Regional Business? The Role of Syndication**. Discussion Papers on Entrepreneurship, Growth and Public Policy #2506, Max Planck Institute for Research into Economic Systems – Group Entrepreneurship, Growth and Public Policy, Jena, Germany.
- Fritsch, Michael and Dirk Schilder, 2007. Does Venture Capital Investment Really Require Spatial Proximity? An Empirical Investigation. **Environment and Planning A**: forthcoming (accepted for publication).
- German Private Equity and Venture Capital Association, 2006, “Statistics” <http://www.bvk-ev.de>.
- Gompers, Paul A., 1995. Optimal Investment, Monitoring, and the Staging of Venture Capital. **The Journal of Finance** 50: 1461-1489.
- Gompers, Paul A., 1996. Grandstanding in the Venture Capital Industry. **Journal of Financial Economics** 42: 133–156.
- Gompers, Paul and Joshua Lerner, 2001. The Venture Capital Revolution. **Journal of Economic Perspectives** 15: 145-168.

- Green, Milford B., 1991. Preferences for US Venture Capital Investments 1970 - 1988. In: Green, Milford, ed., **Venture Capital: International Comparisons**, London and New York: Routledge 1991, 18-58.
- Gupta, Anil K. and Harry J. Sapienza, 1992. Determinants of Venture Capital Firms' Preferences Regarding the Industry Diversity and Geographic Scope of their Investments. **Journal of Business Venturing** 7: 347-362.
- Hochberg, Yael V., Ljungqvist, Alexander and Lu Yang, 2007. Whom You Know Matters: Venture Capital Networks and Investment Performance. **Journal of Finance** 62: 251-301.
- Lerner, Joshua, 1994: The Syndication of Venture Capital Investments. **Financial Management** 23: 16-27.
- Lerner, Joshua, 1995. Venture Capitalists and the Oversight of Private Firms. **Journal of Finance** 50: 301-318.
- Lockett, Andy and Mike Wright, 1999. The syndication of private equity: evidence from the UK. **Venture Capital** 1: 303-324.
- Lockett, Andy and Mike Wright, 2001. The syndication of venture capital investments. **Omega** 29: 175-190.
- Manigart, Sophie, Andy Lockett, Miguel Meuleman, Mike Wright, Hans Landström, Hans Bruining, Philippe Desbrières and Ulrich Hommel, 2006. Venture Capitalists' Decision to Syndicate. **Entrepreneurship Theory and Practice** 30: 131-153.
- Martin Ron, Peter Sunley, Dave Turner, 2002. Taking Risks in Regions: the Geographical Anatomy of Europe's Emerging Venture Capital Market. **Journal of Economic Geography** 2: 121-150.
- McGlue, David 2002. The Funding of Venture Capital in Europe: Issues for Public Policy. **Venture Capital** 4: 45-58.
- Powell Walter W., Kenneth W. Koput, Bowie James I. and Laurel Smith-Doerrs, 2002: The Spatial Clustering of Science and Capital: Accounting for Biotech Firm – Venture Capital Relationships. **Regional Studies** 36: 291-205.
- Sapienza, Harry J., Sophie Manigart and Wim Vermeir, 1996. Venture Capitalist Governance and Value Added in Four Countries. **Journal of Business Venturing** 11: 439-469.
- Schilder, Dirk, 2006. **Public Venture Capital in Germany – Task Force or Forcing a Task?** Technical University Bergakademie Freiberg, Faculty of Economics and Business Administration, Working Paper 12/2006.

- Sorensen, Olav and Toby E. Stuart, 2001. Syndication Networks and the Spatial Distribution of Venture Capital Investments. **American Journal of Sociology** 106: 1546-1588.
- Sunley, Peter, Britta Klagge, Christian Berndt, Ron Martin, 2005. Venture capital programmes in the UK and Germany: In what sense regional policy? **Regional Studies** 39: 255-273.
- Wassermann, Stanley and Katherine Faust, 1994. **Social Network Analysis**, Cambridge: Cambridge University Press 1994.
- Wright, Mike and Andy Lockett, 2003. The Structure and Management of Alliances: Syndication in the Venture Capital Industry. **Journal of Management Studies** 40: 2073-2102.
- Zook, Matthew; 2002. Grounded capital: Venture financing and the geography of the internet industry, 1994 - 2000. **Journal of Economic Geography** 2: 151-177.

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