Patterns in Spatial Proximity between Venture Capital Investors and Investees in Germany

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PATTERNS IN SPATIAL PROXIMITY BETWEEN VENTURE CAPITAL INVESTORS AND INVESTEES IN GERMANY

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Abstract

The paper analyzes patterns in spatial proximity between venture capital investors and investees. We use a dataset of 1256 dyads of venture capitalists and German new ventures which have closed a financing round between January 2002 and March 2007. Our results indicate that different factors relating to characteristics of the new venture, the venture capitalist and the financing round help explain variations in spatial proximity. We find that spatial proximity is more likely for younger ventures and for smaller, (quasi)-public and less specialized venture capitalists. Our evidence indicates that syndication is associated with a wider geographic spread of investments and that consecutive financing rounds are more likely with close distances. Furthermore, we find different effects for lead- and co-investors. Finally, we discuss implications for entrepreneurs, venture capitalists as well as policy makers and outline areas for future research.

Keywords: Venture capital, new venture, spatial proximity, entrepreneurial finance

JEL Codes: G24, G31, M13

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1 Introduction

The role of venture capital for regional development is widely discussed in theory and practice (Florida and Kenney, 1988; Mason and Harrison, 2002; Achleitner et al., 2009). As venture capital investors provide financing to young, high risk and high growth companies, venture capital plays a vital role in alleviating economic growth (Samila and Sorenson, 2008). Furthermore, venture capitalists are found to accelerate innovative output in their portfolio companies (Kortum and Lerner, 2000; Chen, 2009). In addition to this direct effect, the venture capital market also has a positive indirect effect on economic renewal through spill-over effects of the R&D activities in the ventures they nurture (Jaffe, 1986; Audretsch and Feldman, 1996). In this context, the importance of spatial proximity between venture capitalists and their portfolio companies is a relevant topic as it can explain the importance of locally established venture capital firms for a region.

Informational asymmetries as well as transaction costs are expected to be less pronounced in deals with close spatial proximity between the venture capital investor and the new venture. In addition, local networks can help to initiate the first contact, conduct the due diligence, and can be helpful in post-investment support. Empirical evidence of Anglo-Saxon venture capital markets such as the UK, the US or Canada underlines these arguments and shows that venture capital investors prefer investments in close geographic distances (e.g. Mason, 1992; Sorenson and Stuart, 2001; Cumming and Johan, 2006). However, it is not yet fully understood whether the mechanisms behind the importance of spatial proximity differ between certain types of new ventures or venture capitalists.

Evidence on the importance of spatial proximity in denser infrastructures with less pronounced clusters is limited and reveals contradictory results. Based on a survey of German venture capitalists, Fritsch and Schilder (2008) found that the interviewed venture capitalists
did not see spatial proximity as an important investment decision factor. They offer two main explanations for their diverging results compared to other studies. First, Germany has a dense travel infrastructure with a tight network of flight connections, train connections and highways which makes it relatively easy to reach nearly all locations. Second, German venture capitalists may be forced to invest in more dispersed geographic locations in order to find attractive investment opportunities because there may be a relatively lower number of such opportunities in Germany compared to more mature venture capital markets. However, their findings are based on a small sample of German venture capitalists and the perception of venture capitalists on the importance of spatial proximity may differ from their actual investment behavior.

We therefore set out to further investigate spatial proximity effects in venture capital finance and we focus on two main research gaps. First, we investigate the particularities of Germany as a venture capital market with a dense infrastructure and less pronounced spatial clusters than e.g. in the US. In analyzing specific patterns in spatial proximity between venture capitalists and their investees in this institutional context, we yield evidence on the relevance of spatial proximity in a smaller geographical radius. Second, our paper sheds light on how the likelihood of spatial proximity relates to certain factors characterizing the new venture, the venture capitalist and the deal. Analyzed factors include the development stage of the new venture as well as the size, experience, level of specialization and type of the venture capitalist. Finally, round specific aspects such as the syndication benefit or consecutive investment rounds are analyzed. In addition to these characteristics, we investigate differences between lead- and co-investors in regard to the found relationships.

We use a sample of 1256 dyads of venture capitalists and German new ventures which were involved in a financing round between January 2002 and March 2007 based on a dataset from Dow Jones VentureSource. For estimating spatial proximity between the venture capitalist and the new venture we use the minimum journey time which for longer distances includes
travel by plane. We find spatial proximity to be more likely for younger ventures and for smaller, (quasi-) public and less specialized venture capitalists. Furthermore, we reveal that syndication is associated with larger distances and consecutive rounds to be more likely with shorter journey times between the venture capitalist and the investee. In addition, we show that the patterns in spatial proximity differ between lead- and co-investors.

Important implications can be drawn from our detailed analysis of patterns in spatial proximity in the venture capital market. Venture capitalists can review their investment strategies in terms of their geographic focus in the light of their specific business model. Entrepreneurial teams can gain important insights on where to focus their search for adequate venture capitalists. Public policy makers can get a view on the group of new ventures for which locally established venture capital investors seem to be particularly important. Hence, they can evaluate what type of new ventures profit the most from policies targeting to build up a vital local venture capital market.

2 Theoretical background and hypotheses

The relationship between venture capital investors and investees is often investigated in the light of principal agent theory (e.g. Gompers, 1995; Wright and Robbie, 1998; Sapienza and De Clercq, 2000; Kaplan and Strömberg, 2001). The venture capitalist can be viewed as principal investing in a new venture in which the entrepreneurial team as agent has an informational advantage pre- and post-investment e.g. in regard to the business model, the technology, the product or the service and regarding their own experience and capabilities (Sapienza, 1992; Hellmann and Puri, 2002). These informational asymmetries can lead to incentive problems which can be defined as agency costs. In order to reduce these costs, monitoring and bonding are described as two general solutions (Jensen and Meckling, 1976) which can be applied to the venture capital context. The screening and intensive appraisal of a potential investment through due diligence can be subsumed under monitoring. The venture capitalist
evaluates the uncertainty related to the investment based on different investment criteria such as characteristics of the entrepreneur, the product, the market and the financial situation of the venture (Kollmann and Kuckertz, 2009). Furthermore, monitoring also includes measures of control applied post-investment by the venture capitalist, e.g. through a seat on the board of directors, special control and voting rights or frequent reporting obligations of the venture (Gompers, 1995; Kaplan and Strömberg, 2001). Bonding measures include self bonding contracts by the entrepreneurial team which align the interests of the venture capital investor and the investee (Kaplan and Strömberg, 2003). In addition, high reputation can serve as a signal for post-investment behavior of the venture capitalist and the entrepreneurial team.

The journey time between the new venture and the venture capitalist as proxy of spatial proximity is likely to affect the measures to mitigate agency costs as described above. Pre-investment, the screening and due diligence process is easier and less expensive for venture capitalists if they are located closer to the venture. Onsite meetings and personal contacts are less difficult to arrange. In addition, it is less complicated to acquire information through direct or indirect sources on the venture or the venture capitalist if both of them are based in the same geographic region. Therefore, the reputation of potential partners is easier to assess if a personal regional network can be used. Post-investment, frequent visits to the venture are easier to undertake as less time is spend in transit. Therefore, short journey times facilitate monitoring of the venture capitalist as the direct involvement in the venture and control of the entrepreneurial team is easier to pursue (Sorenson and Stuart, 2001).

Transaction cost theory uses the total transaction costs, which include all costs and disadvantages incurred by the contracting parties in order to realize a transaction, as criteria to evaluate alternative institutional structures or transactions (Williamson, 1981). Accordingly, a venture capital investor is going to choose the investment opportunity with lowest transaction costs when deciding between opportunities with identical expected returns. Many of the transaction costs relevant in a venture capital deal are sensitive to the geographic dispersion of the in-
involved parties. Search and information costs are expected to be lower if the venture capital investor and the new venture are located in the same area because they can use their regional network to identify and evaluate potential targets. Negotiation and decision costs occur in an iterative process prior to closing a venture capital deal whereas monitoring and enforcement costs become relevant post-investment. All of these costs incur travel and information expenses which are less when the journey time between the venture capitalist and the new venture is short (Sorenson and Stuart, 2001). Information expenses are likely to be higher for more dispersed dyads of venture capitalists and new ventures because less experience with local markets, regional particularities or local service providers is likely to require additional information which leads to higher labor effort or the need for support from third parties. Hence, it can be assumed that transaction costs decrease with shorter journey times between the venture capitalist and the venture.

In addition, social exchange theory postulates that the likelihood and intensity of a relationship increases sharply if parties are located close to each other as the probability of a random encounter is higher and a reduced effort is necessary to get in contact with each other (Thibaut and Kelley, 1959; Blau, 1977). Local personal relationships facilitate the transfer of information as well as tacit knowledge and build closely knit personal networks (McPherson et al., 2001). Applied to the venture capital context, this implies that short journey times between the venture capital investor and investee not only facilitate opportunity recognition through denser local networks but also enhances value-adding activities post-investment as the transfer of information as well as tacit knowledge and the provision of local contacts is easier.

In the light of principal agent theory, transaction cost theory and social exchange theory described above, we hypothesize that the likelihood of short journey times between venture capital investors and investees will be systematically associated to certain characteristics of
the parties involved and the type of deal. These characteristics are shortly described below and summarized in testable hypotheses.

**Development stage of the new venture**

The development stage of the new venture is likely to impact the need for a thorough due diligence pre-investment and for monitoring and non-financial support by the venture capitalist post-investment. Less developed companies are usually characterized by technological, resource or management uncertainties and, therefore, problems arising from informational asymmetries can be expected to be stronger than in more mature companies. Furthermore, ventures in early development stages usually have a small network with a strong regional bias which makes it even more difficult to gather information about the venture (Sorenson and Stuart, 2001). In addition, entrepreneurial teams of less mature companies are likely to be less experienced and to be less complementary in their set of capabilities. Thus, it can be expected that they require more non-financial support by the venture capitalist compared to more mature companies (Gupta and Sapienza, 1992; Powell et al., 2002; Jain, 2001). Due to the venture capitalist’s aim to react appropriately to unexpected developments of the venture, the level of monitoring is correlated with the amount of business risk (Barney et al., 1989) leading to more intense monitoring in early development stages of the new venture. As monitoring is easier in spatial proximity, the venture development stage is likely to be related to shorter journey times. Therefore, we hypothesize:

\[ H1: \text{The age of the new venture is positively associated with the minimum journey time between the venture capitalist and the investee.} \]

**Size and experience of the venture capitalist**

Larger venture capital investors are usually able and required to operate within a broader geographic scope. They are likely to have a more dispersed network of contacts and are more
visible in the industry compared to smaller venture capitalists. Therefore, they are able to receive comparably more supra-regional deal flow which can imply higher geographical distance to their portfolio companies compared to smaller venture capitalists (Gupta and Sapienza, 1992). Furthermore, a larger fund size implies that they have to include a larger geographic radius in order to find a sufficient number of high potential new ventures. Thus, we posit:

**H2: The amount of assets under management is positively associated with the minimum journey time between the venture capitalist and the investee.**

In addition to size, the experience of a venture capitalist is also likely to influence the size and geographic dispersion of his network (Sorenson and Stuart, 2001). We use age as proxy for the experience of a venture capitalist. With increasing age, the venture capitalist can build on a growing network of contacts from prior investments. This includes contacts to other industry players as well as to other venture capitalists with which syndicated investments were realized. Furthermore, the reputation of more experienced venture capitalists is also likely to be higher. More experienced venture capitalists are therefore expected to receive more supra-regional deal flow and to be able to support their portfolio companies with a larger network of contacts post-investment compared to less experienced venture capitalists. On average, this could lead to more distant investments by more experienced investors (Powell et al., 2002). However, in addition to the spatial structure of the venture capitalist’s network and thus deal flow also the quantity and quality of deal flow has to be considered. As has been stated, more experienced venture capitalists are expected to have tighter and larger networks, a higher reputation, and thus are likely to receive more and potentially better deal flow compared to younger industry players. If more experienced venture capitalists have the choice, they might focus their efforts on more proximate investment opportunities because they are easier to assess as well as to manage in the future. In contrast, less experienced venture capitalists might be restricted by their deal flow, which forces them to also accept more distant invest-
ment opportunities in order to build up their network and reputation (Cumming and Dai, 2009). Hence, we summarize:

*It is unclear whether experience of the venture capitalist is positively or negatively associated with the minimum journey time between the venture capitalist and the investee. Thus, no hypothesis can be formulated. Nonetheless, the experience of the venture capitalist could turn out to be a relevant variable for the importance of spatial proximity.*

**Specialization of the venture capitalist**

The level of specialization of a venture capitalist is likely to be related to the geographic dispersion of its portfolio companies. Local markets may not offer sufficient numbers of attractive investment targets in a certain industry or development stage. Therefore, venture capitalists with a high specialization on an industry or stage are likely to be forced to include a broader geographic region in their search for attractive investment targets. However, more specialized venture capitalists are found to be more involved in monitoring and supporting the new venture (Murray and Lott, 1995) and to interact more frequently with the new venture (Sapienza et al., 1996). As short distances ease the provision of monitoring and support, spatial proximity could be more important for more specialized venture capitalists. We thus conclude:

*It is unclear whether industry or stage specialization of the venture capitalist is positively or negatively associated with the minimum journey time between the venture capitalist and the investee. Thus, no hypothesis can be formulated. Nonetheless, industry or stage specialization of the venture capitalist could turn out to be relevant variables for the importance of spatial proximity.*

**Type of venture capitalist**
Corporate venture capitalists are expected to focus their venture capital activities on industries related to the industry of their holding company in order to create strategic benefits. Therefore, they are likely to have a rather narrow industry focus which may require a larger geographic investment radius in order to find appropriate investments. Also, corporate venture capitalists may perceive higher risks of more distant investments differently as they are focused on strategic advantages of an investment such as a window on technology or strategic synergies (Knockaert et al., 2006). Furthermore, corporate venture capitalists tend to have a high public visibility due to their holding company so that they receive distant investment opportunities. Thus, we expect the likelihood of spatial proximity to be lower for corporate venture capitalists.

In contrast to non-publicly funded venture capitalists which are solely focused on achieving a financial return, (quasi-)public venture capitalists also pursue the objective to facilitate regional development through their investments. Therefore, they target a specific region with their investment strategy and, hence, they should be located closer to their portfolio companies compared to other venture capitalists (Gupta and Sapienza, 1992; Fritsch and Schilder, 2008). Thus, we hypothesize:

**H3a:** Corporate venture capitalists are positively associated with the minimum journey time between the venture capitalist and the investee.

**H3b:** (Quasi)-public venture capitalists are negatively associated with the minimum journey time between the venture capitalist and the investee.

**Consecutive investment round**

As explained above, informational asymmetries and transaction costs are expected to be lower for deals with shorter journey times between the venture capitalist and the venture. In addition, the support through the provision of local contacts is easier. Therefore, it can be hypothesized that financing rounds which include venture capital investors and investees lo-
cated closer to each other incur less problems compared to financing rounds with regionally dispersed actors. In addition, venture capitalists could be more willing to finance consecutive financing rounds of ventures close to them as they have build up a closer relationship and as value-adding activities in future rounds are easier. Underlining these arguments, Sapienza and Gupta, (1994) find first empirical evidence that geographic distance and the venture’s performance are negatively correlated. The likelihood of receiving future financing rounds is then expected to be higher for deals with closer spatial proximity between the venture capital investor and the investee. We thus posit:

\[ \textit{H4: Consecutive investment rounds are negatively associated with the minimum journey time between the venture capitalist and the investee.} \]

\[ \textit{Lead-investor vs. co-investor and syndication benefit} \]

Lead-investors usually have a key role in a syndicated venture capital deal. They are likely to be more involved in trying to mitigate informational asymmetries by supporting and monitoring the venture more closely compared to co-investors. Empirical evidence shows that they have more face to face meetings with the management of their portfolio companies compared to co-investors (Wright and Lockett, 2003) and that they spend more time on average per month to visit a portfolio company (Elango et al., 1995). Therefore, it is expected that for lead-investors spatial proximity to the venture is more important than for co-investors.

Furthermore, first empirical indications exist that syndication is used to overcome challenges of regionally dispersed investments (Fritsch and Schilder, 2006). A syndicate may profit from one investor being close to the venture regardless whether that investor has the role of the lead investor. Spatial proximity could be less important for a venture capitalist as long as at least one member is located close to the new venture. In addition, despite a usually dominant role of the lead investor, the members of a syndicate are expected to share the due diligence and later on the monitoring as well as support of the new venture. Therefore, it is likely that
spatial proximity is less relevant in a syndicate when at least one investor is located close to the venture, thereby creating a syndication benefit (Tyková and Schertler, 2008; Cumming and Dai, 2009). Thus, we anticipate:

\textit{H5a: Lead investors are negatively associated with the minimum journey time between the venture capitalist and the investee.}

\textit{H5b: The syndication benefit is positively associated with the minimum journey time between the venture capitalist and the investee.}

3 Empirical evidence

3.1 Sample description and methodology

Our analysis is based on a sample of 1256 dyads of venture capitalists and new ventures which have closed a financing round between January 2002 and March 2007. The dyads include 474 German new ventures that received 657 financing rounds from 245 venture capitalists. The data was gathered from the Dow Jones VentureSource database. In total, VentureSource reports 1402 dyads of venture capitalists and portfolio companies. Unfortunately, 146 dyads had to be excluded due to missing values in the specialization variables. In order to check whether our sample represents the population of German venture capital investments, we compared our sample to the aggregated data from the German Venture Capital and Private Equity Association (BVK). The BVK has one of the most comprehensive aggregated data sources for the German venture capital market. Our sample represents c. 40% of the investment volume reported by BVK and c. 15% in terms of the number of companies. Our sample underrepresents small investments and it is not representative of investments by German MBGs (Mittelständische Beteiligungsgesellschaften). MBGs are regional development agencies which are largely supported by the public sector. Typically, they invest relatively small volumes, mainly in the form of mezzanine capital and usually they do not offer hands-on support to their
investees (Achleitner et al., 2009). Therefore, our data represents mainly “pure” venture capital including both financial as well as non-financial support.

**Dependent variable: Minimum journey time**

Various measures of spatial proximity like spherical distance, car distance, or car travel time are proposed in the literature (Lerner, 1995; Sorenson and Stuart, 2001; Fritsch and Schilder, 2006). These measures have the common weakness of providing very large values for longer distances, especially for intercontinental relationships. The long distance does not represent the actual journey time in case a good flight connection exists. Venture capitalists are highly time constrained and, hence, prefer the shortest journey time. They would prefer a flight connection over a long car distance even if this would imply higher travel costs. In order to represent spatial proximity more realistically, one therefore has to estimate the shortest journey time which can be achieved with different means of transport including car or airplane. By using the minimum journey time, we adequately account for long distances between the venture capitalist and the new venture.

We used Google Maps to collect average travel times by car between the two parties’ ZIP codes. In case a venture capitalist runs several offices, we assumed that the office located the closest to the new venture is in charge of the deal. If the journey time by car was greater than three hours, a flight option was investigated. Then the journey time was assumed to be the sum of the journey time by car from the investor to the closest airport, a check-in time of 60 minutes, the average flight time to the airport closest to the venture, a check-out time of 30 minutes and the journey time by car from the airport to the venture. The appropriate airport was assigned to each venture capitalist and new venture as follows: First, Germany was divided into 97 areas according to the first two digits of the five digit ZIP code. Second, each of the areas was assigned to one of the 13 largest German airports. If there was no flight connection between two airports or if a foreign venture capitalist was involved, the optimal flight connec-
tion was investigated manually. Finally, the smaller value of car or flight option was used as minimum journey time. In c. 30% of the dyads the flight option was finally used.

**Independent variables**

*Development stage of the new venture.* We used the age of the new venture in years at each financing round provided by VentureSource as proxy for the development stage of the new venture.

*Size and experience of the venture capitalist.* Assets under management on the firm level were used as proxy for the size of a venture capitalist. For experience, we used age of the venture capital firm in years at each financing round as proxy. Both of these variables were provided in the VentureSource database.

*Specialization of the venture capitalist.* To characterize the portfolio strategy of each venture capitalist on the firm level, we used Herfindahl-Hirschman Indices (HHI) to measure the specialization across different industries and financing stages. To calculate the HHI, the fraction of investment rounds per industry and stage was determined for each venture capitalist over the whole sample time period. The respective fractions were then squared and summed up. In consequence, a HHI of 1 indicates a very high specialization (i.e. a venture capitalist investing in only one industry or stage) and a HHI close to 0 indicates a very high diversification. The venture capitalists included in our analysis participated in at least three financing rounds throughout the sample period. As categorization of industries, the VentureSource industry segment, which entails 16 categories, was used. The VentureSource round class, which comprises seed stage, first stage, second stage, and later stage, was used to categorize financing stages for the stage specialization variable.

*Type of venture capitalist.* We determined the type of venture capitalist by analyzing his shareholder structure. Most of the venture capitalists report their shareholder structure to the BVK which publishes them on their website. In case a venture capitalist was not included, a
web search was conducted or the venture capitalist was contacted directly. Each venture capitalist was categorized in one of the following three groups: independent venture capitalist, corporate venture capitalists and (quasi-)public venture capitalists (i.e. subsidiaries of savings or cooperative banks, state banks, promotional banks, and other institutions linked to the German government). We included two dummy variables in our analysis for corporate venture capitalists and (quasi-)public venture capitalists.

**Consecutive investment round.** We used a discrete variable indicating the number of financing rounds by an investor as given in VentureSource. Hence, the first financing round had the index number zero, the second financing round the index number one and so forth until the last financing round from one particular venture capitalist.

**Lead-investor vs. co-investor.** We created a dummy variable for lead investors based on the data given in VentureSource.

**Syndication benefit.** In order to measure the benefit of syndication to overcome longer journey times, we constructed a numerical variable. We calculated the ratio of the venture capitalist’s journey time to the new venture to the shortest journey time to the new venture in the syndicate. We increased the numerator as well as the denominator by one to avoid a division by zero and finally subtracted one in order to set the syndication benefit to zero in case the venture capitalist’s journey time was equal to the shortest journey time in the syndicate. We used the following formula to calculate the syndication benefit:

$$\text{Syndication benefit} = \frac{\text{VC’s journey time} + 1}{\text{Closest journey time in the syndicate} + 1} - 1$$

**Control variables**

To control for further effects influencing journey times between venture capitalists and new ventures, we also collected several control variables. To account for structural differences in the historical and present economic development as well as development of the German ven-
ture capital industry, a dummy variable was collected which entails whether a new venture is located in the former German Democratic Republic (GDR). Venture capitalists might also perceive investment opportunities differently depending on whether the venture is located in an urban or rural area. Therefore, data on the annual population density of each German district was collected from the GENESIS database of the federal statistical office. We constructed a dummy variable based on the annual population density which was one for urban areas and zero otherwise. Furthermore, we controlled for economic development by including the discrete return of the MSCI Germany Small Cap Index over the last twelve months before the respective financing round. These variables were collected from Datastream. Finally, the venture capitalist’s total number of offices in Germany as provided by VentureSource was included to control for short journey times between both parties which is simply induced by multiple offices.

Methodology

In comparing the distribution of the minimum journey time to other measures of spatial proximity like car journey time and distance in kilometers, the consequence of the flight option can be seen (see Figure 1). It results in many observations with a journey time between three and four and a half hours. The journey time is not normally distributed due to the multiple maxima as well as the restriction to positive values. In consequence, OLS and Tobit models are not appropriate to analyze the observed spatial proximity (Wooldridge, 2008). However, the journey time can sensibly be divided in ordinal categories, which are easy to interpret. Thus, we use ordered logit regressions to test our hypotheses.

Each dyad was assigned to a certain category depending on its journey time. The used categories are depicted in Figure 2. The first category contains all dyads with a journey time from zero to half an hour, which represents a very short distance and means that the venture is a taxi ride away. The second category (greater than half an hour to one and a half hours) repre-
sents relatively short car distances, while the third category (greater than one and a half hours
to three hours) already represents quite substantial car distances. The fourth category (greater
than three to four hours) mainly contains national and European flight connections as well as
longer car distances. Finally, the fifth category (greater than four hours) contains longer flight
connections.

It is important to recognize that our analysis does not imply causal relationships. Some new
ventures or venture capitalists may intentionally choose their location and, hence, determine
the minimum journey time. However, in most cases it can be assumed that both parties have a
given location and thus a minimum journey time to each other. The journey time may then be
systematically associated to certain factors. Our analysis shows relationships under the ceteris
paribus assumption, but it is not possible to detect causal effects.

*Table 1* shows descriptive statistics of our variables. Some variables either have a very large
skewness or contain some outliers. Whenever it makes economic sense, these variables were
included with their logarithmic value in our final models. In consequence, the problem of
skewness and outliers is alleviated and the impact of these variables is modeled with a de-
creasing impact of their absolute variations. An analysis of the correlation matrix, which is
shown in *Table 2*, offers first insights into bivariate relationships. The correlations of our
variables are small and reveal significant relationships in expected places such as between the
dummy variable for corporate venture capitalists and the industry specialization variable or
the dummy variable for lead investors and the syndication benefit. However, an analysis of
VIFs shows that the correlations did not influence the robustness of our coefficient estimates.

### 3.2 Empirical results

*Table 3* shows the results of our ordered logit regression analysis. Model 1 is our base model
and includes all variables despite the specialization variables. Model 2 also tests the influence
of the venture capitalist’s specialization on the minimum journey times. This test was con-
ducted separately as it reduces the available sample size to 1108 dyads. However, the results are robust across the two models and, thus, the following discussion of results will be mainly based on Model 2. In addition, we tested whether there are structural differences between lead- and co-investors other than the general intercept. Therefore, we ran regressions on different subsamples. The results are shown in Model 3 for a subsample of lead investors and in Model 4 for a subsample of co-investors.

Our models are estimated with the maximum likelihood method and account for heteroskedasticity through estimating Huber-White robust standard errors (White, 1980). Furthermore, we correct the standard errors for non-independence across observations on the same venture capitalist.

Development stage of the new venture

The results show that on average younger ventures exhibit shorter journey times to their investors and thus support Hypothesis 1. A closer look at the separate models for lead- and co-investors reveals that this effect is only significant in the subsample of lead investors. Short journey times seem to be more important for lead investors which underlines that the lead investor plays an important role in monitoring and supporting the venture.

Size and experience of the venture capitalist

All analyzed models show that larger venture capitalists in terms of assets under management have a larger investment radius. It could be that they are under pressure to invest their assets. Thus, Hypothesis 2 is supported. The effect itself seems to be diminishing with increasing size of the venture capitalist because the significance level of the logarithm of assets under management exhibits a higher significance level compared to the linear effect tested in unreported regressions.
The empirical analysis further reveals that older and thus more experienced venture capitalists on average invest in more proximate ventures. In consequence, the effect that more experienced venture capitalists are able to choose more proximate investment opportunities among a higher quantity and quality of deal flow outweighs the effect of a geographically more dispersed network. However, this effect is not significant.

Specialization of the venture capitalist

Model 2 indicates that longer journey times are associated with higher levels of specialization of venture capitalists is in regard to stage but not in regard to industry. Hence, venture capitalists are willing or forced to realize deals with longer journey times in order to follow their stage specialization strategy. Model 3 and Model 4 reveal that there seem to be structural differences between lead and co-investors. While the stage specialization variable is highly significant for the co-investor sample, it is not significant for the lead investor sample. Therefore, syndication is used by stage specialists to overcome longer distances particularly in the role of co-investors. The value adding activities are less relevant for them as usually the lead investor has a dominant role post-investment in supporting and monitoring the venture leading to a lower importance of spatial proximity for co-investors than for lead investors.

The coefficient for the industry specialization is not significant and not robust across the Models 2, 3 and 4. This may imply that shorter journey times are more relevant for venture capitalists specialized in a certain industry rather than a certain stage in order to provide industry-specific support such as networks. At the same time, an industry specialization may also lead to a larger geographic radius in order to find appropriate deals. Taken together, these effects may explain the non-significant relationship between industry specialization and journey times. Alternatively, the results may also be explained by the spatial structure of investment opportunities. Some industries are characterized by particularly pronounced clusters. For instance in Germany, the biotechnology industry is clustered around the Munich
area in Martinsried and in the Rhine-Neckar area or the optical industry is concentrated around Jena. In consequence, venture capitalists specialized in these industries may locate close to the clusters and, thereby, they still receive sufficient deal flow.

Type of venture capitalist

The coefficient of corporate venture capitalists is positive and, hence, points in the hypothesized direction that co-investors are willing to invest in more distant ventures due to their strategic interests and industry focus. However, the estimated coefficients are not significantly different from zero and, therefore, we can not support Hypothesis 3a.

The results support hypothesis 3b, which states that semi-profit oriented venture capitalists invest in more proximate ventures. These venture capitalists are mainly influenced by public policy or other restrictions, which leads to a limitation of their target area on specific regions.

Consecutive investment round

Consecutive investment rounds by the same venture capitalist have on average shorter journey times which supports Hypothesis 4. This result indicates that the spatial proximity between both parties is relevant in order to continue the relationship. The observed shorter journey times of consecutive investment rounds may have two rationales. Either the involved parties decide not to continue distant relationships more often because closer relationships have more advantages. Or portfolio companies decide to move their venture closer to typical locations of venture capital investors after initial investment rounds because proximity is regarded as success factor. As the second rationale seems to be less realistic, the effect may prove the importance of spatial proximity for venture capital investment decisions.

Lead-investor vs. co-investor and syndication benefit
The coefficient of the lead-investor dummy variable points into the expected direction; on average lead investors are located closer to the new ventures compared to co-investors. However, the coefficient is not significantly different from zero and we can therefore not support Hypothesis 5a. But a comparison of the results of the different subsamples in Model 3 and Model 4 indicate that there are structural differences between lead- and co-investors. A Chi² difference test whether the models on the divided subsamples provide a better fit compared to Model 2 is significant at a 10% level. In most cases the difference in the coefficient’s point estimates for lead and co-investors are in line with our hypotheses. Thus, the coefficients for the venture’s age, the venture capitalist’s age and the consecutive financing round indicate a stronger impact for lead investors compared to co-investors. In contrast, the venture capital investor’s size has a greater impact on the average minimum journey time for co-investors compared to lead investors. This implies that co-investors are less reluctant to increase their investment radius in order to find a sufficient number of investment opportunities compared to lead investors. Furthermore, specialized venture capital investors seem to prefer the role of a co-investor if they are investing in more distant ventures as the coefficient for specialization is more pronounced for co-investors. The remaining coefficients for the corporate venture capitalist dummy and industry specialization show mixed results.

Our analysis shows that the minimum journey time of a venture capitalist is significantly higher if he syndicates the deal with another venture capitalist which is closer to the new venture. Thus, Hypothesis 5b is supported. This further supports the notion that syndication acts as an instrument to overcome large distances.

3.3 Robustness checks

Various robustness checks were conducted to verify the empirical results presented above. All models were tested for multicollinearity. The maximum VIFs in our models of around 3.5 are relatively low (Wooldridge, 2008) and indicate that there is no problem of multicollinear-
ity in our variables (see Table 3). We also conducted an outlier analysis with leverage-versus-squared-residual plots, Cook’s D influence statistics and DfBeta statistics (Rousseeuw and Leroy, 2003). The potential outliers were excluded from our ordered logit regression, but the results remained the same.

In unreported regressions, multiple alternative category definitions for the dependent variable minimum journey time were tested. Furthermore, alternative model definitions including smaller sub-models were tested. The results remained unchanged which supports the reported results. In addition, alternative measures of spatial proximity such as car journey time and distance in kilometers were tested. Unreported regressions suggest that alternative measures do not lead to differing results. However, the models based on minimum journey times show a better fit based on the Nagelkerke’s $R^2$, the McFadden’s $R^2$ and the Akaike Information Criterion (AIC).

For all presented models we also tested OLS regressions with $\ln(1 + \text{minimum journey time})$ as dependent variable and Tobit regressions with the untransformed minimum journey time as dependent variable. Our results remain unchanged with only minor differences in the significance of the coefficients.

4 Conclusion

We make two important contributions with our paper. First, we analyze whether spatial proximity measured as minimum journey time is likely to be relevant in venture capital finance even in a small geographic radius focusing on Germany as a country with a dense infrastructure. Second, we investigate how spatial proximity is systematically related to characteristics of the new venture, the venture capitalist and the investment round. We use a dataset of 1256 dyads of venture capitalists and German new ventures which closed a financing round between January 2002 and March 2007. We apply ordinal logit regressions to depict patterns in the geographic dispersion of these dyads.
An important finding is that younger ventures are likely to be located closer to their venture capitalist. This is in line with principal agent theory as age is an indicator for the level of informational asymmetries. Our results suggest that a local investor base is crucial to support new ventures in their initial phases of company development thereby helping to spur innovation within regions. This has important implications for policy makers in countries which have pronounced clusters of venture capitalists in certain regions. It could possibly help to improve regional development in deprived areas if a local venture capital market is fostered through institutional settings.

In addition, we find that larger venture capitalists are forced to increase their investment radius in order to find a sufficient number of high potential ventures and seem to have a larger network from which they benefit as they are found to realize more geographically dispersed deals. Venture capitalists with a high degree of specialization in terms of stage were found to realize deals with less spatial proximity. Also, corporate venture capitalists on average invest in more distant new ventures. As expected, semi-profit oriented venture capitalists in our sample were focused on local new ventures in their investment strategy. Finally, we found structural differences between lead and co-investors and relevance of a syndication benefit if a co-investment includes a venture capitalist which is particularly close to the new venture.

An important limitation of our study is the problem of causality. Spatial proximity is not a pure endogenous variable but is likely to impact the investment decision. Venture capitalists and/or new ventures are likely to base their decision to close a deal also on the geographical distance between them. This effect then determines the composition of our sample of venture capital financing rounds and causes the relationships that we explored in our study. In consequence, our results can not be interpreted as causal relationships but have to be interpreted as correlations. Future studies could tackle this problem by modeling spatial proximity in conjecture with other decisive factors as a variable impacting the likelihood that a venture capital financing round will take place to shed further light on this issue.
Overall, our results indicate that the patterns in spatial proximity in venture capital finance are shaped by a broad combination of factors. In finding patterns in the geographic dispersion of German venture capital deals, we are able to show that the relevance of spatial proximity seems to differ systematically for certain types of new ventures, venture capitalists and deals. This gives an important indication that spatial proximity is in fact relevant for an investment decision even in dense infrastructures like Germany contradicting the findings of Fritsch and Schilder (2008). Our study leads to important implications for entrepreneurial teams, venture capitalists and policy makers alike as the results give indications for what type of venture capital deals spatial proximity seems to be particularly relevant and, hence, a vital, locally established venture capital market appears to be more important.
References


Cumming Douglas J., Dai Na. Local bias in venture capital investments. working paper, York University, University of New Mexico 2009.


Samila Sampsa, Sorenson Olav. Venture capital, entrepreneurship, and regional economic growth. working paper, Brock University, University of Toronto 2008.


Appendix

Figure 1: Distribution of different measures of spatial proximity

The figure shows frequency as well as cumulative density distribution of different measures of spatial proximity. The sample consists of 1256 dyads of venture capitalists and German new ventures which have closed a financing round between January 2002 and March 2007.
Figure 2: Categorization of minimum journey time

The figure shows the categorization of the minimum journey time which we used in our ordinal logit regression analysis. The sample consists of 1256 dyads of venture capitalists and German new ventures which have closed a financing round between January 2002 and March 2007.
Table 1: Descriptive statistics
This table reports descriptive statistics for the variables used in the ordered logit regression analysis. The sample consists of 1256 dyads of venture capitalists and German portfolio companies which have closed a financing round between January 2002 and March 2007. Smaller sample size for HHI (Herfindahl-Hirschman Index) variables due to missing values.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Median</th>
<th>Min.</th>
<th>Max.</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ordinal minimum journey time</td>
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<td>3.00</td>
<td>1.00</td>
<td>5.00</td>
<td>1,256</td>
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<tr>
<td>New venture's age in years</td>
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<td>1.40</td>
<td>-4.51</td>
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<tr>
<td>Assets under management in EUR millions</td>
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<td>4.83</td>
<td>0.69</td>
<td>10.57</td>
<td>1,256</td>
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<td>VC's age in years</td>
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<td>-3.13</td>
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<tr>
<td>HHI stage</td>
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<td>1.00</td>
<td>1,108</td>
</tr>
<tr>
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<td>0.00</td>
<td>0.00</td>
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<td>1,256</td>
</tr>
<tr>
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<td>1,256</td>
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<td>No. of consecutive round</td>
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<td>0.00</td>
<td>7.00</td>
<td>1,256</td>
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<tr>
<td>Dummy lead-investor</td>
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<td>Syndication benefit</td>
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<td>0.00</td>
<td>816.00</td>
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</tr>
<tr>
<td>Dummy East German new venture</td>
<td>0.25</td>
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<td>0.00</td>
<td>1.00</td>
<td>1,256</td>
</tr>
<tr>
<td>Dummy urban venture location</td>
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<td>0.00</td>
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<td>1,256</td>
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<tr>
<td>Return of MSCI SC Germany (ltm)</td>
<td>0.09</td>
<td>0.16</td>
<td>-0.46</td>
<td>0.83</td>
<td>1,256</td>
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<tr>
<td>VC's no. of German offices</td>
<td>1.32</td>
<td>1.00</td>
<td>0.00</td>
<td>8.00</td>
<td>1,256</td>
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</table>
Table 2: Correlation matrix
This table presents the correlation coefficients based on Kendall’s tau between the variables used for the ordered logit regression analysis. The sample consists of 1256 dyads of venture capitalists and German portfolio companies which have closed a financing round between January 2002 and March 2007. HHI: Herfindahl-Hirschman Index, * significant at the 5% level.

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<th>12</th>
<th>13</th>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Ln(average venture age in years)</td>
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<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Ln(assets under management)</td>
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<td>1.000</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Ln(venture capitalist age in years)</td>
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<td>0.108 *</td>
<td>0.065 *</td>
<td>1.000</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>HHI industry</td>
<td>0.126 *</td>
<td>0.005</td>
<td>-0.085 *</td>
<td>-0.097 *</td>
<td>1.000</td>
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</tr>
<tr>
<td>HHI stage</td>
<td>0.099 *</td>
<td>0.111 *</td>
<td>0.116 *</td>
<td>0.064 *</td>
<td>0.098 *</td>
<td>1.000</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dummy corporate VC</td>
<td>0.065 *</td>
<td>-0.041</td>
<td>0.013</td>
<td>-0.103 *</td>
<td>0.109 *</td>
<td>0.031</td>
<td>1.000</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Dummy (quasi-)public VC</td>
<td>-0.224 *</td>
<td>-0.014</td>
<td>-0.055 *</td>
<td>-0.031</td>
<td>-0.120 *</td>
<td>-0.131 *</td>
<td>1.000</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of consecutive round</td>
<td>-0.050 *</td>
<td>0.254 *</td>
<td>-0.069 *</td>
<td>0.075 *</td>
<td>0.058 *</td>
<td>-0.016</td>
<td>0.003</td>
<td>-0.027</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dummy lead-investor</td>
<td>-0.033</td>
<td>-0.063</td>
<td>-0.056</td>
<td>-0.017</td>
<td>0.008</td>
<td>0.018</td>
<td>-0.099 *</td>
<td>-0.130 *</td>
<td>-0.165 *</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Syndication benefit</td>
<td>0.370 *</td>
<td>0.032</td>
<td>0.155 *</td>
<td>0.048 *</td>
<td>0.120 *</td>
<td>0.051 *</td>
<td>0.040</td>
<td>-0.015</td>
<td>0.040 *</td>
<td>-0.018 *</td>
<td>0.030</td>
<td>-0.025</td>
<td>-0.120 *</td>
<td>0.025</td>
<td>0.098</td>
</tr>
<tr>
<td>Dummy East German new venture</td>
<td>0.005</td>
<td>0.128 *</td>
<td>-0.097 *</td>
<td>-0.022</td>
<td>-0.072 *</td>
<td>0.002</td>
<td>-0.030</td>
<td>0.230 *</td>
<td>0.051</td>
<td>0.005</td>
<td>-0.053</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dummy urban venture location</td>
<td>-0.057</td>
<td>-0.062 *</td>
<td>0.047 *</td>
<td>0.036</td>
<td>-0.032</td>
<td>0.071 *</td>
<td>0.086</td>
<td>-0.099</td>
<td>0.025 *</td>
<td>0.025</td>
<td>0.027</td>
<td>0.178 *</td>
<td>1.000</td>
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</tr>
<tr>
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<td>0.016</td>
<td>0.112 *</td>
<td>0.076</td>
<td>0.142 *</td>
<td>-0.008</td>
<td>0.033</td>
<td>-0.041</td>
<td>0.015</td>
<td>0.083 *</td>
<td>0.012</td>
<td>0.002</td>
<td>-0.007</td>
<td>0.036</td>
<td>1.000</td>
<td></td>
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<tr>
<td>VC’s no. of German offices</td>
<td>-0.413 *</td>
<td>0.014</td>
<td>0.012</td>
<td>-0.014</td>
<td>-0.318 *</td>
<td>-0.117 *</td>
<td>-0.084 *</td>
<td>0.188 *</td>
<td>0.008</td>
<td>0.003</td>
<td>-0.230 *</td>
<td>0.041</td>
<td>-0.005</td>
<td>-0.015</td>
<td>1.000</td>
</tr>
</tbody>
</table>
Table 3: Ordered logit regressions

This table presents the estimated coefficients of our ordered logit regression analysis with ordinal categories of the minimum travel time as dependent variable. The sample consists of 1256 dyads of venture capitalists and German portfolio companies which have closed a financing round between January 2002 and March 2007. Smaller sample sizes in some models are due to missing values. Standard errors are adjusted for heteroskedasticity and non-independence across observations of the same venture capitalist. HHI: Herfindahl-Hirschman Index; *, **, ***: significant at the 10%, 5%, and 1% level, respectively.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3 (Lead Inv.)</th>
<th>Model 4 (Co-Inv.)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dependent variable: Ordinal minimum journey time</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Independent variables</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ln(new venture age in years)</td>
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<td>0.1497 **</td>
<td>0.2369 ***</td>
<td>0.0960</td>
</tr>
<tr>
<td>Ln(assets under management)</td>
<td>0.3195 ***</td>
<td>0.3195 ***</td>
<td>0.2848 ***</td>
<td>0.3306 ***</td>
</tr>
<tr>
<td>Ln(venture capitalist age in years)</td>
<td>-0.0660</td>
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<td>-0.2170</td>
<td>-0.1328</td>
</tr>
<tr>
<td>HHI industry</td>
<td>0.2936</td>
<td>0.2936</td>
<td>-0.1016</td>
<td>0.4467</td>
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<tr>
<td>HHI stage</td>
<td>1.6339 **</td>
<td>1.0680</td>
<td>0.6495</td>
<td>2.1043 ***</td>
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<tr>
<td>Dummy corporate VC</td>
<td>0.0010</td>
<td>0.1394</td>
<td>1.0680</td>
<td>-0.0833</td>
</tr>
<tr>
<td>Dummy (quasi)-public VC</td>
<td>-1.2782 ***</td>
<td>-1.1449 ***</td>
<td>-1.3862 ***</td>
<td>-1.0722 ***</td>
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<tr>
<td>No. of consecutive round</td>
<td>-0.2280 ***</td>
<td>-0.2301 ***</td>
<td>-0.2150 *</td>
<td>-0.2017 **</td>
</tr>
<tr>
<td>Dummy lead-investor</td>
<td>-0.1580</td>
<td>-0.1345</td>
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</tr>
<tr>
<td>Syndication benefit</td>
<td>0.0083 ***</td>
<td>0.0079 ***</td>
<td>0.0074 **</td>
<td>0.0083 ***</td>
</tr>
<tr>
<td><strong>Control variables</strong></td>
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<td></td>
</tr>
<tr>
<td>Dummy East German new venture</td>
<td>0.6100 **</td>
<td>0.6199 **</td>
<td>1.1275 ***</td>
<td>0.3469</td>
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<tr>
<td>Dummy urban venture location</td>
<td>-0.6593 **</td>
<td>-0.7097 **</td>
<td>-0.6359</td>
<td>-0.6612 *</td>
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<td>VC's no. of German offices</td>
<td>-0.6893 ***</td>
<td>-0.5814 ***</td>
<td>-0.5193 ***</td>
<td>-0.5965 ***</td>
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<tr>
<td>Year f.e.</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>cut1</td>
<td>-1.1672 ***</td>
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<td>-0.4346</td>
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<tr>
<td>cut2</td>
<td>-0.2851</td>
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<td>0.4682</td>
<td>0.7125</td>
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<tr>
<td>cut3</td>
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<td>1.3902 ***</td>
<td>1.3902</td>
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<tr>
<td>cut4</td>
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<td>3.4213 ***</td>
<td>3.6978</td>
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<tr>
<td>N</td>
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<td>691</td>
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<td>LR Chi²</td>
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<td>366.40 ***</td>
<td>131.82 ***</td>
<td>257.47 ***</td>
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<td>Nagelkerke's R²</td>
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<td>McFadden's R²</td>
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<td>0.10</td>
<td>0.12</td>
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<td>-571.20</td>
<td>-937.54</td>
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<tr>
<td>AIC</td>
<td>3513.61</td>
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<tr>
<td>Maximum VIF</td>
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<td>3.42</td>
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