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Venture Capital Investment and Firm Performance: A Spatially-informed Social Network Approach

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Abstract

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State-of-the-art and theoretical arguments
Relational ties and network status, in contrast to armâ??s length transactions, are central to many financial activities. In this study we bring together social network theory and a resource-based view on firm performance by investigating if structural as well as spatial differentiations of venture capital [VC] investors in syndication networks imprint on the early growth prospects of their portfolio firms.
Starting businesses often face problems collectively referred to as â??liability of newnessâ?•, describing the dearth of internal resources such as strategic assets, legitimacy, organizational structure, and funding. In this context, social networks are regarded as an external avenue to source lacking knowledge and skills important for the survival and growth of firms. Prior research indicates that venture capitalists get actively involved in the development of their portfolio company, consequently we hypothesize that they function as important transmitters of social capital and external network resources towards their portfolio companies.
Many social networks are characterized by an asymmetric interconnectedness of nodes. If we regard relational ties as channels to transfer information, those actors that possess a higher social status in form of a higher quantity or better quality of linkages are supposed to enjoy better access to the circulating knowledge than actors inheriting a relatively peripheral position. To determine opportunities to tap information flows, it is therefore suggested to look more closely at the structural position of actors in a network.

With respect to VC activity, albeit a tremendous rise in cross-border VC investments during the past years, causing an acceleration in the globalization of co-investment networks, ambiguity still exists with respect to performance consequences resulting from VC investorsâ?? global integration. Related studies have exclusively focused on domestic syndication networks of VC investors, the impact on venture performance of investorsâ?? integration in co-investment networks that transcend the domestic playing field remains nevertheless still largely unknown. The aim of this paper is therefore to explore performance consequences resulting from differences in both the structural integration of VC investors in syndication networks and the geographical scope of these network ties.

Research gap

By linking a resource-based view, insights from regional economics on the role of geography for knowledge flows, and social capital theory in the context of VC investment, the study contributes to the existing entrepreneurship literature in various ways. To our knowledge, this is the first exploratory study that looks, in addition to domestic co-investment ties, at cross-border syndication networks in a systematic way. Using longitudinal data on early growth performance-related variables at the firm level, the analysis also leads to a better understanding of growth trajectories of portfolio firms prior to exit. Concentrating on Belgian VC deals, implications of investorsâ?? network status on portfolio firm performance were assessed for a relatively small and still developing VC market.

Data and Method

The effect of VC investorsâ?? network status and geographical network position on the early growth performance (first three years after the initial VC round) of ventures is tested using longitudinal data on 64 Belgian portfolio firms and their domestic as well as international VC providers. The dataset comprises Belgian target firms that received initial VC funding between 2001 and 2008 and has been retrieved from the Zephyr database (Bureau van Dijk).

Financial statement data provided by the National Bank of Belgium were consulted for information on target firm performance. This resulted in a unique dataset on growth performance related ciphers including employment and sales growth of young venture-backed firms in Belgium.

To construct and analyze structural and spatial features of VC co-investment networks, graph theory is applied. Networks are based on dynamic adjacency matrices that are traced over time using 4-year windows with as starting point the year foregoing the year of the initial VC injection. The forwarded hypotheses on the relation between network attributes and portfolio firm performance were consequently analyzed employing multilevel models of change. Robustness of results is ensured with respect to the normal distribution of variables and different error structures including first order autocorrelation and heteroscedasticity. Different tests were performed to foreclose reverse causality. All calculations were undertaken in the statistical software program R using the NLME package to model growth curves and the igraph package for the computation of network attributes.

Results

The study departs from a customary neoclassical understanding of finance and provides a sociological as well as geographically-informed understanding of VC activity. Applying a multilevel framework on longitudinal growth data of Belgian VC investors and their syndication partners, we find that both VC investorsâ?? local and cross-border network embeddedness impacts venture performance. The results of the study suggest that inter-firm relational ties and, particularly, cross-border linkages (1) are important channels for the transfer of information and knowledge and (2) expand the resource-base of a portfolio firm. Despite distance-constraints with respect to the transmission of tacit knowledge resources, particularly international relational ties are found to be beneficial for headcount growth which is associated with their role as crucial sources of non-redundant information and innovation-triggering knowledge.

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Venture Capital Investment and Firm Performance: A Spatially-informed Social Network Approach

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Abstract: This article employs a network perspective to venture capital [VC] investment and portfolio firm performance. We focus on formal relational ties among VC investors established through common investment deals. Applying a multilevel framework to longitudinal data of Belgian VC investors and their syndication partners, we find that both structural and geographic characteristics of syndication networks impact venture performance. Especially young firms backed by investors maintaining a large number of syndication linkages with international VC funds denote an accelerated growth performance of full time equivalents. The results of the study suggest that inter-firm relational ties and, particularly, cross-border linkages are important channels for the transfer of information and knowledge and expand the resource-base of firms.

Keywords: Venture Capital, Co-investment Networks, Social Capital, Firm Performance

1. Introduction

With respect to financial transactions, a small though growing body of literature recognizes the importance of network ties instead of arm's length transactions (Granovetter, 1985; Joel M. Podolny, 1993; Joel M Podolny, 2001). The underlying assumption being that interaction between actors leads to the dissemination of information and knowledge (Inkpen & Tsang, 2005; Uzzi, 1997). Social ties between actors can take different forms ranging from more formal alliances such as trade associations, interlocking board memberships and educational linkages to more informal friendship contacts (Inkpen & Tsang, 2005).

From an advanced resource-based view of the firm, not only organizations' resource endowment constitutes a potential competitive advantage, but also knowledge and skills that are inherent in firms' social networks (Kogut & Zander, 1992). Looking at mutual fund portfolio profits, Cohen, Frazzini, and

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Malloy (2008) forward that portfolios where managers share a strong educational bond outperform those where no such link exists. Similarly, for mergers and acquisitions, social ties between acquirer and target executives established via a shared educational or employment background reduce the occurrence of abnormal returns (Ishii & Xuan, 2014).

Also in the venture capital [VC] industry, the main focus of this paper, social networks among actors are prevalent. Here network ties between investors arise through the syndication of investment deals. Hochberg, Ljungqvist, and Lu (2007) find that both VC firms' fund returns are higher as well as their portfolio firms exit earlier when VC firms maintain a multitude of co-investment ties with other VC investors and, particularly, with those that are well-networked themselves.

In most networks access to knowledge flows is asymmetrical and largely dependent on the structural network position of an actor (see also Gulati, Nohria, & Zaheer, 2006; Uzzi, 1996; Zaheer & Bell, 2005). If we regard relational ties as channels to transfer information, those actors that hold a more central or embedded position i.e. possess a higher quantity of linkages or ties of better quality (i.e. frequency and intensity), are consequently supposed to enjoy more opportunities to obtain new knowledge than actors inheriting a relatively peripheral position (Tsai, 2001).

The international entrepreneurship literature provides evidence that besides structural features also the geographical configuration of social networks matters. Formal and informal network relations of the entrepreneur in foreign target markets are found to impact the likelihood of international expansion and the consequent performance of small firms (Bell, 1995; Coviello & Munro, 1997; Ellis, 2000; Majkgård & Sharma, 1998; Sharma & Blomstermo, 2003).

With respect to VC, albeit a tremendous rise in cross-border investments during the past years, ambiguity still exists with respect to performance consequences resulting from differences in VC investors' global integration. Prior studies have focused on domestic syndication networks (see Hochberg et al., 2007), the impact on venture performance of co-investment networks that transcend the domestic playing field remains still largely unknown. The aim of this paper is therefore to explore which structural and spatial patterns of syndication networks are most advantageous for portfolio firms in their early growth phase.

To construct and analyze structural and spatial features of VC co-investment networks, graph theory is used. Given that for the transfer of knowledge the number of network linkages is regarded decisive, we estimate degree centrality scores per actor. The spatiality of syndication linkages, in turn, is accounted for by dividing the network of each actor into local and global ties. Firm performance is approached from two angles, using employment and sales ciphers.

Contrary to the traditional focus on US target companies in the existing literature on venture performance, Belgian portfolio firms are at the center of our analysis. The Belgian VC market is characterized by a large

openness towards foreign investors, while at the same time registering an active domestic VC scene and thus well-suited for our analysis.

Focusing on social network characteristics of VC investors and linking them to the early growth performance of portfolio firms, this article makes several distinct contributions to the entrepreneurship and economic geography literature: Existing studies on venture performance are primarily focusing on survival-related variables (Das, Jo, & Kim, 2011). Little is known so far about differences in growth trajectories of portfolio firms prior to exit (Devigne, Vanacker, Manigart, & Paeleman, 2013). Using longitudinal data on performance-related parameters at the firm level, this study sheds light into the early growth patterns of portfolio firms. The findings forwarded suggest that, overall, network centrality of investors is positively associated with the employment evolution of ventures.

Furthermore, by taking into account cross-border syndication ties, our research expands the geographical scope of earlier analyzes. Previous work on co-investment networks has predominantly been focused on the domestic realm (Hochberg et al., 2007), whereas those studies that investigate cross-border VC investments in more detail have largely neglected the network dimension (Devigne et al., 2013). The results of our combined approach suggest that domestic and international linkages are qualitatively different in scope, making it essential to analyze them independently. Especially international relational ties are found to be beneficial for headcount growth which is hypothesized to be associated with their role as crucial sources of non-redundant information and innovation-triggering knowledge.

We explore the effect of structural and geographical syndication network attributes on the early growth patterns of portfolio companies in the following way. In the next section, an overview is provided of the VC investment process and the role attributed to social capital in this context. Section 3 presents a detailed description of the Belgian VC co-investment network. Furthermore, network analysis techniques referred to in this paper are reviewed. The data is described in Section 4, whereas the effect of local versus global networking on portfolio firm performance is assessed in Section 5. Finally, Section 6 concludes and proposes future research directions.

2. Theory and Hypotheses

To understand the role social networks play in economic transactions and for firm performance, in this paper, we uniquely combine a resource-based view on firm performance with a social network theory approach. The latter is augmented by insights from economic geography to grasp the importance of geography in the VC investment process.

VC is regarded as a special form or subset of private equity. Gompers and Lerner (2001) most prominently define VC as “independent, professionally managed, dedicated pools of capital that focus on equity or equity-linked investments in privately held, high growth companies” (p. 146). Besides supplying

incumbent innovative firms with funds, venture capitalists often also provide advisory and monitoring services to target firms (Gorman & Sahlman, 1989; Sapienza, 1992; Sapienza, Manigart, & Vermeir, 1996). Reverting to their vast professional knowledge and personal contacts, they are e.g. frequently facilitating the entry of startups into existing industry networks (Gorman & Sahlman, 1989; Steier & Greenwood, 1995).

The resource-based view of the firm (RBV) conceptualizes differences between growth patterns of organizations. The creation of a competitive advantage and thereof resulting performance differentials are ascribed to disparities in firms' resource and capability endowment (Barney, 1991; Peteraf, 1993; Wernerfelt, 1984). Firms that have scarce, imperfectly imitable and immoveable physical-, human-, and organizational capital at their disposal and, beyond that, find unique ways to combine these resources, are better able to implement sustainable value-creating and growth enhancing strategies. The traditional RBV perspective hereby particularly emphasizes internal resources defined by Barney (1991, p. 101) as "all assets, capabilities, organizational processes, firm attributes, information, knowledge, etc. controlled by the firm that enable the firm to conceive of and implement strategies that improve its efficiency and effectiveness". Besides internal resources, recent studies show that external resources, in form of social network relations, also constitute potential sources of competitive advantage for firms, in that they function as important channels for the transfer of resources including innovative knowledge, information on new business opportunities and legitimacy (Lavie, 2006; Lee, Lee, & Pennings, 2001; Yli-Renko, Autio, & Sapienza, 2001).

Applying RBV to the VC context, it is supposed that investors do not only provide the venture with financial resources, but also transfer relevant business knowledge and capabilities to the firm. Especially in the early growth phase of a portfolio firm, when making first experiences in the market environment, "liability of newness" related problems and frequent strategy adaptations are common. In this phase the abundant expertise and resources of the venture capitalist are therefore of particular importance (Brander, Amit, & Antweiler, 2002; Freeman, 2002; Devigne et al., 2013).

Social networks in the VC industry

The syndication of investments (the joint investment of two or more venture capitalists in the same financing round of a specific target firm) leads to the establishment of social networks among venture capitalists (Bygrave, 1988). Previous studies have found evidence for the performance enhancing effect emanating from obtaining funding from an investor syndicate (Brander et al., 2002; Das et al., 2011; De Clercq & Dimov, 2008). The combination of different sets of capabilities and resources aids the coaching and monitoring of the portfolio firm after a deal has been closed (Gorman & Sahlman, 1989; Macmillan, Kulow, & Khoylian, 1989; Timmons & Bygrave, 1986). As a result, portfolio companies that receive funding

from an investor syndicate are found to take shorter until launching a successful exit in form of an acquisition or initial public offering [IPO] (Das et al., 2011).

In their seminal study, Hochberg et al. (2007) clearly distinguish between investment syndication and network integration (embeddedness). They forward robust results showing that portfolio firms that obtain money from well-embedded venture capitalists, investors maintaining a multitude of linkages to other actors in the network, perform better in that they take shorter time to exit than their counterparts supported by less central players. This also holds when distinguishing between syndicated and non-syndicated deals. Portfolio firms are thus able to benefit from the syndication linkages of investors even in cases where the investment at hand is not syndicated, however where the investor co-invested with other venture capitalists during previous investments in other firms. Consequently, Hochberg et al. (2007) conclude that the network resulting from investors' syndication ties can be taken as proxy for a venture capitalists' overall operation network. In other words, investors do not only source knowledge from those partners they currently invest with, rather they rely on their entire network consisting of former and current network contacts to obtain resources. This suggests that rather the syndicate underlying factors such as the increased interconnectedness of actors than the fact that a portfolio firm is supported by an investor syndicate improve portfolio firms' exit odds.

A vocal assumption in social network theory is that an actor's position in a network is a reflection of its power. In that, a central location in a network facilitates actors to access and to exploit the knowledge and information flows that exist between network partners (Gulati et al., 2006; Joel M. Podolny, 2001; Tsai, 2001). On the contrary, a peripheral position impedes and largely deprives actors from benefiting from the capabilities and resources exchanged between network parties. Hence, their structural position affects actors' ability to leverage network ties to source knowledge and skills (Ibarra & Andrews, 1993; Tsai, 2001; Whittington, Owen-Smith, & Powell, 2009).

Linking the insights from social network theory with a RBV inspired view on firm growth, it is consequently suggested that venture capitalists disposing a large number of industry contacts i.e. inheriting a central network position, are in a more advantageous position to support portfolio firms' growth evolution ex post deal closure. Referring to their broader rolodex, well-embedded VCs are supposed to be more proficient in adding resources to the young firm including the identification of potential business partners, customers, market opportunities, and the development of business-related skills and capabilities (Bygrave, 1988).

Social networks and spatial proximity: Local network ties

Regional economic scholars have pointed out that knowledge transmissions are not a completely space blind process. Since Alfred Marshall's (1890) influential work on firm agglomeration, the assumption that the co-location of agents facilitates coincidental face-to face contacts that promote information exchange has been repeatedly seized by industrial district theorists (Fujita, 2012; Fujita & Krugman, 1995; Krugman, 1991; Puga, 2010; Rosenthal & Strange, 2001). They argue that the diffusion of knowledge, and

particularly that of non-codified tacit one, is more vivid between geographically localized firms as the co-location of firms facilitates (personal) interaction and by that furthers knowledge flows (Maskell & Malmberg, 1999). The insight that geographical proximity is still important for knowledge transfer, despite a reduction in communication costs during the last decennia, gets reflected in a number of recent studies (Whittington et al., 2009) also beyond the industrial district literature (see McPherson, Smith-Lovin, & Cook, 2001). Prior empirical work using patent data, for example, has shown that knowledge spillovers between inventors are more frequent when they are co-located than when agents are separated by large spatial distances (Jaffe, Trajtenberg, & Henderson, 1992).

A tendency towards space sensitivity is also observable in the case of VC activity. For the VC investment process to be successful, the need for physical proximity between investors and investees is repeatedly emphasized in the literature (Mäkelä & Maula, 2006; M. Zook, 2004). The co-location of investors and investees facilitates regular face-to-face encounters, which particularly ease the tapping of 'nonmonetary' resources such as the investors' social capital (Mason & Harrison, 1995; Powell, Koput, Bowie, & Smith-Doerr, 2002; Sunley, Klagge, Berndt, & Martin, 2005). Geographical distance between venture capitalists and the entrepreneurial firm, instead, increases transaction costs associated with the exchange of knowledge and causes information asymmetries (Sorenson & Stuart, 2001). Given the lower intensity of interaction between more geographically distant partners, distance between a portfolio firm and its investors is negatively related to the startup's probability of a successful exit (Cumming & Dai, 2010). Zook (2002) asserts the importance of spatial proximity for the occurrence of knowledge spillovers including the easier and cheaper transfer of tacit knowledge: "Getting the most from a venture capitalist or 'smart money' […] is constrained by geography […] Firms located near sources of VC have better access to the funding, networks, and advice of venture capitalists" (pp. 163).

Also social networks are in many cases characterized by a large degree of homophily in that connected agents are oftentimes similar with respect to a large number of socioeconomic attributes as well as geographical patterns (McPherson et al., 2001). Generally, agents are more likely to establish social relations with local (geographical proximate) partners than with those located spatially further apart (Inkpen & Tsang, 2005; McPherson et al., 2001). Also when exchanging critical and, particularly, tacit resources, agents are inclined to rely on those connections that are more parochial in nature and with whom they subsequently interact on a more frequent base, than on their, in geographical terms, extended network contacts (Feldman, 2000; Jaffe et al., 1992; Whittington et al., 2009).

Based on the arguments stressing the spatially constraint nature of knowledge transfers and those elaborated in the beginning of this chapter emphasizing the importance of agents' network position for the access to knowledge flows, we arrive at the following hypothesis.

Hypothesis 1: Portfolio firms that receive VC from domestic investors that possess a multitude of domestic linkages show faster initial growth compared to portfolio firms that are assisted by domestic VCFs that are less well-embedded in the local VC co-investment network.

Social networks and Spatial distance: Non-local network ties

Although we hypothesized in the first part of this chapter that more remote international investors interact less with portfolio firms due to distance constraints, we also find counter evidence in the literature suggesting a positive relation between international ties and firm performance (see Bathelt, Malmberg, & Maskell, 2004; Gertler & Levitte, 2005; Wolfe & Gertler, 2004). This assumption is mainly inferred from the observation that more diversified and broader networks offer more varied information and that those actors that possess a more diverse network oftentimes perform better (Ronald S Burt, 2004). Obviously, this claim is in sharp contrast to the previously made assumption that especially dense and proximate network ties are of added value regarding the transmission of external knowledge.

The antagonism between the importance of geographic proximity for knowledge spillovers and the peril of lock-in or overembeddedness due to too restricted contacts is repeatedly stressed in the regional economics literature on industrial clusters (see Bathelt et al., 2004; Bathelt & Taylor, 2002; Uzzi, 1997). Besides relying on local networks, successful dynamic clusters are dependent on external, international linkages. Global contacts are important in that they feed local clusters with new knowledge generated in innovative hubs elsewhere. By inducting 'new knowledge', global linkages guard to some extent against lock-in and too rigid, innovation hampering networks (Bathelt et al., 2004; Uzzi, 1997).

Bathelt et al. (2004) argue that local and international relational ties are not only different in a geographical context, but that also their formation process and aim is diverging. Whereas local knowledge flows are a relatively automatic process triggered by the co-presence of actors in a cluster, international relational ties, also referred to as 'international pipelines', are consciously established connections with partners situated in more distant innovative hot spots around the world. Due to the distance constraints associated with the transmission of knowledge, it is rather unlikely that new knowledge created elsewhere finds its way to the cluster in a timely manner, if it is not for directly established contacts with those distant innovative hubs. The industrial district literature therefore regards international pipelines as particularly value-adding for firms with respect to innovation, growth and the achievement of a competitive advantage.

On a more abstract level, similar results can be drawn from social network theory. Agents that are able to bridge "structural holes" between different network players or separated clusters of interconnected actors generally show an accelerated performance (Ronald S Burt, 2004). Their structural position enables them to tap resources from otherwise peripheral or weakly connected parts of the network (Ronald S. Burt, 2000). This information in turn has the potential to bring fresh impetus to the individual or organization and

increase its innovative capacity as it is likely to be more diversified and not redundant (Zaheer & Bell, 2005).

Applying these findings to the case of VC investment, we anticipate that investors' global integration affects portfolio firm growth positively as it adds complementary capabilities and knowledge to the venture. Given that the arguments forwarded regarding the positive effect of geographically more distant (international) relational ties on venture performance are equally compelling to those that stress the advantages of highly locally embedded investors, as framed in the previous section, we advance the following alternative hypothesis.

> *Hypothesis 2: Portfolio firms that receive VC from investors that possess a multitude of international ties show a faster initial growth rate compared to portfolio firms assisted by VCFs that are less well-integrated in global VC co-investment networks.*

The interplay of spatial proximity and distance: local and global investment ties

The industrial district literature nevertheless does not treat domestic and international linkages in isolation. Rather, the interplay between both kinds of knowledge channels is emphasized (Gertler & Levitte, 2005; Whittington et al., 2009). Clusters that are characterized by a multitude of local linkages as well as a large openness towards external markets are often showing a higher innovative capacity and are in general more competitive than loosely connected inward-looking clusters (Bathelt, 2002; Larsson & Malmberg, 1999). Only by combining local knowledge with external inputs, it is argued, a firm or, respectively a cluster, will stay competitive in the long run (Bathelt et al., 2004; Oinas, 1999; Wolfe & Gertler, 2004).

Applied to the VC investment context, we suppose that investors that maintain local co-investment linkages as well as invest in portfolio firms abroad, have a more diverse knowledge base and are consequently better equipped to support the early-growth process of their portfolio firms. Given the originality of the knowledge and information acquired from international ties, we nevertheless expect international linkages to be of a slightly higher value addition with respect to venture performance than their domestic counterparts. Summing up the forgoing discussion, we arrive at our third and final hypothesis:

> *Hypothesis 3: Portfolio firms that receive VC from both locally and globally well-embedded investors show a steeper initial growth evolution compared to PFs that are supported by less central VCFs.*

3. Network Analysis

A network is established when actors (nodes) are connected to each other via direct or indirect linkages (edges) (Wasserman & Faust, 1994). In this paper, we suppose that VC investors that co-invest in the same portfolio firm (event) establish a relational tie. The network underlying is a binary adjacency matrix where 'zero' represents the absence of a tie between investors and 'one' refers to the existence of a co-investment relation. The concept of degree centrality (Freeman, 1978), offering an uncomplicated indication of the total amount of connections an actor maintains, is applied to estimate actors' centrality quantitatively (Hanneman & Riddle, 2005). If we express the existence of a co-investment partnership between two investors *i* and *j* as $x_{ij} = 1$, then actor *i*'s degree centrality is defined by $C_D(i) = \sum_j^N x_{ij}$, whereby N reflects the total number of nodes in the network. To take into account the changing nature of co-investment relations over time, actor's degree centrality is normalized by the maximum number of connection in the network *n*. Formally, the normalized degree centrality of an actor is described by $\frac{C_D(i)=\sum_j^N x_{ij}}{(n-1)}$.

4. Methods

4.1. Data Collection

To estimate the effect of VC investors' structural and geographical network position on ventures' growth performance, we obtain data on VC investments from Zephyr, a collection of publicly available information on private equity and VC deals, initial public offerings and merger and acquisitions around the world with a focus on Europe compiled by Bureau van Dijk (Bureau van Dijk, 2014). A comprehensive set of VC deals involving portfolio firms headquartered in Belgium that received their initial VC financing round between 2001 and 2008 is developed based on this data. The chose time frame is suggested by the development of the Belgian VC market that only chronicles a small, negligible number of VC investments before the millennium. The final sample consists in case of Model 1 of 44 portfolio firms and for Model 2 and 3 of respectively 37 and 29 young firms.

Besides investment linkages between Belgian VC investors and their Belgian target firms, we account for linkages of international investors in their home markets as well as Belgian investors' partners from syndicated deals involving non-Belgian target firms.

A restriction of the data set is that Zephyr solely provides information as to the VC fund that underwrites a deal. No details are available concerning the broader corporate structure a fund belongs to, consequently, we consider networks of VC *funds* in this study and not VC *firms*. Potentially, this might lead to an

underestimation of the size of investors' knowledge networks as it is assumed that VC fund managers' knowledge and contacts diffuse in the VC firm rather than that they remain limited to the individual fund.

For information on target firm performance, we consulted financial statement data provided by the National Bank of Belgium [NBB] resulting in a unique dataset on growth performance related indicators of young private firms including employment growth and sales growth. Closing the period of observation at 2008 allows us to measure growth performance over a 3-year period after the year of the initial VC round for any given company. No distinction is made between portfolio firms that successfully exit (trade sale or IPO) during this time and those that fail (bankruptcy). In that, our dataset is unlikely to entail any survivorship bias.

Overall, it is assumed that focusing on young ventures allows for a relatively homogenous sample of firms in terms of business development, their business orientation on often highly innovative new technologies and processes, and firm size. The geographical focus on Belgian portfolio firms ensures that external economic conditions such as labor market regulations are alike. Given the similar context of venture-backed startups in contrast to non-VC financed young firms, we consider the early development paths of portfolio firms as generally comparable (Davila, Foster, & Gupta, 2003). It is therefore regarded reasonable to compare the growth performance of the sample firms and to test by means of the obtained data whether there is an association between (a syndicate's) network embeddedness and the evolution of firm growth.

4.2. Measures

4.2.1. Dependent Variable: Measurements of Portfolio Firm Performance

In the following sections variables applied to test the advanced hypotheses are presented. Table 1 provides an overview of the descriptive statistics on the 64 portfolio firms in our sample. The goal of the dependent variable is to reflect firm performance. Earlier studies on firm performance have stressed that firms often exhibit very different growth patterns according to the growth measure that has been chosen (Delmar, Davidsson, & Gartner, 2003). Measuring performance solely along one dimension, we may therefore fail to observe important growth processes (Wiklund & Shepherd, 2005). To account for the heterogeneity in growth patterns of companies, it is therefore suggested to include different types of performance measures in the analysis. With respect to small and unquoted firms, growth-related financial data is nevertheless sparse (Davila et al., 2003). In that, a common proxy for young venture performance is *employment growth* (Bruton & Rubanik, 2002) which has been found to be closely related to ventures' equity valuation (Davila et al., 2003). We take the absolute change in the number of full-time equivalents as dependent variable.

A second useful performance measure is *sales growth* (Lee et al., 2001). The major shortcoming of the latter is nevertheless that not all firms generate sales at an early stage (Holcomb, Combs, Sirmon, &

Sexton, 2010). Industries like the biotech sector are often characterized by long lasting product development phases and it commonly takes several years until a marketable product is launched and sales numbers are generated. Consequently, we primarily focus on employment-related data in the subsequent analysis. All data is collected for the period 2001-11.

Table 1. Descriptive Statistics

Parameter	Model 1 Local	Model 2 Global	Model 3 Local + Global
FTE			
Mean	17.11	23.02	20.91
S.D.	26.37	30.45	31.83
Min.	0.10	0.40	0.40
Median	9.95	14.90	13.90
Max.	158.80	158.80	158.80
N	138	114	86
Intl. Degree			
Mean		0.037	0.04
S.D.		0.049	0.05
Min.		0.000	0.00
Median		0.016	0.01
Max.		0.246	0.25
N		114	86
Local Degree			
Mean	0.48		0.53
S.D.	0.48		0.51
Min.	0.02		0.02
Median	0.34		0.37
Max.	2.92		2.92
N	138		68
VC Amount (thousand €)			
Mean	10,538.76	13,173.04	14,673.98
S.D.	14,769.78	15,639.24	17,099.65
Min.	125.00	764.00	764.00
Median	5,000.00	8,000.00	8,400.00
Max.	70,000.00	70,000.00	70,000.00
N	138	114	68
PF Age (days)			
Mean	892.54	1,005.14	928.22
S.D.	1,384.44	1,290.59	1,403.32
Min.	1.00	9.00	9.00
Median	411.00	453.00	425.00
Max.	6,064.00	6,064.00	6,064.00
N	138	114	68

S.D.: Standard Deviation

4.2.2. Independent Variables

Local embeddedness. We distinguish between a syndicate's or, in case of non-syndicated deals, a stand-alone investors' local and international embeddedness. As local embeddedness we understand the number of ties of domestic investors to other local (Belgian-based) VC investors. The distinction between local and international syndication partners is necessary in order to clearly determine the importance of local social capital on VC-backed company performance. Degree centrality scores are calculated over trailing 4-year periods with the first window ending in t-1, the year preceding the initial deal. By applying 4-year windows, we account for the fact that ties once established through a common investment are likely to be extant also after several years. The local embeddedness score is thus the sum (per syndicate or stand-alone investor) over a moving period of four years of the normalized total of a Belgian investor's co-investment linkages established via participation in domestic VC deal. The average local embeddedness score in Model 1 is 0.48 and in Model 3 0.53 (see Table 1). Network measures are linked to performance variables with a lag of one year.

International embeddedness. To approximate international integration, data is collected on domestic investors' involvement in deals abroad as well as international syndication partners' investment in firms outside of Belgium. Consequently, as basis for the calculation of centrality scores, a co-investment network is constructed including investors active in Belgium (domestic and foreign) and their syndication partners in VC rounds with non-Belgian portfolio firms.

Besides those network-related key independent variables, a range of other factors might affect firm performance. We therefore chose a number of control variables, whose scope and definition are explained in the next section.

4.2.3. Control Variables

As control variable we include *portfolio firm age*. It is anticipated that younger companies have a tendency to grow faster than more mature firms (Evans, 1987; Hart, 2000). Age is measured in the number of days between a portfolio firm's incorporation date and the closing of the VC deal. For deals where only the year of incorporation was available, we chose June 30 of that year as day of incorporation. The natural logarithm of age is taken to account for any non-linear effects.

Though C. M. Mason and Harrison (2002) find that the magnitude of a deal is not strongly linked to venture performance, at least in the case of informal business angel investment, we test whether the amount of VC impacts portfolio firm growth by introducing the variable *deal value*. Deal value is the amount of VC the venture obtained during the full 4-year period of observation. We anticipate a positive relation between VC received and early growth performance, in that firms receiving a higher amount of capital are generally better able to secure resources crucial for the further development process such as skilled labor, specialized equipment, product advertisement etc. (Devigne et al., 2013; Lee et al., 2001). As can be seen from Table 1, VC deals vary largely with respect to their size. On average, portfolio firms

in the sample for model 1 received about 10.53 million Euros for their first VC round or in additional VC rounds up until 3 years after their initial VC injection, however as indicated by the large standard deviation, there exists much variation in the sample.

To control for industry effects we add a *biotech dummy* to our model, setting apart firms whose primary business activity is in the biotech sector. Due to the necessity of often long-standing clinical trials, biotech startups are characterized by longer development phases than startups in other knowledge-intensive sectors, which might defer their growth pattern. Consequently, we anticipate a negative effect on growth if a portfolio firms is active in the biotech sector (Biotech Dummy = 1).

5. Results

5.1. Analytical Approach and Model development

To estimate the effect of structural and geographical syndication network characteristics on the growth behavior of portfolio firms, we calculate a number of longitudinal multilevel models of change using R and the NLME (Nonlinear and Linear Mixed Effects models) package (Bliese & Ployhart, 2002; Hox, 2010; Pinheiro, Bates, DebRoy, & Sarkar, 2014; Singer & Willet, 2003). In contrast to conventional multilevel models that regard individuals to be nested within groups, we view the observations over time of a distinct variable to be nested within a subject (portfolio firm) (Hox, 2010).

A model contrasting approach is applied to retrieve the most parsimonious model adequately capturing the impact of syndication network characteristics and other control covariates on portfolio firm growth. To estimate the improvement between nested models, chi-square likelihood-ratio testing is used. Only final results are provided in this paper in order to conserve space.

The multilevel models specified in this study are in accordance to the notations introduced by Hox (2010). Equation 1 resembles a simple linear growth model where Y_{it} represents the dependent variable (FTE or sales) of portfolio firm i (i = 1,…, n_t) at time t (t = 0, 1, 2, 3). The slope coefficients of the occasion level (level 1) covariates are indicated by π whereas the second level variables, the firm-level attributes, have the slope coefficient β. The intercept term π_{0i} is interpreted as the average value of Y_{it} , e.g. the number of FTEs, of a firm at the time of its initial VC injection while accounting for the remaining explanatory variables in the model. The occasion variable is $\pi_{1i}T_{it}$. The degree centrality score per investor syndicate of portfolio i at time t is given by $X_{1_{it}}$. The time-invariant variables deal value, portfolio firm age and the biotech industry dummy for firm i are represented by X_{2i}, X_{3i}, and X_{4i}, respectively. All coefficients fluctuate across firms, however only T_{it} and $X_{1_{it}}$ are time varying variables, as indicated by the subscript t,

and consequently may vary within portfolio firms from one year to another. The residual error at the occasion level is represented by e_{it}.

$$Y_{it} = \pi_{0i} + \pi_{1i}T_{it} + \pi_{2i}X_{1_{it}} + \beta_{01}X_{2_i} + \beta_{02}X_{3_i} + \beta_{03}X_{4_i} + e_{it} \quad (1)$$

To reflect differences in portfolio firms' initial level of Y_{it}, a random intercept term (u_{01}) is introduced in Equation 2. To account for the fact that firms exhibit different growth rates over time, the random term u_{1i} is added to the coefficient of time $(\beta_{10}T_{it})$ in Equation 3. This allows each firm's growth curve to differ in slope.

$$\pi_{0i} = \beta_{00} + u_{01} \quad (2)$$

$$\pi_{1i} = \beta_{10} + u_{1i} \quad (3)$$

$$\pi_{2i} = \beta_{20} \quad (4)$$

Rearranging equation 1 through 4, we receive the following random slope multilevel regression model:

$$Y_{it} = \beta_{00} + \beta_{10}T_{it} + \beta_{20}X_{1_{it}} + \beta_{01}X_{2_i} + \beta_{02}X_{3_i} + \beta_{03}X_{4_i} + u_{1i}T_{ti} + u_{0i} + e_{it} \quad (5)$$

5.2. Hypotheses Testing

We begin by testing a variance component model, that solely contains a random intercept and no predictors of change besides the occasion variable (not reported here). Introducing a random slope improves the model fit, thus, as our baseline models, we adopt random slope models that only account for 'time' (Model 1a, 2a, 3a). Subsequently, more complex models are compared to these models. Model 1a estimates an intercept variance (firm level variance) of $\sigma^2_{u_0} = 1.84$ (Table 2) which is significant at the 1 per cent level and implies that firms differ in their initial amount of FTEs at the time of their first VC round. The variance between the time-FTE slope across firms is $\sigma^2_{u_1} = 0.186$ ($p < 0.005$) and shows that the employment growth rates differs between firms and that it is therefore useful to include a random slope term. The variance of the occasion level residuals (Level 1) is $\sigma^2_e = 0.089$ ($p < 0.005$). Summing up, 2.12 is the total variance of the response variable.

The negative correlation ($r_{u_{01}} = -0.599$) between the intercept and slope shows that firms with a higher number of employees at the time of their initial VC round tend to enjoy a smaller employment growth (weaker slope) in the years following the investment than those firms that only recorded few employees (steeper slope).

Table 2. Results of multilevel analysis with FTE as dependent variable

Variable	Model 1a Null Model	Model 1b Local VCF Local ties	Model 2a Null Model	Model 2b Local VCF Intl ties	Model 3a Null Model	Model 3b Local VCF Local & Global ties
Fixed part						
Time	0.194*** (0.074)	0.157** (0.077)	0.225*** (0.049)	0.179*** (0.047)	0.262*** (0.058)	0.177*** (0.060)
Ln Local Degree		0.141* (0.084)				0.173 (0.107)
Ln Intl. Degree				0.174** (0.072)		0.170** (0.082)
Ln VC Amount		0.456*** (0.118)		0.293 (0.200)		0.350 (0.233)
Ln PF Age		0.222** (0.084)		0.338** (0.127)		0.241* (0.138)
Biotech Dummy (=1 biotech firm)		-0.702* (0.387)		-0.137 (0.464)		-0.350 (0.500)
Random part						
$\sigma^2_{u_0}$	1.840 (0.010)	0.959 (0.083)	2.178 (0.013)	0.967 (0.092)	2.064 (0.017)	0.856 (0.100)
$\sigma^2_{u_1}$	0.186 (0.003)	0.182 (0.036)	0.048 (0.002)	0.037 (0.018)	0.053 (0.003)	0.047 (0.023)
σ^2_e	0.089 (0.002)	0.081 (0.024)	0.070 (0.002)	0.078 (0.026)	0.065 (0.003)	0.067 (0.028)
AIC	310.26	291.18	223.09	215.32	171.19	165.54
BIC	327.82	320.45	239.51	242.69	185.91	192.54
Log likelihood	-149.13	-135.59	-105.55	-97.66	-79.59	-71.76
N	138	138	114	114	86	86

Standard errors in parantheses

Significance levels: *: 10% **: 5% ***: 1%

To estimate the impact of domestic investors' local ties on portfolio firm performance more precisely, we add, in addition to VC syndicates' local embeddedness scores (ln Local Degree), the control variables deal value (ln VC Amount), portfolio firm age (ln PF Age) and an industry dummy term (Biotech Dummy) in Model 1b. In Model 2b, assessing growth implications arising from differences in syndicates' international ties, we replace the local embeddedness score by an international embeddedness score (ln Intl. Degree). The final model, Model 3b, reports the effect of both local and international embeddedness scores per investor(syndicate) on employment growth.

If we compare the extended models to the respective baseline model on basis of their -2loglikelihood ratios, we see that adding additional variables improves the model fit. Augmenting the baseline models with explanatory variables decreases the occasion level and, respectively, the firm level variance terms, implying that the added parameters indeed add explanatory power to the models. This is also supported by the decreasing BIC and AIC values.

Our first hypothesis assumes that particularly geographically proximate, domestic ties offer vast opportunities for the exchange of information and, especially, tacit knowledge which in turn constitutes a competitive advantage for the venture and accelerates growth. The positive and statistically significant coefficient ($\beta = 0.141$; $p < 0.1$) for the domestic degree centrality score of Belgian investors signals that portfolio firms supported by locally more embedded VC investors denote on average a higher growth in FTEs than those financed by less locally interconnected VC funds. The standardized coefficients (model not reported) moreover indicate that, although the control variables age ($\beta=0.320$; $p < 0.05$) and deal value ($\beta=0.538$; $p<0.001$) have a larger effect on employment growth, the number of local co-investment contacts also has a non-negligible impact ($\beta=0.133$; $p<0.05$). In practice, the results from model 1b show that, ceteris paribus, any 10 per cent increase in the natural logarithm of the local degree centrality score leads to a 1.35 per cent increase of the natural logarithm of FTE. In other words, by expanding the local co-investment tie score of a stand-alone investor or syndicate by 10 per cent, a firm of 10 FTE will on average experience an employment increase equal to about 2.59 FTEs. Also the amount of VC portfolio firms receive as well as their age at the initial VC round have a statistically significant and positive effect on FTE growth. In accordance to our expectations, biotechnology-related firms are characterized by slower initial growth in employment ($\beta=-0.702$; $p<0.1$) after their first round of VC.

Model 2b estimates syndicates' international degree centrality score as $\beta=0.174$ ($p<0.05$). In that, for any 10 per cent increase in the latter, the response variable (log FTE) increases by 1.67 per cent. The findings provide strong evidence for our second hypothesis stating that investors' international ties are beneficial for portfolio firms' development. It is proposed that the larger effect of international ties compared to local ones on portfolio firm growth, results from the tendency of international ties to comprise more diversified knowledge. Interestingly, if we model the impact of international ties, the estimates of deal value and the industry dummy denote no longer a statistically significant impact on employment.

Model 3b integrates both syndicates' local and international interconnectedness. We no longer find a statistically significant effect of the local degree centrality score. Controlling for domestic linkages, we find that the international degree centrality score ($\beta=0.17$; $p<0.05$) continues to affect portfolio firm growth positively. Multicollinearity problems between the local and international centrality scores that may impact the estimation of parameters are eliminated. The findings suggest that domestic ties and international ties are distinct in their value creating capacities. Particularly international linkages, it seems, are likely to provide important stimuli for the development of portfolio firms.

Industrial district scholars frequently argue that accessing local knowledge sources is less costly and more automatic than acquiring knowledge created by innovative firms elsewhere, however also less informative. Whereas local resources are often tapped without taking deliberate actions, benefiting from more distant sources of knowledge requires systematic and conscious actions to build contacts with dedicated international partners. Given the higher costs associated with the construction of international network linkages and the association of global pipelines as important sources of innovative and non-redundant

knowledge, it is forwarded that the value-adding capacity of international pipelines might exceeds that of local relational ties.

Applied to the case of VC co-investment networks, one potential explanation for the more prominent role of international co-investment ties on portfolio firm performance is the lower degree of resource redundancy in international networks compared to the local sphere. Thus, in cases where portfolio firms, via their VC investors, gain access to both local and global knowledge flows, we presume that there is a tendency to particularly exploit benefits arising from the international connectedness. This would explain the statistically insignificant results with respect to investors' local embeddedness in Model 3b.

As a second proxy for portfolio firm growth, the sales evolution of portfolio companies has been chosen. Nevertheless, in all three extended models we do not find any statistically significant relationship between the embeddedness scores and sales growth. (To conserve space, models with sales as dependent variable are not reported here.) One possible explanation for these results is the circumstance that we specifically focus on early growth patterns of portfolio firms and that most of these firms do not yet produce reliable sales figures.

Summing up, overall the different models suggest that portfolio firms' employment stock is increasing over time and that both investors' local and international embeddedness have a statistically significant and positive effect on portfolio firm growth. In that, the findings provide first evidence that more integrated or central VC investors enjoy better access to knowledge flows which also seems to constitute an advantage for the early development of their portfolio firms. By integrating both centrality scores in the same model, we furthermore observe that international and local co-investment ties are not congruent in scope, but seemingly provide portfolio firms with different capabilities. Especially investors possessing geographically expanded networks also encompassing cross-border ties seem to be particularly value adding to venture performance. These findings evidently connect to the regional economics literature on knowledge creation in clusters.

5.3. Robustness test

We test the robustness of the analyses by constructing a number of models that take into account different covariance structures. Given the large degree of interdependence in our data, mainly caused by its longitudinal nature, we look into problems associated with autocorrelation. First-order autocorrelation is found to be higher in models that solely allow for a random intercept. However, by integrating a random slope term into the models, autocorrelation problems largely diminish. Consequently, we decide to continue with the most parsimonious model in all cases, being a random slope model.

A second issue that potentially inflates goodness of fit measures is the existence of heteroscedasticity in the data. A comparison of models accounting for heteroscedasticity and those assuming homoscedasticity by means of log likelihood testing reveals that, at first sight, we have to presume a small degree of

heteroscedasticity with respect to Model 1a and b. However, the subsequently introduced more complex model that is accounting for heteroscedasticity, does not seem to fit the data notably better. Visual inspection of the residual plots precludes any severe violation of the homoscedasticity assumption. Hence, the more compact random slope model is kept.

A third concern addresses the issue of reverse causality. It is evident to assume that better networked investors might also be more capable in selecting startups for their portfolio that are already more promising at the outset. After their initial round of VC, these ventures are then likely to continue to show a higher-growth performance. In this case however, the largest impact of investors' social capital would have been realized in the selection phase and not during the business development and monitoring phase as assumed in this paper. Prior studies have embraced this problem and concluded that, although the 'selection hypothesis' cannot be neglected, investor syndicates (Brander et al., 2002) as well as better networked funds (Hochberg et al., 2007) are in general not denoting any large advantages in the selection of investment targets. Instead, the value-adding hypothesis with respect to investors' involvement ex post deal closure plays a crucial role.

To test for selection bias, we collect performance data of portfolio firms from the two years preceding the year of the initial VC injection. This leads to a sample of 17 firms for which it was possible to obtain pre-deal growth figures. We apply ordinary least square regression analysis [OLS] to test whether firms that show an increased employment growth before their initial VC round where eventually selected by a particular sort of investor. We do not find any statistically significant estimators confirming a 'selection hypothesis' and consequently it is imputed that in the case of Belgian portfolio firms reverse causality problems are not severely impacting the validity of the calculated longitudinal multilevel models of change.

6. Conclusion

Recently, there has been a renunciation of the arm's length principle with regard to economic transactions. Instead, the importance of social networks for financial markets has been repeatedly emphasized. In this paper, we contribute to the emerging literature on social capital in finance by examining the effect of the structural and spatial network position of VC investors on the early growth evolution of portfolio firms. Given the accelerated development of international VC activity during the past years, particular attention is hereby paid to the value addition of global co-investment linkages. For the analysis, we collected data on Belgian-based VC deals between 2001 and 2008 and traced FTE growth as well as sales growth of the involved portfolio firms over a period of 3-years after deal closure. It is hypothesized that co-investment ties serve VC investors as important channels for the transfer of knowledge and skills, that are subsequently exploited to assist portfolio firms in their early development phase.

Using multilevel modelling, we find that the early growth pattern of portfolio firms is impacted by structural as well as geographic features of their respective VC investors' co-investment network. Overall, a higher

integration of domestic investors in local co-investment networks impacts the employment growth process of a venture positively. This effect however seems to fade in the presence of a growing number of international co-investment ties. International co-investment ties appear to be growth enhancing in both cases, when analyzed apart as well as when tested in conjunction with local embeddedness scores.

The findings are reviewed in light of regional economic studies on knowledge spillovers in industrial clusters. It is forwarded that the clustering of firms almost automatically leads to local knowledge spillovers increasing firms' innovative capabilities and competitive advantage. To maintain their competitive position in the medium or long-term, information and skills inherent in local networks are nevertheless not sufficient for most firms. Instead, leading companies often develop ties with dedicated partners located in innovative hot spots around the world. These consciously established international pipelines are important sources of new and non-redundant innovative inputs. Given the differences in knowledge resources acquired through either local or international ties, it is inferred that local and non-local ties are qualitatively different in scope.

Results presented in this paper offer a first indication that differences in the nature of local and international linkages might also hold with respect to VC co-investment networks. At first sight, domestic syndication ties, which are most common given the spatial restrictedness of VC activity, have a value-adding effect on the business development of young firms. However, in the presence of international investment linkages, their impact declines. One possible explanation in line with the industrial district literature and the resource-based view is that international ties are associated with more novel information properties, which consequently allow for a better combination of resources, enhancing the competitive advantage of firms. Whereas knowledge assets stored in the local environment may be taken up via other channels, knowledge and skills acquired through non-local linkages will not be gained if it was not for the consciously established tie. Following, it is assumed that investors that possess international contacts are particularly beneficial for portfolio firms in that they are able to provide unique resources enhancing the company's resource base.

Summing up, a first exploratory insight into the impact of structural and geographical VC coinvestment network features on portfolio firm performance has been provided in this article. Many central issues however still remain unresolved and are subject for future discussions. Prospective research should consider weighting the potential for social capital spillovers between investee and investors proportionally to the latter's stance in the investment. Prior research has shown that in syndicated investment deals not all investors are involved to the same degree. Instead, often one investor acts as lead investor whereas other investors take on a more passive role. Consequently, also their interaction with the target firm is likely to differ. It is hypothesized that portfolio companies benefit more from the capabilities and contacts of the lead investor than from that of more passive investors. Closely linked to the previous issue is the question whether there are qualitative differences between relational ties and whether ventures benefit more from some ties than from others. Furthermore, referring to the discussion on overembeddedness, it

still has to be examined if there exists any threshold level with respect to network embeddedness beyond which value-adding effects are inverted. Lastly, revealing that centrality in co-investment networks positively affects portfolio firm development poses the question if and to what degree other forms of relational ties such as a shared professional background or a common educational history increases VC fund managers' value-adding capabilities and impacts the growth evolution of ventures.

7. Bibliography

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management, 17*(1), 99-120.

Bathelt, H. (2002). The Re-emergence of a Media Industry Cluster in Leipzig. *European Planning Studies, 10*(5), 583-611. doi: 10.1080/09654310220145341

Bathelt, H., Malmberg, A., & Maskell, P. (2004). Clusters and knowledge: local buzz, global pipelines and the process of knowledge creation. *Progress in Human Geography, 28*(1), 31-56. doi: 10.1191/0309132504ph469oa

Bathelt, H., & Taylor, M. (2002). Clusters, Power and Place: Inequality and Local Growth in Time–Space. *Geografiska Annaler: Series B, Human Geography, 84*(2), 93-109. doi: 10.1111/j.0435-3684.2002.00116.x

Bell, J. (1995). The internationalization of small computer software firms: A further challenge to "stage" theories. *European journal of marketing, 29*(8), 60-75.

Bliese, P. D., & Ployhart, R. E. (2002). Growth Modeling Using Random Coefficient Models: Model Building, Testing, and Illustrations. *Organizational Research Methods, 5*(4), 362-387. doi: 10.1177/109442802237116

Brander, J. A., Amit, R., & Antweiler, W. (2002). Venture-capital syndication: Improved venture selection vs. the value-added hypothesis. *Journal of Economics & Management Strategy, 11*(3), 423-452. doi: DOI 10.1111/j.1430-9134.2002.00423.x

Bruton, G. D., & Rubanik, Y. (2002). Resources of the firm, Russian high-technology startups, and firm growth. *Journal of Business Venturing, 17*(6), 553-576. doi: http://dx.doi.org/10.1016/S0883-9026(01)00079-9

Burt, R. S. (2000). The network structure of social capital. *Research in Organizational Behavior, 22*(0), 345-423. doi: http://dx.doi.org/10.1016/S0191-3085(00)22009-1

Burt, R. S. (2004). Structural holes and good ideas1. *American Journal of Sociology, 110*(2), 349-399.

Bygrave, W. D. (1988). The structure of the investment networks of venture capital firms. *Journal of Business Venturing, 3*(2), 137-157. doi: http://dx.doi.org/10.1016/0883-9026(88)90023-7

Cohen, Frazzini, & Malloy. (2008). The Small World of Investing: Board Connections and Mutual Fund Returns. *Journal of Political Economy, 116*(5), 951-979. doi: 10.1086/592415

Coviello, N., & Munro, H. (1997). Network relationships and the internationalisation process of small software firms. *International Business Review, 6*(4), 361-386. doi: http://dx.doi.org/10.1016/S0969-5931(97)00010-3

Cumming, D., & Dai, N. (2010). Local bias in venture capital investments. *Journal of Empirical Finance, 17*(3), 362-380. doi: DOI 10.1016/j.jempfin.2009.11.001

Das, S. R., Jo, H., & Kim, Y. (2011). Polishing diamonds in the rough: The sources of syndicated venture performance. *Journal of Financial Intermediation, 20*(2), 199-230.

Davila, A., Foster, G., & Gupta, M. (2003). Venture capital financing and the growth of startup firms. *Journal of Business Venturing, 18*(6), 689-708. doi: http://dx.doi.org/10.1016/S0883-9026(02)00127-1

De Clercq, D., & Dimov, D. (2008). Internal Knowledge Development and External Knowledge Access in Venture Capital Investment Performance. *Journal of Management Studies, 45*(3), 585-612. doi: 10.1111/j.1467-6486.2007.00747.x

Delmar, F., Davidsson, P., & Gartner, W. B. (2003). Arriving at the high-growth firm. *Journal of Business Venturing, 18*(2), 189-216. doi: http://dx.doi.org/10.1016/S0883-9026(02)00080-0

Devigne, D., Vanacker, T., Manigart, S., & Paeleman, I. (2013). The role of domestic and cross-border venture capital investors in the growth of portfolio companies. *Small Business Economics, 40*(3), 553-573. doi: DOI 10.1007/s11187-011-9383-y

Ellis, P. (2000). Social Ties and Foreign Market Entry. *Journal of International Business Studies, 31*(3), 443-469. doi: 10.2307/155651

Evans, D. S. (1987). The Relationship Between Firm Growth, Size, and Age: Estimates for 100 Manufacturing Industries. *The Journal of Industrial Economics, 35*(4), 567-581. doi: 10.2307/2098588

Feldman, M. P. (2000). Location and innovation: the new economic geography of innovation, spillovers, and agglomeration. In G. L. Clark, Feldman, M.P., Gertler, M.S. (Ed.), *The Oxford Handbook of Economic Geography* (pp. 373–394). New York: Oxford University Press.

Freeman, L. C. (1978). Centrality in social networks conceptual clarification. *Social Networks, 1*(3), 215-239. doi: http://dx.doi.org/10.1016/0378-8733(78)90021-7

Fujita, M. (2012). Thünen and the New Economic Geography. *Regional Science and Urban Economics, 42*(6), 907-912. doi: http://dx.doi.org/10.1016/j.regsciurbeco.2011.12.002

Fujita, M., & Krugman, P. (1995). When is the economy monocentric?: von Thünen and Chamberlin unified. *Regional Science and Urban Economics, 25*(4), 505-528. doi: http://dx.doi.org/10.1016/0166-0462(95)02098-F

Gertler, M. S., & Levitte, Y. M. (2005). Local Nodes in Global Networks: The Geography of Knowledge Flows in Biotechnology Innovation. *Industry and Innovation, 12*(4), 487-507. doi: 10.1080/13662710500361981

Gompers, P., & Lerner, J. (2001). The venture capital revolution. *Journal of Economic Perspectives, 15*(2), 145-168.

Gorman, M., & Sahlman, W. A. (1989). What do venture capitalists do? *Journal of Business Venturing, 4*(4), 231-248. doi: http://dx.doi.org/10.1016/0883-9026(89)90014-1

Granovetter, M. (1985). Economic Action and Social Structure: The Problem of Embeddedness. *American Journal of Sociology, 91*(3), 481-510. doi: 10.2307/2780199

Gulati, R., Nohria, N., & Zaheer, A. (2006). Strategic Networks. In D. Hahn & B. Taylor (Eds.), *Strategische Unternehmungsplanung — Strategische Unternehmungsführung* (pp. 293-309): Springer Berlin Heidelberg.

Hanneman, R., & Riddle, M. (2005). *Introduction to Social Network Methods*. Riverside, CA.: University of California.

Hart, P. E. (2000). Theories of Firms' Growth and the Generation of Jobs. *Review of Industrial Organization, 17*(3), 229-248. doi: 10.1023/A:1007887626165

Hochberg, Y. V., Ljungqvist, A., & Lu, Y. (2007). Whom you know matters: Venture capital networks and investment performance. *Journal of Finance, 62*(1), 251-301.

Holcomb, T. R., Combs, J. G., Sirmon, D. G., & Sexton, J. (2010). Modeling Levels and Time in Entrepreneurship Research: An Illustration With Growth Strategies and Post-IPO Performance. *Organizational Research Methods, 13*(2), 348-389. doi: 10.1177/1094428109338401

Hox, J. (2010). *Multilevel Analysis: Techniques and Applications*. London: Lawrence Erlbaurn Associates.

Ibarra, H., & Andrews, S. B. (1993). Power, Social Influence, and Sense Making: Effects of Network Centrality and Proximity on Employee Perceptions. *Administrative Science Quarterly, 38*(2), 277-303. doi: 10.2307/2393414

Inkpen, A. C., & Tsang, E. W. K. (2005). Social Capital, Networks, and Knowledge Transfer. *The Academy of Management Review, 30*(1), 146-165. doi: 10.2307/20159100

Ishii, J., & Xuan, Y. (2014). Acquirer-target social ties and merger outcomes. *Journal of Financial Economics, 112*(3), 344-363. doi: http://dx.doi.org/10.1016/j.jfineco.2014.02.007

Jaffe, A. B., Trajtenberg, M., & Henderson, R. (1992). Geographic localization of knowledge spillovers as evidenced by patent citations: National Bureau of Economic Research.

Joel M. Podolny. (2001). Networks as the Pipes and Prisms of the Market. *American Journal of Sociology, 107*(1), 33-60. doi: 10.1086/323038

Kogut, B., & Zander, U. (1992). Knowledge of the Firm, Combinative Capabilities, and the Replication of Technology. *Organization Science, 3*(3), 383-397. doi: 10.1287/orsc.3.3.383

Krugman, P. R. (1991). *Geography and trade*: MIT press.

Larsson, S., & Malmberg, A. (1999). Innovations, Competitiveness and Local Embeddedness: A Study of Machinery Producers in Sweden. *Geografiska Annaler: Series B, Human Geography, 81*(1), 1-18. doi: 10.1111/j.0435-3684.1999.00045.x

Lavie, D. (2006). The Competitive Advantage of Interconnected Firms: An Extension of the Resource-Based View. *The Academy of Management Review, 31*(3), 638-658. doi: 10.2307/20159233

Lee, C., Lee, K., & Pennings, J. M. (2001). Internal capabilities, external networks, and performance: a study on technology-based ventures. *Strategic Management Journal, 22*(6-7), 615-640. doi: 10.1002/smj.181

Macmillan, I. C., Kulow, D. M., & Khoylian, R. (1989). Venture capitalists' involvement in their investments: Extent and performance. *Journal of Business Venturing, 4*(1), 27-47. doi: http://dx.doi.org/10.1016/0883-9026(89)90032-3

Majkgård, A., & Sharma, D. D. (1998). Client-Following and Market-Seeking Strategies in the Internationalization of Service Firms. *Journal of Business-to-Business Marketing, 4*(3), 1-41. doi: 10.1300/J033v04n03_01

Mäkelä, M. M., & Maula, M. V. J. (2006). Interorganizational Commitment in Syndicated Cross-Border Venture Capital Investments. *Entrepreneurship Theory and Practice, 30*(2), 273-298. doi: 10.1111/j.1540-6520.2006.00121.x

Maskell, P., & Malmberg, A. (1999). Localised learning and industrial competitiveness. *Cambridge Journal of Economics, 23*(2), 167-185. doi: 10.1093/cje/23.2.167

Mason, & Harrison, R. T. (1995). Closing the Regional Equity Capital Gap - the Role of Informal Venture Capital. *Small Business Economics, 7*(2), 153-172.

Mason, C. M., & Harrison, R. T. (2002). Is it worth it? The rates of return from informal venture capital investments. *Journal of Business Venturing, 17*(3), 211-236. doi: http://dx.doi.org/10.1016/S0883-9026(00)00060-4

McPherson, M., Smith-Lovin, L., & Cook, J. M. (2001). Birds of a Feather: Homophily in Social Networks. *Annual Review of Sociology, 27*, 415-444. doi: 10.2307/2678628

Oinas, P. (1999). Activity-specificity in organizational learning: implications for analysing the role of proximity. *GeoJournal, 49*(4), 363-372. doi: 10.1023/A:1007184012189

Peteraf, M. A. (1993). The cornerstones of competitive advantage: A resource-based view. *Strategic Management Journal, 14*(3), 179-191.

Pinheiro, J., Bates, D., DebRoy, S., & Sarkar, D. (2014). nlme: Linear and Nonlinear Mixed Effects Models (Version R package version 3.1-117).

Podolny, J. M. (1993). A Status-Based Model of Market Competition. *American Journal of Sociology, 98*(4), 829-872. doi: 10.2307/2781237

Podolny, J. M. (2001). Networks as the Pipes and Prisms of the Market1. *American Journal of Sociology, 107*(1), 33-60.

Powell, W. W., Koput, K. W., Bowie, J. I., & Smith-Doerr, L. (2002). The Spatial Clustering of Science and Capital: Accounting for Biotech Firm-Venture Capital Relationships. *Regional Studies, 36*(3), 291-305. doi: 10.1080/00343400220122089

Puga, D. (2010). The Magnitude and Causes of Agglomeration Economies*. *Journal of Regional Science, 50*(1), 203-219.

Rosenthal, S. S., & Strange, W. C. (2001). The Determinants of Agglomeration. *Journal of Urban Economics, 50*(2), 191-229. doi: http://dx.doi.org/10.1006/juec.2001.2230

Sapienza, H. J. (1992). When do venture capitalists add value? *Journal of Business Venturing, 7*(1), 9-27. doi: http://dx.doi.org/10.1016/0883-9026(92)90032-M

Sapienza, H. J., Manigart, S., & Vermeir, W. (1996). Venture capitalist governance and value added in four countries. *Journal of Business Venturing, 11*(6), 439-469. doi: http://dx.doi.org/10.1016/S0883-9026(96)00052-3

Sharma, D. D., & Blomstermo, A. (2003). The internationalization process of Born Globals: a network view. *International Business Review, 12*(6), 739-753. doi: http://dx.doi.org/10.1016/j.ibusrev.2003.05.002

Singer, J. D., & Willet, J. B. (2003). *Applied Longitudinal Data Analysis: Modeling Change and Event Occurrence*. New York: Oxford University Press.

Sorenson, O., & Stuart, T. E. (2001). Syndication networks and the spatial distribution of venture capital investments. *American Journal of Sociology, 106*(6), 1546-1588.

Steier, L., & Greenwood, R. (1995). VENTURE CAPITALIST RELATIONSHIPS IN THE DEAL STRUCTURING AND POST-INVESTMENT STAGES OF NEW FIRM CREATION. *Journal of Management Studies, 32*(3), 337-357.

Sunley, P., Klagge, B., Berndt, C., & Martin, R. (2005). Venture capital programmes in the UK and Germany: In what sense regional policies? *Regional Studies, 39*(2), 255-273.

Timmons, J. A., & Bygrave, W. D. (1986). Venture capital's role in financing innovation for economic growth. *Journal of Business Venturing, 1*(2), 161-176. doi: http://dx.doi.org/10.1016/0883-9026(86)90012-1

Tsai, W. (2001). Knowledge Transfer in Intraorganizational Networks: Effects of Network Position and Absorptive Capacity on Business Unit Innovation and Performance. *The Academy of Management Journal, 44*(5), 996-1004. doi: 10.2307/3069443

Uzzi, B. (1996). The Sources and Consequences of Embeddedness for the Economic Performance of Organizations: The Network Effect. *American Sociological Review, 61*(4), 674-698. doi: 10.2307/2096399

Uzzi, B. (1997). Social Structure and Competition in Interfirm Networks: The Paradox of Embeddedness. *Administrative Science Quarterly, 42*(1), 35-67. doi: 10.2307/2393808

Wasserman, S., & Faust, K. (1994). *Social network analysis: Methods and applications* (Vol. 8): Cambridge university press.

Wernerfelt, B. (1984). A resource-based view of the firm. *Strategic Management Journal, 5*(2), 171-180.

Whittington, K. B., Owen-Smith, J., & Powell, W. W. (2009). Networks, Propinquity, and Innovation in Knowledge-intensive Industries. *Administrative Science Quarterly, 54*(1), 90-122. doi: 10.2189/asqu.2009.54.1.90

Wiklund, J., & Shepherd, D. (2005). Entrepreneurial orientation and small business performance: a configurational approach. *Journal of Business Venturing, 20*(1), 71-91. doi: http://dx.doi.org/10.1016/j.jbusvent.2004.01.001

Wolfe, D. A., & Gertler, M. S. (2004). Clusters from the Inside and Out: Local Dynamics and Global Linkages. *Urban Studies, 41*(5-6), 1071-1093. doi: 10.1080/00420980410001675832

Yli-Renko, H., Autio, E., & Sapienza, H. J. (2001). Social capital, knowledge acquisition, and knowledge exploitation in young technology-based firms. *Strategic Management Journal, 22*(6-7), 587-613. doi: 10.1002/smj.183

Zaheer, A., & Bell, G. G. (2005). Benefiting from network position: firm capabilities, structural holes, and performance. *Strategic Management Journal, 26*(9), 809-825. doi: 10.1002/smj.482

Zook. (2002). Grounded capital: venture financing and the geography of the Internet industry, 1994-2000. *Journal of Economic Geography, 2*(2), 151-177.

Zook, M. (2004). The knowledge brokers: venture capitalists, tacit knowledge and regional development. *International Journal of Urban and Regional Research, 28*(3), 621-641. doi: 10.1111/j.0309-1317.2004.00540.x