

# A CRITICAL RE-EXAMINATION OF THE ACADEMIC LITERATURE ON VENTURE CAPITAL NETWORKS

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## Abstract

This paper proposes a critical re-examination of the recent trends of the academic literature on venture capital networks. Network analysis is a trustworthy and reliable methodology for analyzing inter-organizational networks. It is extremely useful especially for venture capital firms, as they are characterized by several connections between each other. Although important steps ahead have been made in this field of study, several research questions remain still unanswered.

This brief review thoroughly scrutinizes three papers that are representative of the recent academic literature in this field of study. Analysing these articles, I identify their points of strength and limitations, in order to pave the way for future research.

This paper shows that the study of network weak and informal ties and the role of risk management strategies are promising areas for pushing the frontiers of research on venture capital networks.

Even though less recent academic articles are not taken into consideration in this analysis, the in-depth discussion of the most recent literature provides interesting insights for scholars willing to investigate further into this field of study.

Extending our knowledge on this topic is crucial to understand the best strategic decisions venture capital firms should take, as parts of an inter-organizational network.

I contribute to the extant literature by critically analysing a stream of literature that is important from both a scientific and managerial point of views. Moreover, this paper poses interesting questions to be addressed by future research.

**JEL Classification Numbers:** G20, G24, G32, M10, M21, L14.

**Keywords:** Venture Capital, Private Equity, Network Analysis, Risk Management, Inter-organizational Networks, Network Weak Ties.

## 1. Introduction

Network analysis has assumed considerable importance over the last few decades (Barabási, 2002, Newman, 2010). Early research focused on sociometry, psychology, and anthropology, over the first half of the previous century (Borgatti, 2003), but network analysis was not meant to be bound in such a small field of studies. Network analysis provides helpful and reliable methodological tools for business economics and financial studies, because of its

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intrinsic characteristics (Ahuja, Soda, & Zaheer, 2012). Firms have plenty of connections with each other<sup>1</sup>, and their study is an important and challenging aim for management and banking scholars (Baker, & Faulkner, 2017). The first important seminal paper about inter-organizational networks has been Powell, Koput and Smith-Doerr (1996) "Interorganizational Collaboration and the Locus of Innovation: Networks of Learning in Biotechnology". After this milestone, several other authors have contributed to this field, but discussing about them goes beyond the aim of this paper. The focus of this paper is on venture capital firms' networks. Venture capital firms have plenty of connections, with both other institutional investors and their clients (i.e. the investee companies). Thus, adopting the methodological perspectives proposed by network analysis in this context is a straightforward and useful choice. Over the last few years, some reputable academic scholars have written interesting research articles on venture capital firms' networks<sup>2</sup>. They adopted the methodological techniques of the network analysis to tackle some research issues related to venture capital firms' operations. On closer inspection, their main objectives are the following:

- Understanding whether or not the structure of the network has an impact on venture capital firm performance, and which kind of network structure is the best for different types of venture capital firms;
- Assessing how the choices made by venture capital firms affect the structure of the network;
- Analyzing the relationships between the reputation of the venture capital firms and their role within their inter-organizational network;
- Analyzing the different risk management strategies adopted to select the companies to connect with.

The aim of my contribution is to provide an overview of the most important of these research papers. However, in order to understand them properly, it is crucial to know the basics of network analysis, at least the most important aspects related to inter-organizational networks (useful references for further information are Amati, Lomi, & Mascia, 2019; Provan, Fish, & Sydow, 2007; Rosenkopf, & Padula, 2008; Wegner, de Mattos Zarpelon, Verschoore, & Balestrin, 2017), and what a venture capital firm is, what it does and how it operates<sup>3</sup>.

It is crucial to notice that, this stream of literature provides some very useful insights for further development of the research in this field, even though there are still some unanswered questions that could turn out to be crucial from a scientific and practical viewpoint. Although this topic has been studied thoroughly in certain aspects, there are several further investigations to carry out. Since the debate on venture capital networks is still open, the analysis of the recent literature on this topic is a necessary and important step to pave the way for further research on this topic.

The remainder of this paper is organized as follows: section 1 provides some introductory concepts on (inter-organizational) network analysis; section 2 explains what venture capital firms are and how they operate; section 3

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<sup>1</sup> Typical connections are those with customers or supplier firms (vertical connections) or with companies that operate at the same level of the supply chain (horizontal connections).

<sup>2</sup> These theoretical perspectives have been studied not only for venture capital firms, but also for networks composed by other institutional investors. In this regard, see Porretta, 2010.

<sup>3</sup> This is what sections 1 and 2 try to do.

provides a brief review of the research on venture capital network; Section 4 concludes.

## **2. Basic concepts on (inter-organizational) network analysis**

This section provides some useful introductory aspects. The main focus is on inter-organizational network analysis, which is characterized by some peculiarities that make it different from general network analysis. The definitions and methodologies explained in this section are crucial to understand properly the remainder of this paper.

First, it is important to understand what is a network. It can be defined as a set of nodes that are connected by different types of ties. With reference to inter-organizational networks, the nodes are companies and the ties are any type of (strong or weak) connection between them. Studying single firms is a crucial step, but, in order to have a more general view of the industry as a whole, network analysis is equally important<sup>4</sup>. However, studying a new phenomenon requires a new methodological perspectives and techniques. The connections between companies can be classified as strong or weak ties (Levanti, 2010). Examples of strong ties are joint ventures, alliances, joint investments in special purpose vehicle or other sturdy relationships that are usually formalized through a contractual agreement (for further explanations see Tiwana, 2008; Wuebker, Hampl, & Wuestenhagen, 2015). On the other hand, weak ties are less strong connections which are usually not formalized through contracts. For instance, a personal friendship between two employees of different companies can be considered a weak tie. Notice that it is difficult to study weak ties, as the lack of data is often an insurmountable issue. This is the reason why, the existing literature has dealt with strong ties only, without taking into account weak ties, even though it would be extremely useful studying them (Bužavaitė & Korsakienė, 2018).

In this regard, another crucial concept to be introduced is that of component: it is the maximal sets of nodes where each node is able to reach every other node by some path. Bridges are a very important type of tie: it is a tie which increases the number of components if it is removed. Roughly speaking, if there is the chance of creating several bridges within a network, the latter is said to be characterized by a structural holes configuration, whilst, if there is not this possibility, the network is said to be cohesive. However, it is fundamental to notice that the cohesiveness is not a binary condition (cohesive or not cohesive network), as there is an indefinite set of configurations between these two extremes network structures.

It is important to introduce also the measures of the degree centrality of a node within a network. They are a set of measures used to assess how a node is well connected to the others. The first measure is closeness, which indicates how long the information takes to get a certain location. In other words, it shows how far a node is from the others. Another widely used and powerful measure is the eigenvector, which can be interpreted as the extent to which a node is connected to the other well-connected nodes. The study of these measures led to the definition of the core-periphery models that are characterized by a single cohesive subgroup, and by sets of other nodes that are loosely connected to the core of the network. Hence, core members are characterized by several connections with each other, whereas the nodes of the periphery interact with a few core members (through the aforementioned bridges).

This set of new definitions and concepts about network analysis is absolutely partial and incomplete. The aim of this section is just explaining in a simple and linear way some introductory aspects to understand the academic literature on

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<sup>4</sup> Network analysis can be extremely useful also for competition studies. In this perspective, a trustworthy reference is Porter (2008).

venture capital networks.<sup>5</sup>

### 3. The role of venture capital firms

This section aims at providing a general idea of what a venture capital firm is, what it does and how it operates<sup>6</sup>.

Venture capital firms are institutional investors whose business objective is investing in the equity capital of unlisted firms, with the final aim of making the investee grow and, in the medium-long term, sell the shares either in a regulated market through an Initial Public Offering (IPO) or to other investors, without any stock exchange listing. Especially in Europe, the academic literature distinguishes between venture capital and private equity (Gervasoni & Sattin, 2008); the latter is a general term used to identify investments in any period of the life cycle of the investee, whilst the former refers to investments during the start-up phase only. However, this slight distinction will not be considered in this paper. As for the description of the activity of the venture capital firms, it is crucial to focus on the advisory services they supply to their investee firms. Venture capital firms work in strict collaboration with the board of directors<sup>7</sup> of the investee in order to be sure that they will make optimal (or, at least, rational) economic decisions, as they want the investee to grow. This is the reason why, venture capital firms operate in a large network made up by other institutional investors and by the investee companies, because of their activities and role. Hence, venture capital does not only provide funding, but it is also a valuable source of strategic organizational and financial skills, managerial know-how and, most important, a network of contacts.

In order to give a general overview of the phases of the venture capital process, six different steps can be identified:

- Deal flow, which “describes the rate at which business proposals and investment pitches are being received by financiers”<sup>8</sup>;
- Selection of the firms that deserve further evaluation before choosing whether or not to invest in them;
- Due diligence, which is the process that consists in evaluating the firm looking at its financial and economic conditions, and in estimating the risks the eventual acquisition would generate<sup>9</sup>;
- Investment decision, which is the final decision to invest or not to invest in the firm;
- Monitoring, this important phase is not only about observing the behavior of the investee, as venture capital firms have an important and active role in providing advises within the board of directors itself;
- Divestment, after the investee has grown enough, the venture capital firm decides to exit the investment, selling the shares/stocks of the investee to other investors.

After this brief description<sup>10</sup>, it is straightforward to identify some of the most valuable resources and skills for venture capital firms’ success. It is trivial to understand that the right choice of risk (or uncertainty) management strategies is

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<sup>5</sup> For further information on interorganizational networks, see also Dagnino et al. (2015), Mariotti & Delbridge (2012).

<sup>6</sup> For deeper explanations on this topic see Ozmel, Reuer, & Gulati (2013).

<sup>7</sup> Actually, venture capitalists often have the responsibility to propose some appointments to the management boards. For a wider description of the relationships between firms and financial intermediaries see Scannella (2016).

<sup>8</sup> See the enacademic website for further information: [http://enacademic.com/dic.nsf/enwiki/1037218/Deal\\_flow](http://enacademic.com/dic.nsf/enwiki/1037218/Deal_flow)

<sup>9</sup> Notice that, in these situations, investors have to choose under uncertainty conditions or even under ambiguity conditions, defined as the “lack of clarity about the meaning and implications of particular events or situations” (Santos & Eisenhardt 2009).

<sup>10</sup> For further information on the importance of venture capital firms see Capizzi (2011).

fundamental for venture capital firms. They are crucial to identify the best investee companies, and to carry out a cost-benefit analysis. As for risk management<sup>11</sup>, it is important to notice that, even though an investment is considered convenient, it may be the case that one single venture capital firm is not willing to invest in a company all by itself. In certain circumstances, it is likely that two or more venture capital firms share costs and benefits (and also risks) of the investment, and decide to invest together in one firm, reducing their level of commitment. Other valuable intangible resources for venture capitalists are its maturity and status. The more mature the investor is, the more likely it is that its investment will be profitable. Good investments require a high level of managerial skills, and it takes time to acquire these skills. Hence, venture capital firms tend to cooperate with other venture capital firms with a similar degree of maturity and status, as they do not want to invest with lower status investors, whilst higher status investors do not want to invest with them<sup>12</sup>.

The concepts explained in this paragraph are some of the forces that are able to shape the structure of venture capital networks<sup>13</sup>.

#### **4. A brief review of the academic literature on venture capital network**

This section explains how previous contributions have studied venture capital networks. More specifically, three recent research articles are analyzed in depth. For each of them, a discussion is provided, in order to detect the main advantages and disadvantages of their approaches, and to assess how and to what extent they have provided a contribution to the existing literature. The final aim is to identify open problems for future research. The choice of analyzing only three papers relies on the fact that they are representative of the recent trends of the scientific literature on this topic, as they are published in highly reputable academic journals. Thus, analyzing other articles would not add anything interesting for the conclusions of this work<sup>14</sup>.

##### **4.1. A seminal paper on Venture Capital Networks**

The title of the first article analyzed is “Whom You Know Matters: Venture Capital Networks and Investment Performance”, written by Hochberg, Ljungqvist, and Lu in 2007 and published in the *Journal of Finance*. It is one of the most important seminal paper in this field of study. This analysis is carried out on a sample of 3,469 venture capital funds, whose headquarters are located in the United States, and which were started between 1980 and 1999. The authors found that better-networked venture capital firms<sup>15</sup> experience significantly better performances, as measured by the proportion of investments that are profitably exited through an IPO or sold to other investors. Furthermore, the portfolio companies of better-networked venture capitalists are more likely to survive to subsequent financing and eventual exit.

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<sup>11</sup> Another suggestion for further research on this topic is to focus on the risk management strategies companies need to apply when they operate within a network, as it is an under-researched field.

<sup>12</sup> Even if maturity and status are two different concepts, some authors argue that for venture capital firms these two variables are highly correlated. For further information see Petkova et al. (2014).

<sup>13</sup> For further information on the importance of the structure of the network, see Capaldo (2007).

<sup>14</sup> For other recent papers on this topic see Bottazzi, Da Rin, & Hellmann (2016), Cox Pahnke et al. (2015), Zhelyazkov & Gulati (2016).

<sup>15</sup> Notice that the authors take into account only strong and formal ties (such as alliances and joint ventures).

Venture capitalists tend to syndicate their investments with other venture capitalists, rather than investing alone, as a risk management strategy. There are three main reasons why syndication networks are useful. Firstly, venture capital firms co-invest in their deals, in the expectation of future reciprocity (Lerner, 1994). Secondly, in order to check each other's willingness to invest in potentially promising companies, venture capital firms can pool correlated signals and select only the best investments in contexts of high uncertainty. Thirdly, individual venture capital firms use to have a sector-specific and location-specific investment knowledge. Syndication networks spread information across industry boundaries, and enables venture capital firms to diversify their portfolio of investments. In order to measure network centrality, the authors use the abovementioned eigenvector centrality, whereas their measure of venture capital firm performance is the exit rate<sup>16</sup>. One of the main important findings of the authors is that a one standard deviation increase in network centrality leads to an increase in exit rates of about 2.5 percentage. Thus, the network centrality of the venture capital firm plays a crucial role in influencing its performances. This is tightly related to the fact that well-networked venture capital firms are able to provide better advisory services to their investee. Another possible explanation for the better performance of well-connected venture capital firms is related to their maturity. It seems reasonable that the network centrality of a venture capital firm is strongly correlated with its experience<sup>17</sup>. In order to avoid the mistake that the measures of network centrality are a proxy for experience, the models used by the authors' control for a variety of dimensions of venture capital firms' experience. Their findings suggest that improving the network position (i.e. to be closer to the core of the network) should be a fundamental strategic consideration for venture capital firms, and it is a strong barrier to entry for new investors. This research is absolutely brilliant, and it is one of the most important and trustworthy in this field. The authors adopted a traditional network analysis approach and their findings have extremely important implications. This article has provided a crucial contribution to the extant literature, especially because in 2007 the scholars who were writing about this topic were just a few. Although the correlation between venture capital firms' network centrality and performances is supported by a theoretical point of view, it is extremely difficult to test empirically. Furthermore, this paper has paved the way for further research on this topic. However, this work is characterized by some limitations. From a methodological perspective, even if the authors tried to exclude the possibility that the measure of network centrality is a proxy for experience, it is difficult to be sure about this aspect. Moreover, it seems reasonable that network centrality is also a proxy for reputation, but the author did not compute any robustness test to rule out this hypothesis<sup>18</sup>. Another critical problem is related to the sample. Even if the period analyzed is quite long, the cross-sectional dimension of the sample is characterized by the issue that they take into consideration only venture capitalists headquartered in the United States. There is no guarantee that the same results hold in other countries, making difficult the generalizability of the results. Finally, there are several unanswered questions (as the authors themselves admit):

- There is not any reference to weak or informal ties (such as interpersonal connections);
- There is no analysis on the cost venture capital firms have to pay in order to become well-connected to the core

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<sup>16</sup> Exit rate is generally accepted as the best measure for venture capital firm performances.

<sup>17</sup> For further information on venture capital firms' experience see Rosemary and Pat (2013).

<sup>18</sup> They probably did not care about reputation, as it is extremely difficult to quantify it in a reliable way. However, in the next paragraph, another article which deals with this problems is analysed.

of the network;

- An explanation on how to connect with the most influential (and central) venture capital firms is missing as well.

#### ***4.2. Venture capital firms' reputation within an inter-organizational network***

The study of venture capital firms' reputation within their inter-organizational network is an important aspect that has been analyzed by Petkova, Wadhwa, Yao, and Jain (2014) in their paper titled "Reputation and decision making under ambiguity: a study of U.S. venture capital firms' investments in the emerging clean energy sector", published in the *Academy of Management Journal*. In this paper, the authors argue that firm reputation exerts dual pressure on its decision making under ambiguity conditions. More specifically, on the one hand, reputation increases the firm's aspirations for future performances and its engagement in risky strategies to achieve them, and on the other hand, preserving the established reputation requires companies to deliver consistent performances over time, which, in turn, promotes greater use of risk management strategies. The analysis is carried out on a sample of U.S. venture capitalists' investments in the clean energy industry, for a time period running from 1990 to 2008. Their important finding is that while reputable venture capital firms are more likely to invest in the aforementioned emerging industry, they also employ risk reduction strategies more extensively. The authors measure the reputation of the venture capital firm within the network adopting the measure proposed by Lee, Pollock, and Jin (2011), which is a composite index that takes into account the centrality of the venture capitalist in the network, as well as its maturity. Ambiguity is typically experienced in situations characterized by novelty, complexity, or insolubility, and the clean energy industry in that period was characterized by these exact conditions. Unlike situations of uncertainty, where decision-makers can recognize and guess the desired outcomes and the means to achieve them, but cannot predict the probability of a specific outcome, in ambiguity conditions firms lack even the understanding of which outcomes are worth or better pursuing. This situation is complex, as the ambiguity in an emerging industry leaves significant room for interpretation, and venture capital firms' differ in their assessment of the attractiveness of the emerging sector, and in the selection criteria that they consider to be relevant. The willing to discover the "next big thing" is a strong incentive for reputable venture capital firms to channel their investments towards the most promising emerging industries. Another important aspect to consider is related to the need to meet high shareholders' expectations. Moreover, reputation improves venture capital firms' ability to raise funds, and increases the availability of resources to explore new opportunities, creating a virtuous circle. Hence, the first research hypothesis of the authors is the following "Hypothesis 1: the higher the reputation of a venture capital firm, the higher the likelihood that it will invest in an emerging sector". If this hypothesis turns out to be true, another problem may arise: if decision making under ambiguity is challenging for any venture capital firm, the more reputable ones are likely to perceive such decisions as riskier, because of the potential reputation damage they may incur. The existing literature suggests that there are essentially three risk reduction strategies available for venture capital firms: syndication, later stage investment, and low levels of commitment (Wadhwa & Basu, 2013; Sorenson, 2001). Although a reputable venture capital firm might be more likely to invest in an emerging industry, because of its high aspirations, it is also likely that it is willing to make greater efforts, in order to manage the risks related to these investments, and to balance the exploration of new opportunities with the pressures towards high performances. The second hypothesis of the authors

follows: “Hypothesis 2. The higher the reputation of a venture capital firm, the greater its use of (a) syndication and (b) later stage investment, and (c) the lower its levels of commitment when investing in an emerging sector”. Another crucial aspect is the sector legitimation, which, according to the authors, can be synthesized through three variables: media attention, regulatory approval, and actions of peers. Remarking the importance of sector legitimation, the authors develop their third research hypothesis as follows: “Hypothesis 3. Sector legitimation will increase the likelihood of a venture capital firm investing in an emerging sector”<sup>19</sup>. In order to test the aforementioned hypotheses, they carried out a random effects panel regression, a logistic regression, and they calculated the correlation matrix. Hypothesis 1 is verified, because the authors found that venture capital firms’ reputation has a positive and statistically significant effect on its likelihood to invest in an emerging industry. In support of hypotheses 2a and 2b, they found that venture capital firms’ reputation has positive and significant effect on the use of syndication, and concerning hypothesis 2c, it is supported as well, as reputation turns out to have a negative and statistically significant effect on the level of commitment. The authors also find support for their third hypothesis, which predicted a positive effect of sector legitimation on a venture capital firms’ likelihood to invest in firms belonging to an emerging industry. Thus, their results show that reputable venture capital firms are more likely to invest in an emerging sector, and they tend to use risk reduction strategies more extensively. The analysis conducted by these authors provides some useful insights for venture capitalists’ network analysis. This research has provided an important contribution to the extant literature on venture capital networks. It analyses deeply the role of reputation to explain venture capital firms’ performance. Reputation is a very important aspect in venture capital networks, and it is tightly related to the network centrality analyzed by Hochberg et al. (2007). Broadly speaking, this paper provides a complementary analysis to the that proposed by Hochberg et al. (2007), and it overcomes one of its main drawbacks: it was crucial to quantify the role of reputation to explain more deeply venture capital firms’ superior performances. Although this work is extraordinary, it is characterized by some limitations. First, from a methodological viewpoint, their results hold only if the measure of venture capital firms’ reputation proposed by Lee et al. is truly reliable. It is crucial to realize that reputation is very difficult to quantify. This is a fundamental point in the analysis. It would be interesting to compute some robustness tests using other measures of reputation, and check whether the results still hold. Another limitation is related to the choice of restricting the analysis to three risk reduction strategies only. There are several other risk reduction strategies to be considered, and excluding them is a drawback for this research. Another limitation is related to the sample: an intercountry sample would provide results generalizable to a larger population. The authors themselves recognize this limitation. Lastly, they just analyze the reputation of the venture capital firms as a whole, without taking into consideration the reputation of individuals that work within the company. In actuality, it may be the case that this kind of reputation is significant within the network. Hopefully, future research could overcome these drawbacks.

### ***4.3. Status, maturity and network configurations***

Although the study of venture capital firms’ reputation has been crucial to extend our knowledge in this field of study, the analysis of venture capital firms’ maturity and status in different network configurations is equally important. This is the

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<sup>19</sup> There are other hypotheses tested by the authors, but analysing them would not add anything interesting for the analysis of this paper.



topic of the last academic article analyzed in this brief review, which is the following: Bellavitis, Filatotchev, and Souitaris (2017), "The impact of investment networks on venture capital firm performance: a contingency framework", published in the *British Journal of Management*. This paper aims at investigating the role of both venture capital firms' maturity and status to explain their performance. More specifically, the authors study the effects of these two firm-level resource proxies on the relationship between network cohesion and venture capital firms' performance. From their results, it emerges that status and maturity simultaneously determine the performance effects on network cohesion. Since the most popular way to create connections between venture capital firms is the use of syndicates (Hochberg et al. 2017), the authors focus on this kind of links. When choosing the partner to invest with, a venture capital firm has to decide whether it wants to invest with partners that are already in its network of connections (making the network more cohesive), or to establish a new connection with a firm that is outside its network (creating a network richer in structural holes). Both choices have their points of strength and weaknesses. A cohesive network is useful to its members, as it creates an environment of trust, and promotes the flow of resources and competencies within the network. In contrast, the main disadvantage of this network configuration is that it puts a constraint on the flexibility of the actors and on the scope of exchange in non-redundant resources. On the other hand, a network rich in structural holes supplies non-redundant resources and permits brokerage opportunities that may be beneficial for network members. Bellavitis et al. (2017) shed lights on the effect of the structural characteristics of venture capital firms' syndication networks on the performance of individual venture capital firms, and on the trade-off associated with different network configurations. In particular, the authors focus on maturity and status as important firm-level factors that can help to determine the balance between the benefits and the costs associated with different network configurations. The research question of the paper is the following "What are the effects of the local venture capital firm's maturity and status on the relationship between network cohesion (versus structural holes) and venture capitalists' performance?". The authors test their hypotheses on a sample of venture capital investments in the United Kingdom. For each venture capital firm, they construct its time-varying syndication network, and compute network cohesion and status measures. The performance measure adopted is the exit rate also in this case. Their main finding is that lower status and younger venture capital firms experience better performances, when they operate in a cohesive network, whilst a network rich in structural holes is more beneficial for higher status and more mature venture capital investors. Furthermore, using a three-way interaction model, the authors provide empirical evidence suggesting that maturity and status have joint effects in shaping the cost-benefit trade-offs associated with cohesion or structural holes within venture capital networks. Typically, young venture capital firms have less financial resources than mature ones. Moreover, mature and experienced investors are in a much better position to evaluate deals and, consequently, to add value to their investee, guiding them to a successful and remunerative exit. On the other hand, young venture capital firms can mitigate the drawbacks related to their lack of internal resources, if they operate in a cohesive network. However, even though the socially embedded mechanism of reciprocal support of cohesive networks is beneficial over the early phases of the venture capital firm's development, it could limit its flexibility and opportunities during the maturity phases. In other words, a mature venture capital firm requires less support from the network. Rather, it does need opportunities to grow and sustain its economic performances, and structural hole network configuration should provide better access to these opportunities. This reasoning leads the authors to develop their first research hypothesis as follows: "H1: The relationship between venture

capital network cohesion and individual venture capital firm performance is contingent on the firm's maturity. Specifically, for younger (more mature) venture capital firms, membership in a cohesive (structural holes) network improves performances". The authors define status as a "socially constructed, intersubjectively agreed upon and accepted ordering or ranking in a social system". Within the venture capital industry, centrally positioned firms enjoy high status, as they have a prominent position in the network. On the other hand, lower status venture capital firms are less attractive partners, and they are in a disadvantageous position in terms of number and quality of potential deals. However, network cohesion provides a mechanism which creates resource spill-overs, legitimacy and visibility to low-status venture capital firms. Thus, the authors argue that low-status venture capital firms are in the position to overcome the drawbacks of their status if they operate in a cohesive network, whereas high-status venture capitalists have the power to receive a larger number of good co-investment deals, also in a network rich in structural holes. For these investors, a cohesive network is a constraint, as it forces them to co-invest with their closer alliances, because of the existing relationships. In contrast, a structural hole configuration offers the resources they need most. Moreover, connecting with nodes that are distant in the network, they can exploit new non-redundant resources and information. This reasoning leads the authors to hypothesize that "H2: the relationship between venture capital network cohesion and individual venture capital firm performance is contingent on the firm's status. Specifically, for lower (higher) status venture capital firms, membership in a cohesive (structural holes) network improves performance." The most interesting part of this article is probably the discussion of the third hypothesis. The authors attempt to extend the claims of the other two hypotheses, suggesting that the effects of a venture capital firm's status and maturity are reciprocally reinforcing. In order to fully exploit the opportunities of a network rich in structural holes, a venture capital firm needs to have both a high status and a high maturity. Hence, they theorize a three-way interaction between status, maturity and network structure. In ideal situations, high status combined with maturity and structural holes network will boost the venture capital firm performances. On the other hand, investors operating in intermediate situations<sup>20</sup> might be in trouble in a network which is not cohesive. Hence, the authors develop their third research hypothesis as follows: "H3: The relationship between venture capital network cohesion and individual venture capital firm performance is contingent on the interaction of the firm's maturity and status." The sample includes all venture capital firms investing in British start-ups from 1998 to 2008. The authors use the number of exits as a performance measure, also in this case. In order to measure network cohesion, they used the index suggested by Burt (1992), which measures how redundant is the relationship between venture capital firms. The authors use the number of funds under management at a given time<sup>21</sup>, as a measure of maturity. The measure adopted for status is Bonacich's centrality (Bonacich & Power, 1987), which is similar to that adopted by Petkova et al. (2014). The authors used generalized two-stage least squares random effects instrumental variables regression, to address endogeneity concerns. Specifically, the instrumental variables were average syndicate size, pension fund assets under management as a percentage of GDP and corporate venture capital type. Through this approach, the authors verified that hypothesis 1 is correct, as the interaction coefficient was statistically significant. Supporting hypothesis 2, the two-way interaction between status and network cohesiveness on was highly

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<sup>20</sup> High maturity and low status or vice versa.

<sup>21</sup> The authors argue that it is a better proxy of maturity than age, as it represents the amount of internal resources available to the venture capitalists.

significant, too. Most importantly, the authors found support also for hypothesis 3, as the three-way interaction term was negative and statistically significant at conventional levels. The negative sign indicates that status and maturity (taken together) reinforce the advantages of a structural hole configuration. Thus, in order to fully exploit a structural hole network, a venture capital firm needs both a high level of maturity and status. If the investor has low status and maturity, or if it is in an intermediate position, it benefits more from a cohesive network configuration. This paper represents an important step ahead for the academic literature on venture capital network. It is the first research article that focuses on the importance of the interactions between the variables analyzed. Previous contributions considered status and maturity as two (almost) identical variables, even if they are conceptually different. It must be acknowledged that it is important (and more appropriate) to study these variables as separated ones, and to deal with their interactions. More specifically, the finding that high status alone is not enough for a venture capital firm to benefit from a structural hole configuration is an important and innovative result. It is a crucial point for venture capital firms, and also for an eventual orchestrator of the investors' network (Paquin & Howard-Grenville, 2013). This result provides valuable information also for policymakers, supporting them in their decision-making process. However, also this contribution is characterized by some limitations. First, as the authors themselves recognized, it is difficult to find reliable instruments in such a complex setting. For this reason, it is almost impossible to be sure that the instrumental variables proposed are the optimal ones. The same reasoning applies to the measures of network cohesion, performance and, most importantly, status. Another critique is related to the selection of the sample, which is single-country also in this case. It would be useful to analyze a cross-country sample, for generalizability purposes. Another drawback is related to the fact that, also in this case, the focus is on formal and strong ties. The authors deliberately exclude any type of informal or weak tie. It would be very interesting to investigate into these aspects, which are neglected by most of the scholars for reasons related to data availability, and not for theoretical reasons. Hence, it is absolutely necessary to find a way to collect data on weak and informal ties, to assess whether they can add something interesting to the venture capital network analysis literature<sup>22</sup>.

## 5. Conclusions

This paper provides a critical re-examination of the academic literature on venture capital networks. I analyze in depth the three most recent important contributions on venture capitalists' network analysis.

It is fundamental to analyze the recent tendencies and the unanswered questions in order to understand the methodologies to be applied to extend our knowledge in this important field of study. It is a necessary and useful step to pave the way for further developments.

To my best knowledge, Hochberg et al. (2007) is the first academic article that shed lights on the role of network centrality to explain venture capital firms' performance. The idea of this research is brilliant, even though it has been misleading to focus only on internal resources to explain venture capital firms' performance. Dealing with the position of venture capital firms within the network is a fundamental aspect to take into consideration. It was a seminal paper, which required improvements from a theoretical and methodological viewpoint. Petkova et al. (2014) have provided an important contribution to this field of research, analyzing the role of reputation inside the

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<sup>22</sup> This is a general statement for any interorganizational network, it is not related to venture capital networks only.

network under conditions of ambiguity. According to these authors, network centrality is not enough. Although it is strictly related and highly correlated with network centrality, it is something different which deserves attention by scholars. Reputation is a valuable intangible asset that can partially explain the superior performances of a venture capital firm. However, analyzing single aspects separately is not the best way to investigate into inter-organizational networks. There are several variables to take into account, and dealing with their interactions is as much important as studying them separately. This is the main reason why Bellavitis et al. (2017) analyzes the interaction between venture capital firms' maturity and status. Their important finding is related to the fact that venture capital firms that have both high status and high maturity will benefit from a structural hole configuration, whilst low status and less mature firms (as well as those in intermediate positions) will benefit from a cohesive network. Taking into account the structure of the network is fundamental, and it deserves further efforts by management scholars.

In order to pave the way for further research in this field, it is important to focus on some important aspects and unanswered questions. First, it is fundamental to analyze more deeply the role of risk reduction strategies in venture capital network. Petkova et al. (2014) deal with just a small subset of them. It would be interesting to study the effects of risk management strategies in venture capital firms' performances, as investors adopt different risk reduction strategies in different network configurations and in different network positions. Moreover, also in this case, it would be useful to check whether there is any kind of interaction with other variables, such as firm's dimension, maturity and status. Another crucial aspect is related to the study of weak and informal ties, which is usually neglected by most researchers, because of the lack of available data. They are a crucial aspect of network analysis. It may be the case that an informal tie (for instance a personal friendship) has a stronger impact than a tie that is formalized through a contractual agreement. Hence, it is crucial to study weak and informal ties<sup>23</sup>. Although the methodological approaches adopted to analyze them will always be subject to critiques, it is necessary to make an effort, and try to analyze their effects as well as the structure of the network they create. Weak ties are characterized by advantages and drawbacks. Specifically, since they usually require a small amount of effort (both in terms of money and time), they are, in some sense, less risky. On the other hand, because of the lack of a written contract<sup>24</sup>, the outcomes of the relationships cannot be defined clearly, therefore they can be considered riskier than strong formal ties. Thus, the two aforementioned proposals of analyzing risk management strategies in investors' networks, and of studying weak and informal ties, might be combined in order to analyze how investors utilize weak ties for risk management purposes. These are just a few of several proposals that could be made to promote further developments in this interesting field of study, which is still full of 'structural holes'.

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<sup>23</sup> Scholars have been shown the importance of weak ties in other fields of research. An interesting sociological example is Granovetter (1973).

<sup>24</sup> Which would make the tie formal/strong.

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### **Acknowledgements**

The author would like to thank Gabriella Levanti, Enzo Scannella and the participants of the International Scientific Conference Contemporary Issues in Business, Management and Economics Engineering (Vilnius, 2019) for insightful comments and suggestions on earlier versions of this paper.