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# Network dynamics in business angel group investment decisions

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**Abstract:** Investors within a Business Angel (BA) group are embedded in a cohesive network of relationships that arises from past joint investments. In this paper, we have studied how the network position of a BA within this network affects the likelihood that a company will receive investments from the BA group. We have hypothesized a curvilinear, inverse U-shaped relationship between the centrality of the BA and the probability of a company being funded by the BA group. Moreover, we have explored how the experience of a BA and the geographical proximity between the BA and the company influence such a relationship.

## 1. INTRODUCTION

Business angels (BAs)-i.e. net worth individuals, with considerable past entrepreneurial experience and network ties (Maula et al., 2005; Riding, 2008; Wetzel, 1983) who invest in high-risk, informationally opaque, early-stage ventures- do not always act alone (as solo angels), but they may invest together with other peers in a BA group. A BA group offers a number of advantages to its members, such as the provision of a pre-screened set of investment opportunities, the reduction of due diligence costs and the possibility of making larger and more frequent investments by pooling capital together and sharing the risks of the investments (Croce et al., 2017; Kerr et al., 2014; Paul and Whittam, 2010). In addition to the advantages to its members, the diffusion of BA groups adds a novel, network dimension to the scientific debate on the investment dynamics of informal investors.

There is now consensus, in the academic literature, on the fact that networks play a relevant role in driving entrepreneurs' business and financing decisions (Greve and Salaff, 2003; Hansen, 1995; Jonsson and Lindbergh, 2013; Reynolds, 1991; Shane and Cable, 2002; Uzzi, 1999). When network arguments are applied to investors' behavior, it emerges that the connections of the investors and their positioning in the network, represent an important

channel to acquire relevant information on ventures that have received investments, and likely affect their investment practices (Garmaise and Moskowitz, 2003; Hochberg et al., 2007; Hong et al., 2004; Jääskeläinen and Maula, 2014; Kogut et al., 2007; Sorenson and Stuart, 2001; Uzzi, 1999). While research on financial networks has focused on financial intermediation, especially venture capital (VC) financing, to the best of our knowledge, no evidence has yet been provided on BA financing. The observation that networks affect how investors acquire the information necessary to make informed investment decisions, thus lowering information asymmetries, is a topic that is still underexplored in the literature on BAs. This is quite surprising, given the prominent role that BAs exert in today's entrepreneurial finance landscape (Tenca et al., 2018; White and Dumay, 2017), the global nature of angel investing (Cumming and Zhang, 2019; Lerner et al., 2018) and the different dynamics that underlie BA investment decisions within networks, compared to other types of investors, such as VCs that typically invest in syndication. An exploration of the extent to which the positioning of BAs in a network facilitates (or constrains) firm financing and how this relationship can be moderated is certainly a worthy theoretical endeavor in the context of entrepreneurial finance.

Moving from this premise, in this paper, we argue that, in a BA group investors, are embedded within a network of relationships that develop through co-investment decisions. These relationships facilitate the flow of information (Shane and Cable, 2002), and ultimately contribute to reducing information asymmetries on potential investment targets through a double mechanism. First, occupying a central position within this network allows BAs to access high-quality information that can be used to reduce information asymmetries. Second, group membership allows information about members' investment decisions to diffuse rapidly through the network (Valente, 1995). As the investment decision of central BAs becomes common knowledge, other group members, in the absence of any better information, will

interpret it as certification of the quality of the start-up. As such, the chances of a start-up that has attracted a central BA of receiving investments will increase significantly.

In this paper, we provide insight into how the experience of investors and the geographical proximity between entrepreneurs and investors contribute to shape the investors' embeddedness in networks and their exposure to new information, both of which ultimately affect their willingness to invest in a venture. Discussing to what extent the BAs' network position affects their investment decisions, and what moderates such a relationship, is central to study the matching dynamics between entrepreneurs and investors. The closest paper to ours is Werth and Boeert's (2013), who study US high technology start-ups, to investigate the effects of BA networks on start-ups' performances. However, their focus is on start-ups financed by better connected BAs, which are found to be more likely to receive subsequent funding by VCs. In this work, we take a different perspective, focusing on the investment dynamics within a BA group. We take advantage of an original database of the largest BA group in Italy to argue that, within the BA group, investment decisions are influenced by informal mechanisms. In fact, BAs have the possibility to interact (besides formal meetings) in a number of informal moments (e.g. informal conversations before official meetings at coffee breaks, shared trips to and from the group venue, social dinners etc…) that clearly influence their individual BAs' investment decisions. It follows that, if a BA ,who is central within the BA group, shows interest in a start-up, it is more likely that this is ultimately financed by the BA group.

Our empirical results are in line with the assumption that occupying a central network position may reduce information asymmetries by means of the enhancement of the knowledge on the target venture and of a certification effect over group members. In fact, we find that the level of centrality of BAs in a social network can increase the probability of a start-up being

funded. This relationship follows a curvilinear shape, so that the marginal benefit of attracting a BA with one more additional network connection decreases for high levels of centrality.

However, other factors need to be studied, in conjunction with network centrality, in order to properly understand the mechanisms that link network dynamics to BA investment decisions. This is why we consider how network centrality is moderated by the past investment experience of a BA, as well as the geographical distance between the entrepreneur and the investor. We find that the drawbacks of occupying a too central position in the network are especially compelling for unexperienced investors, while they tend to disappear if the investor has had prior investment experience. Moreover, the centrality of BAs plays an important role whenever the investor and the start-up are geographically distant, while it disappears when the parties are proximate.

We contribute to this early literature in two main ways. First, our paper contributes to the body of knowledge on both investors' networks and BA groups. It adds to the (still) limited literature on the internal investment dynamics of BA groups (Brush et al., 2012; Carpentier and Suret, 2015; Croce et al., 2017), with specific focus on network relationships. The question on whether the network position of a BA is conducive to investment in a start-up, thus helping to reduce the uncertainty on the investment, has not yet been addressed from an empirical point of view and constitutes the core theme of the paper. Second, there has been little scholarly attempt, in the entrepreneurial finance literature on BAs, to look at the interplay between the different moderators of the association between investors' network position and the probability that a start-up will be funded.

The remainder of this paper is organized as follows. The second section describes the functioning of the studied BA group. The third section puts forward some testable hypotheses in the context of prior research. The fourth section introduces the dataset and the summary

statistics. The fifth section presents the used econometric models and illustrates the results. The final section concludes the paper and discusses the implications of our findings.

## 2. THE CONTEXT OF THE STUDY: ITALIAN ANGELS FOR GROWTH

Italian Angels for Growth (IAG) is the largest angel group in Italy (Croce et al., 2017). Established in 2007 in Milan as a non-profit organization, the group gives its members the opportunity to invest in start-ups and young companies (up to 2 million euros in revenues) with a high growth potential. To this aim, IAG focuses on investment opportunities, with offers ranging from €300,000 to €800,000, for companies with no specific industrial specialization. Up until September 2020, IAG had screened a deal flow of more than 5,000 business plans of which 80 proposals were selected for funding. Overall, since its establishment, the group (together with its co-investors) has invested a total of €200 million equity investments. At present, IAG has 154 members from virtually all over the country. However, almost 50% of the group members reside in Lombardy and of these, nearly 40% in Milan, that is, the same region and city as the IAG headquarters. On average, the IAG members are 55 years old, with a mean employment tenure of 26 years. They often have professional working experience in the private equity sector (60% of the cases), or are engaged in managerial positions (38% of the cases). In about one case out of two (45%), the IAG members have had prior or have current entrepreneurial experience. The educational background of the IAG members is often in the field of management. The 53% hold a Master Degree, typically in management-related subjects, 38% have an MBA, and just 7%, have a doctorate. The composition of IAG is very unbalanced, in terms of gender: only 7% of the IAG members are women.

The investment process at IAG is organized so that each member can decide on his/her own on whether and how much to invest in the company under consideration. Every two and half months, members participate in a general assembly, where the entrepreneurial initiatives that

passed a preliminary screening[1] are presented. During the general assembly, all IAG members, who are sitting in the same room (typically in the IAG's headquarter), are asked to provide a non-binding "soft financial commitment", where they indicate if interested in investing in the business and the amount they intend to commit. If a sufficient number of expressions of interest are collected, so that the minimum threshold of €200,000 of capital committed is reached, due diligence, conducted by the IAG staff, starts. Then, members communicate independently on whether they want to contribute to the investment and the amount they want to invest.

The physical co-location of group members is a specificity of our setting that rises interesting research questions. Indeed, despite BAs' investment decisions are autonomous, the configuration of IAG facilitates the emergence of informal moments of interaction among investors (e.g. informal conversations before and during the general assembly; or direct observation of other BAs' behavior during the general assembly), that may influence individual BAs' investment decisions.

## 3. THEORETICAL BACKGROUND

### 3.1 How the network position of a BA affects decision making in a BA group

Over time, as the BA market has matured, a growing number of angel investors have started joining together in semi-formal or organized groups (Bonini et al., 2019; Gregson et al., 2013; Mason et al., 2016; 2019; Paul and Whittam, 2010; Sohl, 2012). This recent phenomenon has attracted an increasing interest of the academic community, and a few recent papers have

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[1] Preliminary screening consists of two subsequent phases. First, an initial filter is made by the IAG staff, with the aim of excluding low growth potential entrepreneurial initiatives or initiatives that do not fit with the investment preferences of the group (e.g. too early stage start-ups). Second, proposals are sent through an online platform to all the group members. If a proposal attracts sufficient interest by at least two members, and if they positively evaluate the proposal after a face-to-face meeting with the entrepreneurs, the investment process moves forward.

tried to shed light on the functioning of such groups. Kerr et al. (2014) studied the internal structures and the investment practices of the two largest BA groups in the USA and showed that start-ups that received investments from these groups have improved survival, exits, employment levels, patenting, web traffic and financing. Croce et al. (2017), Brush et al. (2012) and Carpentier and Suret (2015) focused on the decision-making criteria that BA groups adopt when screening business opportunities during the different assessment phases (pre- screening, screening and due diligence), whereas Mason et al. (2016) and Paul and Whittam (2010) examined the advantages provided by a BA group to its members. Bonini et al. (2018) have recently discussed the network nature of BA groups, and have provided preliminary evidence that membership to a BA group is associated with each angel investor committing a larger share of personal wealth to the start-up.

In this paper, we build on the empirical findings of Bonini et al. (2018). Moving from their intuition that BA groups can be described through network dynamics, we argue that BAs are embedded in a cohesive network of relationships within their group, because of their past joint investments. These relationships may facilitate the flow of information within the BA group and, depending on the network position of the attracted BAs, may affect the likelihood of the start-up being funded.

In the context of entrepreneurial finance, a number of studies have documented that investors consistently use networks when evaluating start-ups (see Hoang and Yi, 2015 for a review). For example, Shane and Cable (2002) showed that network ties influence the VC selection of which start- ups to fund. Similarly, in the context of bank loan negotiations, Engelberg et al. (2012) showed that informal ties between a borrower and a lender result in larger loan amounts, lower interest rates and less restrictive covenants. Landström (1998) pointed out that informal investors use their personal ties to assess new investment proposals.

Overall, this literature has consistently pointed out that an advantage of relying on network ties is linked to the reduction in information asymmetries about new investment opportunities (De Carolis and Saparito, 2006; Stam and Elfrig, 2008; Uzzi, 1997). However, prior studies have noted that the possibility of reducing information asymmetries through network ties depends on the investors' position within the network (Ibarra, 1993). Those investors who occupy a central position in a network, i.e. investors with a large number of ties, have been reported to access higher-quality information on target investments. This information, which is often related to the potential market of the business idea (Davidsson and Honig, 2003), the quality of the entrepreneur/management team, or the environmental conditions a start-up will face in the future (Alexy et al., 2012), can facilitate central investors in the identification of the most promising investment opportunities (Sorenson and Stuart, 2001) and, concurrently, can reduce their risk of selecting bad quality start-ups (Stuart and Sorenson, 2007).

Results from previous studies have suggested that occupying a central position does not only allow higher quality information to be accessed, but also allows central investors to influence the decisions of other network members (Lee et al., 2011). In fact, in the absence of any better information, central individuals are key sources of information for the other members of the network (Cullen et al., 2018; Emerson, 1962; Salancik and Pfeffer, 1974). Moreover, prior research has acknowledged a twofold mechanism that explains how central individuals influence the decisions of other network members. First, these studies have reported that central individuals have the opportunity to withhold or modify information that should be shared with other network members (Friedkin, 1993; Ibarra, 1993; Rice and Aydin, 1991). Second, prior research has noted that, even though central individuals do not undertake any active role in information sharing, their decisions can have a certification content for other network members (Deeds et al., 2004; Elfring and Hulsink, 2003; Gulati and Higgins, 2003;

Shane and Cable, 2002; Stuart et., 1999). This dynamic has frequently been reported in the context of VC financing, where VC firms evaluating a deal infer information about the quality of the investment on the basis of the network position or reputation of the other VCs associated with the start-up (Hochberg et al., 2007; Hsu, 2004; Washington and Zajac, 2005).

We borrow from these arguments to describe the network dynamics within BA groups. Central BAs, because of their network position, are able to access higher quality information and therefore suffer from less information asymmetries. Their decision to invest in a start-up, since information diffuses rapidly in a network (Valente, 1995), will quickly become common knowledge for the other group members. This information, in the absence of any better information, will be used by other BA group members as certification of the start-up quality against conjectures about the (unknown) quality of the entrepreneurial initiative. Accordingly, we can expect that when a central BA decides to invest in a start-up, the probability of other group members investing in the same start-up increases, as they are induced, directly or indirectly (through certification), to believe in its higher value.

However, the so far conducted research has suggested that the outcomes associated with having many network ties are not all positive (see Kwon and Adler, 2014 for a review). Maintaining a very large number of relationships can be detrimental to efficiency and effectiveness, because the information advantages are offset by the time and resources needed to maintain several connections (Elfring and Hulsink, 2007; Mariotti and Delbridge, 2012; Steier and Greenwood, 2000). The literature has shown that there is a limit to the number of productive relationships that an individual can manage (McFadyen and Cannella, 2004). When this limit is exceeded, individuals may receive unnecessary information, which may defocus them from important decisions (Cooper et al., 1999; Uzzi, 1997). Taken to the extreme, individuals occupying a *too* central position within a network experience information

overloading (Cooper et al., 1995) and are likely to receive redundant information (Oldroyd and Morris, 2012), which reduces their ability to exploit the network in order to overcome information asymmetries (Uzzi, 1997). If so, the marginal value of a new connection may be limited or even negative (Uzzi, 1997).

Occupying a *too* central position within a network also affects an individual's ability to rely on ties through another mechanism. It can in fact facilitate the rise in feelings of mutual commitments, obligations and expectations (Coleman, 1988), which lead individuals to assist their ties even when the requests are suboptimal and/or the personal advantages are limited (Gulati and Sytch, 2007). Assistance towards ties usually becomes a priority activity, which reduces the time for other important accomplishments, especially for central individuals (McFadyen and Cannella, 2004). A shared explanation of this finding relies on network closure, which is likely achieved by individuals occupying a too central position within a network (Odzemir et al., 2016). In these cases, the sanctioning of perceived misbehaviors becomes more frequent (Horne, 2001; 2004). Accordingly, individuals comply with network requests to avoid any penalty (Gargiulo and Benassi, 2000; Portes and Sensenbrenner, 1993). A clear example comes from the VC industry. In this context, central VCs face pressure from their networks ties, and, in an attempt to satisfy their request, undertake actions that are detrimental to their own performances (Bellavitis et al., 2017).

We argue that similar dynamics also exists for BAs. When a BA is *too* central, he/she may receive redundant and unnecessary information from his/her ties. At the same time, he/she may be more committed to nurturing and managing his/her existing ties, by assisting them even when the personal advantages are limited. In this scenario, a BA's ability to lever on network ties to reduce information asymmetries and select the most promising start-ups may fade. It follows that when a BA is *too* central, he/she is no longer able to overcome information

asymmetries and may undertake suboptimal investment decisions due to social obligations. In this scenario, other members of the BA group may no longer perceive the investment decision of the central BA as certification of the start-up quality. Similarly, the central BA, being involved in many different activities, will have limited time to influence the behavior of others and convince them to invest in the same companies. As such, the dynamics described above will likely not take place. Therefore, we can expect that when the BA who invested in the company is *too* central, the other group members will no longer be likely to invest in the same company. In other words:

> **H1.** *The association between attracting a central BA and the probability that the company is funded is inverse U-shaped, with the highest probability of the company being funded at intermediate levels of centrality.*

**3.2 Investment decisions and BA centrality: the moderating role of BA experience**

Several studies have stressed that learning by doing is one of the most effective strategies to develop the ability to perform a specific task (Thompson, 2010). Such a learning process, which encompasses trial and error and explicit problem solving (Von Hippel and Tyre, 2005), proved to be used widely by investors in the entrepreneurial finance realm, in the processes of both selecting and coaching start-ups (Croce at al., 2018; 2020a; 2020b; Gompers et al., 2006; Yang et al., 2009). Among the many advantages of learning by doing, prior research has pointed out the ability of investors to manage their networks, so that more experienced investors have more likely learned how to reduce the costs associated with a too central network position (Kor and Sundaramurthy, 2009).

According to this argument, when a BA has prior experience in investing (in terms of both number and realized success of past investments), he/she will be able to process, at the same cost, an increasing amount of information from the network (Gulati, 1999). In addition,

an experienced BA will be able to separate useful from redundant information and will likely avoid processing the latter (Taylor, 1975). At the same time, a BA with greater experience will spend less time in assisting his/her network ties, because of the higher capabilities he/she has developed (Epple et al., 1991).

The ability to process more information, together with the reduced necessity of spending time in assisting network ties, reduces the costs of being too central in the BA group network. Accordingly, the negative effects of being too central will only manifest when a BA has not prior investment experience. Other members of the BA group will likely anticipate this argument and will therefore follow the decision of the central BA who has prior investment experience, even when this individual is very central. Accordingly, we can expect that:

**H2.** *The negative effect of having attracted a too central BA on the probability of a company being funded reduces when the BA has prior investment experience.*

### 3.3 Investment decisions and BA centrality: the role of geographical proximity

In this section, we investigate how the association between having attracted a central BA and the probability of the company being funded varies when the information asymmetries surrounding companies are not particularly high. To this aim, we focus on the role of geographical proximity between the BA and the company (Harrison et al., 2010).

The literature has highlighted that if an investor and a company are geographically proximate, information asymmetries are limited (Wong et al., 2009), because the flow of tacit and codified information between the parties is favored (Sorenson and Stuart, 2001). In this case, the investor likely has a deeper understanding of the context in which the company operates (Chen et al., 2010), of the local rules (Boschma, 2005) and the cultural codes that may affect the return of his/her investment (Martin et al., 2005). Geographical proximity thus facilitates BAs in screening and evaluating start-ups, as well as in providing post-investment

support and monitoring (Harrison et al., 2010; Harrison, 2017). Given all of the above, compared to the case of an investment in a more distant company, investments in geographically proximate companies are characterized by a lower level of information asymmetries.

According to this line of reasoning, geographical proximity, by decreasing information asymmetry, reduces the advantages derived from network centrality. As such, the certification effect associated with the investment decision of a central BA will be weaker when the BA is also geographically proximate to the company. For these reasons, we expect that geographical proximity acts as a substitute of centrality. Hence:

**H3.** *The effect of having attracted a central BA on the probability of a company being funded weakens when the BA is also geographically proximate to the company.*

# 4. METHOD

## 4.1. Dataset

To test our hypotheses, we used a dataset of 1,942 ventures that sought angel investments from the members of IAG from 2007 to April 2014[2]. The data were provided by IAG under the explicit request that the information on all the ventures and angels should remain confidential. The dataset included information on the closed deals and the corresponding list of BAs that had made the investments. We complemented this material with information regarding the professional background of the members of IAG from LinkedIn and/or other available web sources (i.e. Angel List or Crunchbase). The final database comprises all the companies that had passed the pre-screening phase. Focusing on this sample reduces

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[2] The same dataset was previously employed in Croce et al. (2017). Please refer to this paper for a detailed description.

endogeneity concerns due to unobservable variables, for at least two reasons. First, it ensures to deal with a "pre-matched" sample of companies searching for equity capital, thus lowering the risk to include in the analysis firms that are not actively seeking financing. Second, our sample only includes companies for which the investment process moves forward, i.e. that passed the initial filter made by the IAG staff, attracted sufficient interest by at least two members, and were positively evaluated after a face-to-face meeting with the entrepreneur. Accordingly, concerns about the unobserved quality of the start-ups included in the analysis are reduced.

### 4.2. Network analysis and degree of centrality

In line with a long-standing tradition in management (Dess and Shaw, 2001; Tsai and Ghoshal, 1998; Tsai, 2002) and entrepreneurial finance (Hochberg et al., 2007; Sorenson and Stuart, 2001), we applied network analysis to measure our main independent variable, i.e. the centrality of a BA. Network analysis has the goal of describing the structure of relationships among a set of entities (Otte and Rousseau, 2002). To this aim, it resorts to a great extent on the graph theory (West, 2001) in order to build a mathematical structure, namely a graph, of the relationships. By combining network analysis and the graph theory, it is possible to visualize a network through sociograms in which entities are represented as nodes and ties are represented as arcs.

Let us consider the sociogram in Figure 1, which graphs the relationships of the IAG members in 2007. Compared to the networks in VC investments (see Alexi et al., 2011; Hochberg et al., 2007), the relationships in a BA group are much more frequent and lead to a much more cohesive network from the very beginning. In this example, the nodes are the IAG

members, while the arcs represent the connections among them[3]. From this graph, it is possible to derive that *BA #194* is directly tied to *BA # 5*, because they both invested in the same company. On the other hand, *BA #194* is not directly tied to *BA #185*, as they have not invested in the same companies.

//Figure1 about here //

The network in Figure 1 is represented through the graph theory by means of an adjacency matrix (**A**), that is, a square, (0,1)-matrix, which indicates whether two nodes are linked in the graph. However, networks are not static. New entries and exits from the network may change the relationships each BA has over time. We therefore constructed adjacency matrices yearly. We then used the *i*-matrix to compute our measures at year *i*.

In other words, we resorted to the popular concept of valued degree centrality[4], which is defined as the number of arcs incident upon a node (i.e., the number of relationships that a node has). This measure can be interpreted in terms of the possibility of a node of catching and diffusing information and resources through the network (Hochberg et al., 2007). In mathematical terms, valued degree centrality counts the number of ties a node has. Thus, let **A** be the adjacency matrix of a graph, and for $BA_i$, the degree of centrality is equal to $\Sigma_j a_{ij}$, where $a_{ij}$ assumes a value equal to the number of connections between $BA_i$ and $BA_j$. Let us again consider Figure 1, the degree of centrality for *BA #1* is equal to 18. This BA is more central than *BA #19*, whose degree of centrality is equal to 9. In order to ensure comparability of our measure of centrality over time, in light of the consideration that the size of the network varied

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[3] We assume that $BA_i$ and $BA_j$ are connected if they invested in the same start-up in the same round during the previous five years. This is consistent with the idea that ties dissolve when relationships no longer provide critical resources and/or information (Gulati and Gargiulo, 1999; Ingram and Torfason, 2010) or if they are no longer active (Prashantham and Dhanaraj, 2010).

[4] Unlike unvalued degree centrality, valued degree centrality counts <u>as such</u> the multiple co-investment relationships with the same partner.

year by year, we normalized each measure of centrality by dividing by the maximum possible degree of centrality of each node in the network of a given year.

### 4.3 Moderators and control variables

We collected information on the BAs' prior experience and geographical proximity with the company to test the hypotheses on the moderation effects. More in details, in order to test hypothesis *H2*, in the econometric specification that is presented in Section 5, we included a dummy variable, that is, *d_prior_experience*, which assumes a value equal to one if the BA had any prior private equity investment experience before the focal investment. As a robustness check, we resorted to a different proxy of BA experience by including a dummy variable *d_expert_BA*, which relates to a more stringent definition, assuming a value equal to one if the BA performed, before the focal investment, a number of investments that is higher than the median value of the sample. To test hypothesis *H3*, about the moderation of geographical proximity on the association between having attracted a central BA and the probability of a company being funded, we included a measure of the geographical distance between the company and the BA. We used information about the localization of the company and BAs' places of residence, kindly provided by IAG, to create this variable. We converted these locations into ZIP codes and we then obtained the latitude and longitude data for the centres of each zip code. Consistent with Cumming and Dai (2010; 2013), we computed the distance between the centres of the two zip codes (*distance_BA_startup*) using the following equation:

$$distance\_BA\_startup = \log(6371 * arccos[\sin(lat_i)\sin(lat_j) + \cos(lat_i)\cos(lat_j)\cos(|long_i - long_j|)] + 1)$$

where latitude (lat) and longitude (long) were measured in radians. This variable follows a binomial distribution, where the first mode is close to the value 0, the second one to the value 5, and there is virtually no value between 1 and 4. We therefore decided to create a dummy

variable (*d_proximate*) equal to one when the variable *distance_BA_startup* is smaller than one and it assumes the value zero otherwise.

In addition, we included in our econometric models several control variables to avoid misinterpretations of the association between the BAs' centrality and the probability of a company being funded. On the basis of a careful review of the extant literature (see Tenca et al., 2018 for a comprehensive review), we included variables related to the network structure, the BA's and company characteristics and the funding rounds.

As to the network structure variables, we first relied on Burt's measure of network constrain (Burt, 1992), which is an index of the redundancy of a BA's links. This measure was aimed at estimating to what extend $BA_j$ was redundant with other connections of $BA_i$. Thus, we calculated, for each $BA_j$, the proportion of direct $BA_i$ connections that directly or indirectly had a network path through that node. The constraint measure was the sum of the squared proportions of all the nodes in the $BA_i$'s network (*network_constraints*). Second, by looking at the share of investments conducted in the same sectors over the 5 years preceding the focal investment, we included a measure of network specialization (*network_specialization*), which calculated the specialization of a BA's investment portfolio relative to that of the other BAs to whom he/she was connected. To this aim, we defined a set of 16 sectors, and for each BA, we created a vector to specify the share of investment he/she had made in each sector. Then, we computed the cross-product of the vectors for each pair of BAs and we calculated a weighted average of this pairwise specialization index, which uses the number of times two investors co-invested in a company in a moving 5-year period (0 if unconnected) as the weighting factor. This index takes a value of 1 if a member of the BA network invested exactly in the same sectors as the focal BA. It instead assumes a value of zero if a member of the BA network invested in totally different sectors in the past four years.

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We collected information about the BAs' prior experience. First, in order to control for BA experience in investments, we included the number of previous investments in equity capital before the focal investments (*n_previous_investments*). Moreover, we included a set of four dummy variables, to consider the characteristics of the BA's working experience. The variable *d_CEO* assumes a value equal to 1 if the BA had any experience as a CEO before or at the time of the focal investment. Similarly, the variable *d_President_BoardMember* is used to keep track of whether the BA was either the president or a member of any company board at the time of the investment. The variable *d_Consultant_Manager* is equal to one if the BA worked as a manager or consultant before or at the time of the investment. Finally, the variable *d_Entrepreneur* tracks whether the BA had any entrepreneurial experience at the time of the focal investment. In addition, we included a variable, *BA_age,* to indicate the BA's age at the time of the investment and a variable, *d_male*, to control for the BA's gender.

As far as the company characteristics are concerned, we controlled whether the company was located abroad (*d_abroad*) and whether the entrepreneurial initiative was forwarded to the angel group by a member of IAG itself (*d_IAG*). We also controlled, through a dummy variable (*d_same_sector*), whether the company belonged to an industrial sector in which the BAs had prior working experience at any level (i.e. CEO, president, manager, board member, consultant or entrepreneur).

Finally, we included information about the funding round. First, we included a variable that counts the number of BAs that invested in the focal company in the specific round (*count_investors*). Second, we included a variable that considers the amount committed by each BA in a specific round (*amount_committed*). We used the amount committed instead of the amount invested in the company, because the latter information was only available for the

companies that received investments, while the former was available for all the companies that had passed the pre-screening phase.

### 4.4. Descriptive statistics

Table 1 describes the variables used in the analysis, Table 2 reports the preliminary descriptive statistics and Table 3 reports the correlation matrix of the variables included in the models.

//Table 1 about here //

//Table 2 about here //

//Table 3 about here //

Our final sample includes 337 observations. Of these, 155 (45.99%) refer to companies that did not receive investments, while 182 (54.01%) refer to companies that received investments. On average, about one observation out of five (0.282, s.d. 0.451) is related to an entrepreneurial initiative forwarded to the angel group by a member of IAG. Very few entrepreneurial initiatives (3.56% of the observations) operate in industrial sectors in which the BA had prior working experience at any level. In about 95% of the cases, the BA associated with the specific observation is a male. The average age of the BAs is 50.754 years old (s.d. 8.177). Similarly, in about one case out of two, the BA had prior experience as a president in a company before the investment. The average distance between the BA and the company is 3.401 (s.d. 1.190), however, as mentioned before, this variable follows a bimodal distribution. When looking at the *d_proximate* variable, 34 of the BA/company couples are found to be geographically proximate (*d_proximate* equal to 1), while 303 of the couples are geographically distant (*d_proximate* equal to 0). Finally, 275 observations are associated with BAs with prior experience (*d_prior_experience* equal to 1), 166 of which relate to observations

associated to BAs with investment experience higher than the median, in terms of number of investments before the focal one.

As far as the main independent variable is concerned, the average value of centrality is 1.842 (s.d. 1.125). The number of companies that received investments corresponding to each quartile of the centrality variable, reported in Table 4, provide interesting preliminary insights in support of hypotheses H1. A not clear linear relationship is found between centrality and the number of funded companies. Conversely, a curvilinear trend is observed, thus suggesting that the highest number of companies that were funded correspond to the third quartile.

//Table 4 about here //

Moreover, the curvilinear trend seems to disappear when we focus on the number of companies that were funded for the different quartiles of centrality conditional to the *d_prior_experience* variable taking the value one, as reported in Table 5. In this case, the higher the quartile of BA's centrality is, the more companies received investments, thus providing preliminary support to hypothesis *H2*. The same conclusion may be derived when the dummy *d_expert_BA* is considered: when a BA made, before the focal investment, a number of investments higher than the median (i.e. *d_expert_BA*=1), the curvilinear trend disappears and a clear increasing trend is observed between centrality and the number of companies funded.

//Table 5 about here //

Finally, no particular trends are detected when looking at the number of companies that were funded for the different quartiles of centrality conditional to the *d_proximate* variable taking the value of 1 (Table 6). This statistics provides initial support to hypothesis *H3*, that suggests that BA centrality is less important when the BA and the company are close.

//Table 6 about here //

## 5. EMPIRICAL ANALYSIS

We first estimated the following model in order to test H1:

$$\text{Prob (company\_invested)} = b_0 + b_1 \, \textit{Centrality} + b^2 \, \textit{Centrality}^2 + \gamma \, \textit{controls} + \varepsilon \qquad [1]$$

The dependent variable is the likelihood that a company is funded. In accordance with H1, we expect a positive and significant coefficient of *Centrality* and a negative and significant coefficient of *Centrality*$^2$, this confirming an inverse U-shaped relationship between a BA centrality and the probability of a company being funded.

We ran a set of *probit* estimates with robust standard errors to take into account any possible biases due to heteroscedasticity. Results are shown in Table 7. The main model is reported in column I, while in column II and III we perform two robustness checks. More in details, in column II we added fixed effects at company level, while in model III we resorted to an instrumental variable approach to control for BA centrality's possible endogeneity (i.e. the startups more likely to be funded also attract central BAs). In particular, in the first stage, we estimated BA centrality as a function of *BA_age*, *d_male* and two other variables related to BA's education used as instrumental variables (*d_MS* taking value 1 when a BA has a Master Science education level and *d_PhD* when a BA has a PhD education level as described in Table 1).[5]

//Table 7 about here //

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[5] We verified the goodness of the instruments used in the first stage by testing their significance in first stage estimates (as shown in Table 7) and their non- significance in the second stage estimation. Results of this last test are not reported in the text for the sake of brevity but are available from the authors upon request.

Let us first focus on the control variables. It can be observed that BAs' age is negatively and significantly associated with the probability of a company being funded ($p<0.01$), meaning that when an older BA commits to investing in a company, it is less likely that the company is funded. The magnitude of this association is not negligible, with all the continuous covariates at their mean value and the dummy variables at their median value. In terms of marginal effects, a one-SD increase in the value of *BA age*, which means an increase from 50.754 to 58.930 years, leads to a 4.013% decrease in the probability that a company will be funded (from 53.716% to 49.703%). Moreover, the *d_entrepreneur* dummy, which indicates whether the BA who committed to investing in a company had prior experience as an entrepreneur, is negatively associated with the probability that the company will be funded, although this result is only weakly significant in estimates in column II ($p<0.1$). In terms of marginal effects, when this variable assumes the value 1, the probability that the company is funded decreases by 5.701% (from 55.849% to 50.149%). As far as the investment process is concerned, our model indicates that the *d_IAG* dummy variable is positively and significantly associated with the probability of the company being funded, meaning that entrepreneurial initiatives forwarded by a member of IAG are more likely to be funded. Talking about the marginal effect of this variable, a change in the value of this dummy from 0 to 1 is associated with a 12.202% increase (from 50.595% to 62.797%) in the probability of being funded. Unsurprisingly, the companies that receive investments are statistically significantly associated with a larger number of investors ($p<0.001$). A one-SD increase in the *count_investors* variable is associated with a 4.660% increase in the probability that the company will be funded. Finally, companies that receive investments are positively and significantly associated with the network specialization of the BAs ($p<0.001$), thus suggesting that when a BA within a specialized network (i.e. who had invested in the same sector as his/her ties) has committed to investing in a company, it is more likely that the company will be funded. The coefficients of all the other control variables

are not statistically significant. The BA's investment experience (*n_previous_investment*), the BA's gender (*d_male*), prior experience in managerial roles (*d_manager*), as a CEO (*d_CEO*) president or a board member (*d_president_board*), are not statistically associated with the dependent variable. Similarly, the geographical distance between the BA and the company (*distance_BA_*company), as well as whether the company is located abroad (*d_abroad*) and whether the company belongs to an industrial sector in which the BAs have had prior working experience at any level (*d_same_sector*), are not statistically associated with the likelihood of investing in a company. Finally, the measure of network constraint is not statistically significantly associated with the probability of a company being funded.

As far as the independent variable related to BA centrality (*centrality*) is concerned, and consistent with hypothesis *H1*, we find a positive and significant linear term of the BA centrality variable, while the squared term related to the measure of BA centrality (*centrality$^2$*) is negatively and significantly ($p < 0.01$) associated with the dependent variable. Together, the two coefficients of *centrality* and *centrality$^2$* suggest an inverse U-shaped relation between BA centrality and the likelihood of a company being funded, with the *centrality* vertex equal to 3.226, which corresponds to the 87-percentile of the distribution. This evidence is confirmed in Figure 2, which shows a graph of the marginal effects of centrality (i.e. the predicted probability of investing in a company) for different *centrality* values[6].

//Figure 2 about here //

In order to test H2 and H3, we need to add the moderation effects, i.e. the BA's prior investment experience (H2) and the geographical proximity between the BA and the company (H3), for the main independent variables related to centrality (*Centrality* and *Centrality$^2$*).

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[6] The detailed marginal effects on the probability of a company to be funded at different values of centrality, from which Figure 2 is derived, are reported in Table A1 in the Appendix.

Considering that we are testing the moderation of a curvilinear relation (*centrality*), we included two interactive terms in the econometric specification (Dawson, 2014).

Accordingly, the econometric specification to test H2 and H3 is the following:

$$Y = b_0 + b_1 \text{ } centrality + b_2 \text{ } centrality^2 + b_3 \text{ } Moderator + b_4 Moderator * centrality + b_5 Moderator * centrality^2 + \gamma \text{ } controls + \varepsilon \quad\quad [2]$$

where *Moderator* is a proxy of BA experience or geographical proximity between the BA and the company searching for investments, according to the different hypotheses H2 and H3.

We first tested hypothesis *H2,* that is, about the moderation of BA prior investment experience on the association between centrality and the likelihood of a company being funded. Results are reported in Table 8 (Panel A). In the first two columns, we resorted to *d_prior_experience* as a proxy of BA investment experience, while in the last two columns estimates refer to *d_expert_BA*. For each of these proxies, in the first column, we only included investment experience without interactions with centrality variables in order to evaluate the direct effect of the moderator on the probability of a companies being funded. In the second column, we included the interactions, according to Equation 2.[7]

//Table 8 about here //

Consistent with our hypothesis H2, when interactive terms are added[8], the results suggest

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[7] As a robustness check we performed, also for equation [2] referring to BA prior investment experience, the two robustness checks reported for testing equation [1]: we added fixed effects at company level and we resorted to an instrumental variable approach to control for BA centrality, in line with what described for results in Table 7. Results are not reported in the text for the sake of brevity but are available from the authors upon request.

[8] The moderation effect of BA prior experience on the association between centrality and the probability that the company will receive investments was estimated by including two interactive terms in the new econometric specification (Dawson, 2014). Accordingly, the econometric specification in column II of Table 8 is: $Y = b_0 + b_1$ *centrality* $+ b^2$ *centrality*$^2 + b_3$ *d_prior_experience* $+$ *d_prior_experience x centrality* $+ b_5$ *d_prior_experience x centrality*$^2 + \gamma$ *controls* $+ \varepsilon$.

that BA prior investment experience moderates the association between centrality and the dependent variable: the highest probability of a company being funded is associated with higher levels of centrality when the BA had prior investment experience. The interaction effects of the curvilinear relations may appear unclear at first. For this reason, in Panel B of Table 8, we report, for the sake of clarity, the coefficients of centrality variables for BAs without investment experience (i.e. $b_1$ and $b_2$, respectively for Centrality and Centrality$^2$) and with investment experience ($b_1+b_4$ and $b_2+b_5$, respectively for Centrality and Centrality$^2$). Results reported in Panel B of Table 8 show that BA investment experience moderates the relationship between centrality and the probability of a company to be funded. When *d_expert_BA* is taken into account, the impact is even clearer, as the relationship becomes linear: this definitely states that the likelihood of a company to receive funding increases with higher levels of centrality when the BA has investment experience higher than the median value. Moreover, we plotted the relationships in Figure 3[9].

//Figure 3 about here //

The graph in Figure 3 reports the predicted probability of investing in a company as a function of *centrality,* contingent to the *d_prior_experience* and *d_expert_BA* variables. When *d_prior_experience* assumes the value 0, the vertex corresponds to the value 1.211. On the other hand, when *d_prior_experience* takes on the value 1, the vertex is equal to 3.391 (i.e. 2.179 farther than in the previous case). This difference is found to be statistically significant, by means of a t-test ($p<0.001$). Thus, when a BA has prior investment experience, the positive effect of having attracted a central BA also emerges for higher values of centrality. When

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Similarly, the econometric specification in column IV of Table 8 is: $Y = b_0 + b_1$ *centrality* $+ b^2$ *centrality*$^2 + b_3$ *d_expert_BA* + *d_expert_BA x centrality* + $b_5$ *d_expert_BA x centrality*$^2$ + $\gamma$ *controls* + $\varepsilon$.

[9] The detailed marginal effects on the probability of a company to be funded at different values of centrality, according to the two different proxies of BA prior experience, from which Figure 3 is derived, are reported in Table A2 in the Appendix.

*d_expert_BA* is considered, as commented before, the impact is even clearer, as the relationship becomes linear (i.e. the coefficient of Centrality$^2$ becomes not significant at standard confidence levels).

Finally, we tested hypothesis *H3*, namely, that the geographical proximity between BA and a company moderates the association between BA centrality and the probability of the company being funded in estimates reported in Table 9, Panel A. Similarly to what has been reported to test H2, we first included *d_proximate* without interactions to test the direct effect (column I). Then, when interactive terms are added (Column II)[10], interesting results arise. [11]

//Table 9 about here //

In line with our hypothesis, the association between centrality and the probability of the company being funded weakens when the BA and the company are geographically proximate (*d_proximate* equal to one). Again, for the sake of clarity, in Panel B of Table 9, we report the coefficients of centrality variables for BAs without proximity (i.e. $b_1$ and $b_2$, respectively for Centrality and Centrality$^2$) and with proximity ($b_1+b_4$ and $b_2+b_5$, respectively for Centrality and Centrality$^2$). Moreveor, the relationships are shown in a graph in Figure 4[12].

//Figure 4 about here //

The graph in Figure 4 reports the predicted probability of a company being funded as a

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[10] Similarly to what was done to test H2, the moderation effect of geographical proximity on the association between centrality and the probability that the company will receive investments, was estimated by including two interactive terms in the new econometric specification (Dawson, 2014). Accordingly, the econometric specification in column II of Table 9 is: $Y = b_0 + b_1$ *centrality* $+ b^2$ *centrality*$^2$+$b_3$ *d_proximity*+ *d_proximity x centrality*+ $b_5$ *d_proximity x centrality*$^2$+ $\gamma$ *controls*+ $\varepsilon$.

[11] As a robustness check we performed, also for equation [2] referring to the geographical proximity between BA and the company searching for equity investments, the two robustness checks reported for testing equation [1]: we added fixed effects at company level and we resorted to an instrumental variable approach to control for BA centrality in line with what described for results in Table 7. Results are not reported in the text for the sake of brevity but are available from the authors upon request.

[12] The detailed marginal effects on the probability of a company being funded at different values of centrality, according to the geographical proximity between BA and the company funded, from which Figure 4 is derived, are reported in Table A3 in the Appendix.

function of *centrality,* contingent to the *d_proximate* variable taking on the values 0 and 1. In the first case, i.e. when the geographical distance between BA and the company is high, the inverted U-shaped relation is confirmed, with the highest probability of a company being funded corresponding to the value 2.684 of the *centrality* variable. On the other hand, when the geographical distance between BA and the company is low, the association between *centrality* and the probability of the company being funded is no longer inverted U-shaped[13]. Interestingly, the Figure shows that the probability of the company being funded is always higher when it receives investments from a BA located close to the company. This result holds for any level of centrality.

## 6. CONCLUSION

In this paper, we have studied how attracting a central BA within a BA group influences the probability of a company being funded by the other members of the BA group and how contingency factors moderate this main relation. To this aim, we collected and analyzed data about IAG, which is the largest BA group in Italy, and we created network measures to test our hypotheses. The results of the econometric analyses support our contentions that the association between attracting a central BA and the probability a company being funded follows a curvilinear, inverse U-shaped relation, so that the more central the attracted BAs are, the more likely it is that the company will be funded. Instead, for very high values of BA centrality, the positive effect of an additional connection on the probability of the company being funded decreases.

We argue that the main reason for this result pertains to the certification effect associated with having attracted a central BA. Central BAs suffer from less information

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[13] Figure 4, shows that there is a change in the concavity of the relations between *centrality* and the probability that the company will receive investments (U-shaped relation). However, as can be inferred from the confidence intervals, this is not statistically significant.

asymmetries, both before and after the decision to invest in a company, and thus are likely to be able to identify promising investment opportunities. As such, other BAs will pay particular attention to their choices and will likely follow their investment decisions, according to observational learning dynamics. However, when a BA is *too* central, his/her power to reduce information asymmetries diminishes because of information overloading. Therefore, in these situations, other BAs in the group will not follow the investment decision of the focal BA.

We then identified two moderators that affect such a relationship. Specifically, we showed that BAs' prior experience, as a result of the BAs' information processing capacity increasing, acts as a complementary factor, which reduces the side effects of having attracted a too central BA and, thus, moves the decreasing branch of the curvilinear relation forward. Conversely, geographical proximity, by reducing information asymmetries, operates as a substitute factor, which weakens the effect of having attracted a central BA on the probability of a company being funded.

These results contribute to the current literature in several ways. First, this paper contributes to the growing body of research on BA groups (see Tenca et al., 2018 for a review). As the BA market has matured, BAs have joined together in semiformal or organized groups. However, despite some notable exceptions (Paul and Whittam, 2010; Porter and Spriggs, 2013), the investment process, the challenges and the issues faced by these groups have been poorly investigated in the literature. In this paper, we have contributed to this debate by describing the network dynamics in BA groups and have shown how these affect the probability of a company being funded by BA group members. Second, this paper has contributed to the more general literature on entrepreneurial finance by showing moderators of the association between centrality and the probability that a company will be funded. Although the dyadic associations between network centrality, prior investment experience, geographical

proximity and the probability of a company being funded were investigated independently in the prior research, this is, to the best of our knowledge, the first study that has looked at the interplay among these concepts. In doing so, the contribution of the paper to the literature on entrepreneurial finance has been twofold. First, the paper has highlighted that the drawbacks of being too central are particularly compelling for unexperienced investors, while they tend to disappear when the investor has had prior investment experience. Secondly, our analysis has shown that an investor's network position plays a particularly important role when the investor and the company are geographically distant, while this role disappears when the parties are proximate.

We acknowledge our paper is not exempt of limitations. We used the valued degree of centrality to measure the possible interactions among IAG members. However, our measure did not allow us to control for either the real interactions that occur among BAs, or for the nature of these interactions. In this respect, we have not been able to discriminate between BAs who jointly invested in a company and had several interactions after the investment from BAs who barely connected after the investment. Although we believe this latter –extreme- case is quite unlikely, given that BAs are hands-on investors who are generally involved directly in the aftermath of the investment (Politis, 2008), we cannot exclude (or control for) less extreme cases. Moreover, we did not consider such characteristics of the entrepreneurs as prior education or experience, which may affect the probability of the company being funded. For this reason, further studies are needed to extend our analysis so as to include controls for the aforementioned characteristics. Finally, we focused on a single BA group, thus, although we fall short to find arguments against, we cannot strongly claim about the generalizability of our results. Further studies including information on other countries or using data from different BA groups would allow us to discern whether our results are specific to the case of IAG or generalizable to BA groups in general.

Despite these limitations, we believe our work has relevant implications for practitioners and policy makers. Entrepreneurs can benefit from the results of our paper, as it provides clear evidence in support of the idea that attracting central BAs is positively associated with the probability that a company will be funded by a BA group. According to this line of reasoning, our recommendation for entrepreneurs is to target and approach central BAs in particular, as they may function as a certification for the company and may convince other BAs in the group to invest. Entrepreneurs should consider that, according to our study, this relation follows an inverse U-shaped trend. Our second indication is therefore to avoid those BAs that are too central. We acknowledge that obtaining information about a BA's centrality is not an easy task for entrepreneurs. However, our paper provides an answer to this critical aspect. As shown in this work, geographical proximity acts as a substitute of network centrality, which increases the likelihood of obtaining investments. Thus, a possible alternative strategy, which appears much simpler, is related to the targeting of geographically proximate BAs. Finally, our results on BAs' prior investment experience suggest that entrepreneurs should target central BAs, if they have had prior investment experience. These BAs are likely to be more able to process information and hence to suffer less from the drawbacks of being too central.

Policymakers who are interested in favoring a flourishing and functioning entrepreneurial finance market should consider the results of our research. We have shown that attracting central BAs within a BA group increases the likelihood that a company will be funded. Thus, policies that make the network position of BAs known to the public should be favored. For example, the creation of a public register, perhaps by means of exploiting new digital technologies, which keeps track of the investment made by BAs would be very helpful for entrepreneurs. Several BA groups and networks have moved in that direction by promoting initiatives such as the election of the BA of the year, the most active and influential investor of the group. Overall, we believe our paper has provided insight into an important, emerging

aspect of BA investments. As new BA groups are likely to appear, we are convinced that the position of a BA network will play an even more significant role in the near future.

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## TABLES

**Table 1. Description of the variables**

| Variable | Description |
|---|---|
| ***Dependent variable*** | |
| company_invested | Dummy variable that is equal to 1 if the company received financing, and 0 otherwise |
| ***Independent variables*** | |
| Centrality | Network centrality à la Hochberg et al. (2007). See Section 4 for details on the measurement of the variable |
| ***Moderators variables*** | |
| d_prior_experience | Dummy variable that is equal to 1 if the BA had any prior private equity investment experience before the focal investment |
| d_expert_BA | Dummy variable that is equal to 1 if the BA, before the focal investment, performed a number of investments higher than the median number of investments in the sample |
| d_proximate | Dummy variable that is equal to 1 if the variable Distance_BA_start-up is smaller than 1, and 0 otherwise |
| ***Control variables*** | |
| n_previous_investments | Number of investments performed by the BA before the focal investment |
| distance_BA_start-up | Distance between the two centres of the two zip codes estimated in accordance with Cumming and Dai (2010; 2013). See Section 4.3 for details on the measurement of the variable |
| d_IAG | Dummy variable that is equal to 1 if the entrepreneurial initiative was forwarded to the angel group by a member of IAG |
| d_abroad | Dummy variable that is equal to 1 if a company is located outside Italy |
| BA_age | BA's age at the time of the investment |
| d_male | Dummy variable that indicates the BA's gender: 1 if male, 0 if female |
| d_President_BoardMember | Dummy variable that is equal to 1 if the BA was either the president or a member of any company board at the time of the investment. |
| d_CEO | Dummy variable that is equal to 1 if the BA had any experience as a CEO before or at the time of the focal investment |
| d_Entrepreneur | Dummy variable that is equal to 1 if the BA had any entrepreneurial experience at the time of the focal investment |
| d_Consultant_Manager | Dummy variable that is equal to 1 if the BA worked as a manager or consultant before or at the time of the investment |
| network_specialization | Specialization of a BA's investment portfolio relative to that of the other BAs with whom he/she is connected. See Section 4.3 for details on the measurement of the variable |
| network_constraints | Burt's measure of network constraint (Burt, 1992). See Section 4.3 for details on the measurement of the variable |
| d_same_sector | Dummy variable equal to 1 if the company belongs to an industrial sector in which the BA had prior working experience at any level (i.e. CEO, president, manager, board member, consultant, or entrepreneur) |
| count_investors | Variable that counts the number of BAs that invested in the focal company in the specific round |
| amount_committed | Amount committed by each BA in a specific round (in logs) |
| ***Additional instrumental variables*** | |
| d_MS | Dummy variable equal to 1 if the BA has a MS education degree |
| D_PhD | Dummy variable equal to 1 if the BA has a PhD education degree |

**Table 2. Descriptive statistics**

| Variable | Mean | St.Dev | Min | Max | Count obs. |
|---|---|---|---|---|---|
| company_invested | 0.540 | 0.499 | 0 | 1 | 337 |
| Centrality | 1.842 | 1.125 | 0 | 4.667 | 337 |
| d_prior_experience | 0.828 | 0.378 | 0 | 1 | 332 |
| d_expert_BA | 0.493 | 0.501 | 0 | 1 | 337 |
| d_proximate | 0.101 | 0.302 | 0 | 1 | 337 |
| n_previous_investments | 10.255 | 7.478 | 0 | 24 | 337 |
| distance_BA_start-up | 3.401 | 1.190 | 0 | 4.276 | 337 |
| d_IAG | 0.282 | 0.451 | 0 | 1 | 337 |
| d_abroad | 0.142 | 0.350 | 0 | 1 | 337 |
| BA_age | 50.754 | 8.177 | 34 | 69 | 337 |
| d_male | 0.950 | 0.219 | 0 | 1 | 337 |
| d_President_BoardMember | 0.496 | 0.501 | 0 | 1 | 337 |
| d_CEO | 0.231 | 0.422 | 0 | 1 | 337 |
| d_Entrepreneur | 0.285 | 0.452 | 0 | 1 | 337 |
| d_Consultant_Manager | 0.350 | 0.478 | 0 | 1 | 337 |
| network_specialization | 0.022 | 0.032 | 0 | 0.191 | 337 |
| network_constraints | 0.044 | 0.008 | 0 | 0.080 | 337 |
| d_same_sector | 0.036 | 0.186 | 0 | 1 | 337 |
| count_investors | 3.238 | 0.346 | 1.386 | 3.689 | 337 |
| amount_committed | 2.815 | 0.534 | 1.792 | 4.615 | 337 |
| d_MS | 0.598 | 0.491 | 0 | 1 | 316 |
| D_PhD | 0.024 | 0.152 | 0 | 1 | 337 |

# Table 3. Correlation matrix

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 company_invested | 1 | | | | | | | | | | | | | | | | | | | | | |
| 2 Centrality | 0.106 * | 1 | | | | | | | | | | | | | | | | | | | | |
| 3 d_prior_experience | 0.012 | 0.373 *** | 1 | | | | | | | | | | | | | | | | | | | |
| 4 d_expert_BA | -0.008 | 0.742 *** | 0.442 *** | 1 | | | | | | | | | | | | | | | | | | |
| 5 d_proximate | 0.072 | -0.009 | 0.045 | -0.015 | 1 | | | | | | | | | | | | | | | | | |
| 6 n_previous_investments | -0.029 | 0.853 *** | 0.416 *** | 0.826 *** | -0.026 | 1 | | | | | | | | | | | | | | | | |
| 7 distance_BA_start-up | -0.017 | 0.021 | -0.058 | -0.006 | -0.959 *** | 0.021 | 1 | | | | | | | | | | | | | | | |
| 8 d_IAG | 0.062 | -0.068 | -0.001 | 0.016 | 0.206 *** | -0.024 | -0.147 *** | 1 | | | | | | | | | | | | | | |
| 9 d_abroad | 0.018 | -0.057 | 0.047 | -0.079 | -0.137 ** | -0.062 | 0.157 *** | 0.330 *** | 1 | | | | | | | | | | | | | |
| 10 BA_age | -0.040 | 0.162 *** | -0.129 ** | 0.243 *** | 0.011 | 0.158 *** | -0.021 | 0.013 | 0.005 | 1 | | | | | | | | | | | | |
| 11 d_male | 0.059 | 0.158 *** | -0.106 * | 0.227 *** | -0.058 | 0.142 *** | 0.066 | 0.084 | -0.061 | 0.063 | 1 | | | | | | | | | | | |
| 12 d_President_BoardMember | -0.026 | 0.109 * | 0.202 *** | -0.015 | -0.036 | 0.120 ** | 0.015 | -0.067 | 0.004 | -0.061 | -0.178 *** | 1 | | | | | | | | | | |
| 13 d_CEO | -0.058 | 0.018 | 0.139 ** | 0.093 * | -0.044 | -0.017 | 0.037 | -0.016 | -0.022 | 0.157 *** | 0.127 ** | 0.103 * | 1 | | | | | | | | | |
| 14 d_Entrepreneur | -0.011 | 0.067 | 0.097 * | 0.128 ** | 0.007 | 0.081 | -0.026 | 0.028 | -0.032 | -0.168 *** | 0.146 *** | -0.179 *** | -0.237 *** | 1 | | | | | | | | |
| 15 d_Consultant_Manager | 0.041 | -0.130 ** | -0.314 *** | -0.163 *** | 0.023 | -0.174 *** | -0.001 | 0.052 | 0.021 | 0.048 | 0.112 ** | -0.305 *** | -0.344 *** | -0.450 *** | 1 | | | | | | | |
| 16 network_specialization | 0.559 *** | -0.205 *** | -0.180 *** | -0.250 *** | -0.056 | -0.318 *** | 0.091 * | -0.131 ** | -0.106 * | -0.081 | 0.069 | -0.048 | 0.025 | -0.056 | 0.025 | 1 | | | | | | |
| 17 network_constraints | 0.072 | -0.527 *** | -0.340 *** | -0.540 *** | 0.005 | -0.605 *** | 0.012 | 0.017 | 0.055 | -0.154 *** | 0.204 *** | -0.038 | 0.064 | -0.063 | 0.109 ** | 0.442 *** | 1 | | | | | |
| 18 d_same_sector | 0.049 | -0.117 ** | -0.169 *** | -0.125 ** | -0.064 | -0.135 ** | 0.059 | 0.093 * | 0.059 | 0.014 | 0.044 | -0.030 | -0.030 | 0.092 * | -0.007 | -0.031 | 0.070 | 1 | | | | |
| 19 count_investors | 0.351 *** | 0.064 | -0.091 * | -0.001 | -0.053 | -0.058 | 0.062 | 0.032 | -0.219 *** | -0.018 | 0.159 *** | -0.082 | 0.031 | -0.056 | 0.098 * | 0.290 *** | 0.054 | -0.027 | 1 | | | |
| 20 amount_committed | -0.052 | 0.213 *** | 0.131 ** | 0.320 *** | 0.013 | 0.332 *** | -0.042 | -0.149 *** | -0.156 *** | 0.154 *** | -0.024 | 0.108 ** | 0.280 *** | -0.074 | -0.108 ** | -0.104 * | -0.219 *** | -0.094 * | 0.051 | 1 | | |
| 21 d_MS | 0.012 | -0.049 | -0.010 | -0.048 | 0.045 | -0.137 ** | -0.055 | -0.003 | 0.002 | -0.176 *** | 0.033 | 0.138 ** | -0.018 | 0.008 | 0.073 | -0.026 | 0.154 *** | -0.040 | 0.050 | -0.226 *** | 1 | |
| 22 D_PhD | 0.027 | -0.138 | 0.020 | -0.154 *** | 0.013 | -0.094 * | -0.006 | -0.054 | 0.104 * | 0.038 | -0.498 *** | 0.079 | -0.039 | -0.055 | -0.074 | 0.072 | 0.044 | -0.030 | -0.179 *** | 0.082 | -0.156 *** | 1 |

Note: *, **, and *** indicate significance levels at 0.10, 0.05 and 0.01, respectively.

**Table 4. Number of observations related to companies that received investments at different quartiles of centrality**

| Quartile of Centrality | Cut point of centrality | n. obs. of companies NOT funded | n. obs. of companies funded |
|---|---|---|---|
| 1 | | 46 | 42 |
| 2 | 1 | 42 | 39 |
| 3 | 1.494 | 36 | 52 |
| 4 | 2.783 | 31 | 49 |
| **Total** | | **155** | **182** |

**Table 5. Number of observations related to companies that received investments at different quartiles of centrality according to the BA's prior investment experience**

| Quartile of Centrality | BA with prior investment experience (d_prior_experience=1) | | BA without prior investment experience (d_prior_experience=0) | | BA with prior investment experience higher than median (d_expert_BA=1) | | BA with prior investment experience lower than median (d_expert_BA=0) | |
|---|---|---|---|---|---|---|---|---|
| | *n. obs. of companies NOT funded* | *n. obs. of companies funded* | *n. obs. of companies NOT funded* | *n. obs. of companies funded* | *n. obs. of companies NOT funded* | *n. obs. of companies funded* | *n. obs. of companies NOT funded* | *n. obs. of companies funded* |
| 1 | 26 | 22 | 20 | 20 | 1 | 1 | 45 | 41 |
| 2 | 38 | 37 | 4 | 2 | 15 | 6 | 27 | 33 |
| 3 | 31 | 41 | 3 | 8 | 30 | 33 | 6 | 19 |
| 4 | 31 | 49 | 0 | 0 | 31 | 49 | 0 | 0 |
| **Total** | **126** | **149** | **27** | **30** | **77** | **89** | **78** | **93** |

**Table 6. Number of observations related to companies that received investments at different quartiles of centrality according to the geographical proximity between the company funded and the BA**

| Quartiles of Centrality | Geographical proximity between the BA and the company (d_proximate=1) | | NO Geographical proximity between the BA and the company (d_proximate=0) | |
|---|---|---|---|---|
| | *n. obs. of companies NOT funded* | *n. obs. of companies funded* | *n. obs. of companies NOT funded* | *n. obs. of companies funded* |
| 1 | 4 | 4 | 42 | 38 |
| 2 | 3 | 6 | 39 | 33 |
| 3 | 4 | 8 | 32 | 44 |
| 4 | 1 | 4 | 30 | 45 |
| **Total** | **12** | **22** | **143** | **160** |

**Table 7. BA centrality and probability of a company to be funded**

| d.var: company invested | I | | II | | III | |
|---|---|---|---|---|---|---|
| *Control variables* | | | | | | |
| d_IAG | 1.342 | ** | 1.342 | | 1.586 | *** |
| | (0.574) | | (1.163) | | (0.592) | |
| d_abroad | -0.189 | | -0.189 | | -0.537 | |
| | (1.04) | | (2.124) | | (0.958) | |
| n_previous_investments | 0.060 | | 0.060 | | 0.044 | |
| | (0.059) | | (0.054) | | (0.051) | |
| BA_age | -0.061 | *** | -0.061 | *** | -0.064 | *** |
| | (0.022) | | (0.016) | | (0.023) | |
| distance_BA_company | -0.023 | | -0.023 | | -0.029 | |
| | (0.174) | | (0.069) | | (0.163) | |
| d_male | -0.730 | | -0.730 | | -0.661 | |
| | (0.857) | | (0.565) | | (0.793) | |
| d_President_BoardMember | -0.213 | | -0.213 | | -0.194 | |
| | (0.322) | | (0.173) | | (0.294) | |
| d_CEO | -0.016 | | -0.016 | | -0.083 | |
| | (0.542) | | (0.422) | | (0.478) | |
| d_Entrepreneur | -0.698 | | -0.698 | * | -0.756 | |
| | (0.546) | | (0.371) | | (0.473) | |
| d_Consultant_Manager | -0.007 | | -0.007 | | 0.038 | |
| | (0.597) | | (0.449) | | (0.494) | |
| network_specialization | 287.521 | *** | 287.521 | *** | 278.461 | *** |
| | (39.038) | | (28.222) | | (34.457) | |
| network_constraints | -6.375 | | -6.375 | | -28.067 | |
| | (75.597) | | (54.826) | | (74.678) | |
| d_same_sector | 0.640 | | 0.640 | | 0.572 | |
| | (0.878) | | (0.42) | | (0.821) | |
| count_investors | 1.430 | ** | 1.430 | | 1.273 | ** |
| | (0.579) | | (1.47) | | (0.577) | |
| amount_committed | 0.568 | | 0.568 | | 0.636 | |
| | (0.346) | | (0.439) | | (0.395) | |
| *Centrality variables* | | | | | | |
| Centrality | 2.192 | ** | 2.192 | *** | 2.151 | *** |
| | (0.853) | | (0.648) | | (0.808) | |
| centrality$^2$ | -0.340 | ** | -0.340 | *** | -0.334 | ** |
| | (0.164) | | (0.1) | | (0.154) | |
| const. | -6.849 | | -6.849 | | -5.154 | ** |
| | (4.234) | | (5.302) | | (4.383) | |
| *First stage estimation results.* | | | | | | |
| *d.var:centrality* | | | | | | |
| BA_age | | | | | -0.032 | |
| | | | | | (0.031) | |
| d_male | | | | | 1.829 | *** |
| | | | | | (0.578) | |
| d_MS | | | | | 1.023 | * |
| | | | | | (0.590) | |
| D_PhD | | | | | 7.104 | *** |
| | | | | | (0.570) | |
| constant | | | | | 1.651 | |
| | | | | | (1.733) | |

| | | | |
|---|---|---|---|
| Year dummies | YES | YES | YES |
| Industry dummies | YES | YES | YES |
| N | 337 | 337 | 319 |

The dependent variable is a dummy variable that indicates a value of 1 if the company received financing, and 0 otherwise. For a description of the variables see Table 1. Industry and year dummies are included in the estimates (coefficients are omitted in the Table). The estimates in Column I were derived from probit estimates with robust standard errors. Estimates in Column II were derived from probit estimates with company fixed effects. Estimates in Column III refer to an heckman probit estimator: results of first stage estimation, instrumenting BA centrality, are reported at the bottom of the Table. Standard errors in round brackets. *, **, and *** indicate significance levels at 0.10, 0.05 and 0.01, respectively.

**Table 8. Panel A. BA centrality and probability of a company to be funded: role of BA prior investment experience**

| d.var: company invested | I | | II | | III | | IV | |
|---|---|---|---|---|---|---|---|---|
| | d_prior_experience | | | | d_expert_BA | | | |
| *Control variables* | | | | | | | | |
| d_IAG | 1.557 | *** | 1.57 | *** | 1.627 | *** | 1.967 | *** |
| | (0.536) | | (0.504) | | (0.576) | | (0.618) | |
| d_abroad | -0.26 | | -0.194 | | -0.69 | | -0.639 | |
| | (1.081) | | (1.074) | | (1.046) | | (0.983) | |
| n_previous_investments | 0.073 | | 0.076 | | 0.067 | | 0.033 | |
| | (0.06) | | (0.059) | | (0.057) | | (0.063) | |
| BA_age | -0.053 | ** | -0.05 | * | -0.091 | *** | -0.093 | *** |
| | (0.025) | | (0.027) | | (0.033) | | (0.035) | |
| distance_BA_company | -0.008 | | 0.025 | | 0.006 | | 0.027 | |
| | (0.182) | | (0.179) | | (0.192) | | (0.195) | |
| d_male | -0.838 | | -0.95 | | -1.411 | | -0.958 | |
| | (0.856) | | (0.883) | | (0.879) | | (0.937) | |
| d_President_BoardMember | -0.272 | | -0.207 | | 0.025 | | -0.044 | |
| | (0.339) | | (0.341) | | (0.374) | | (0.383) | |
| d_CEO | -0.156 | | -0.137 | | -0.429 | | -0.78 | |
| | (0.549) | | (0.558) | | (0.584) | | (0.626) | |
| d_Entrepreneur | -0.833 | | -0.741 | | -1.209 | ** | -1.512 | ** |
| | (0.558) | | (0.579) | | (0.597) | | (0.682) | |
| d_Consultant_Manager | -0.051 | | -0.052 | | -0.263 | | -0.562 | |
| | (0.591) | | (0.595) | | (0.63) | | (0.719) | |
| network_specialization | 303.378 | *** | 309.505 | *** | 341.149 | *** | 354.402 | *** |
| | (40.365) | | (42.429) | | (63.523) | | (69.805) | |
| network_constraints | 32.077 | | 53.209 | | 56.509 | | 35.758 | |
| | (64.54) | | (54.198) | | (52.295) | | (81.181) | |
| d_same_sector | 1.69 | ** | 2.193 | *** | 1.021 | | 1.122 | |
| | (0.66) | | (0.499) | | (0.882) | | (0.818) | |
| count_investors | 1.501 | ** | 1.626 | *** | 1.284 | ** | 1.408 | ** |
| | (0.594) | | (0.607) | | (0.653) | | (0.67) | |
| amount_committed | 0.592 | | 0.592 | | 0.727 | * | 0.807 | ** |
| | (0.362) | | (0.372) | | (0.392) | | (0.409) | |
| *Centrality variables* | | | | | | | | |
| Centrality | 1.881 | ** | 13.536 | ** | 1.198 | | 6.156 | ** |
| | (0.891) | | (6.179) | | (0.867) | | (2.734) | |
| Centrality$^2$ | -0.274 | | -5.586 | ** | -0.248 | | -2.238 | ** |
| | (0.177) | | (2.507) | | (0.168) | | (1.007) | |
| *Moderator factors* | | | | | | | | |
| d_prior_experience | 1.959 | *** | 7.024 | ** | | | | |
| | (0.605) | | (3.42) | | | | | |
| Centrality##d_prior_experience | | | -11.319 | * | | | | |
| | | | (6.221) | | | | | |
| Centrality$^2$##d_prior_experience | | | 5.26 | ** | | | | |

|  | I |  | II |  | III |  | IV |  |
|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  | (2.51) |  |  |  |
| d_expert_BA |  |  |  |  | 2.697 | ** | 3.597 |  |
|  |  |  |  |  | (1.109) |  | (2.539) |  |
| Centrality##d_expert_BA |  |  |  |  |  |  | -3.714 |  |
|  |  |  |  |  |  |  | (2.978) |  |
| Centrality$^2$##d_expert_BA |  |  |  |  |  |  | 1.829 | * |
|  |  |  |  |  |  |  | (1.029) |  |
| Constant | -11.014 | *** | -18.143 | *** | -7.26 | ** | -9.721 | ** |
|  | (3.827) |  | (5.512) |  | (3.373) |  | (4.269) |  |
| Year dummies | YES |  | YES |  | YES |  | YES |  |
| Industry dummies | YES |  | YES |  | YES |  | YES |  |
| N | 332 |  | 332 |  | 337 |  | 337 |  |

The dependent variable is a dummy variable that indicates a value of 1 if the company received financing, and 0 otherwise. For a description of the variables see Table 1. Industry and year dummies are included in the estimates (coefficients are omitted in the Table). Estimates were derived from probit estimates with robust standard errors. In Column I and Column III only the direct effect of BA prior experience is included, with d_prior_experience and d_expert_BA, respectively. In Column II and Column IV we include the interactions between BA prior investment experience and centrality variables, with d_prior_experience and d_expert_BA, respectively. Standard errors in round brackets. *, **, and *** indicate significance levels at 0.10, 0.05 and 0.01, respectively.

## Table 8. Panel B. Role of centrality according to the moderator effect of BA prior investment experience

| | Without investment experience | | | |
|---|---|---|---|---|
| | II | | IV | |
| | d_prior_experience=0 | | d_expert_BA=0 | |
| Centrality | 13.536 | ** | 6.156 | ** |
| | (6.179) | | (2.734) | |
| Centrality$^2$ | -5.586 | ** | -2.238 | ** |
| | (2.507) | | (1.007) | |
| | With investment experience | | | |
| | d_prior_experience=1 | | d_expert_BA=1 | |
| Centrality | 2.217 | ** | 2.442 | * |
| | (1.013) | | (1.378) | |
| Centrality$^2$ | -0.327 | * | -0.409 | |
| | (0.193) | | (0.258) | |

Coefficients of centrality variables, according to the models with interactions (Column II and Column IV, for d_prior_experience and d_expert_BA, respectively) are reported. We report both coefficients of centrality when the BA has NOT investment experience (i.e. b1 and b2, respectively for Centrality and Centrality$^2$, according to equation [2]) and the coefficients of centrality variables when the BA has investment experience (b1+b4 and b2+b5, respectively for Centrality and Centrality$^2$, according to equation [2]). Standard errors in round brackets. *, **, and *** indicate significance levels at 0.10, 0.05 and 0.01, respectively.

**Table 9. Panel A. BA centrality and probability of a company to be funded: role of geographical proximity**

| d.var: company invested | I | | II | |
|---|---|---|---|---|
| *Control variables* | | | | |
| d_IAG | 1.062 | * | 1.325 | ** |
| | (0.6) | | (0.613) | |
| d_abroad | 0.094 | | 0.128 | |
| | (1.101) | | (1.115) | |
| n_previous_investments | 0.078 | | 0.104 | |
| | (0.059) | | (0.066) | |
| BA_age | -0.060 | *** | -0.086 | *** |
| | (0.021) | | (0.021) | |
| distance_BA_company | 1.279 | *** | 1.694 | *** |
| | (0.363) | | (0.445) | |
| d_male | -1.198 | | -1.457 | |
| | (0.84) | | (0.985) | |
| d_President_BoardMember | 0.024 | | 0.143 | |
| | (0.341) | | (0.363) | |
| d_CEO | 0.496 | | 0.742 | |
| | (0.562) | | (0.648) | |
| d_Entrepreneur | -0.314 | | -0.274 | |
| | (0.552) | | (0.579) | |
| d_Consultant_Manager | 0.337 | | 0.467 | |
| | (0.579) | | (0.6) | |
| network_specialization | 303.354 | *** | 361.945 | *** |
| | (42.419) | | (48.128) | |
| network_constraints | -43.417 | | -79.576 | *** |
| | (42.851) | | (30.224) | |
| d_same_sector | 0.382 | | 0.226 | |
| | (0.825) | | (0.878) | |
| count_investors | 2.299 | *** | 2.791 | *** |
| | (0.611) | | (0.651) | |
| amount_committed | 0.548 | | 0.629 | |
| | (0.372) | | (0.417) | |
| *Centrality variables* | | | | |
| Centrality | 1.905 | ** | 2.424 | *** |
| | (0.806) | | (0.914) | |
| Centrality$^2$ | -0.321 | * | -0.451 | ** |
| | (0.166) | | (0.186) | |
| *Moderator factors* | | | | |
| d_proximate | 5.740 | *** | 16.016 | *** |
| | (1.348) | | (3.209) | |
| Centrality##d_proximate | | | -10.569 | *** |
| | | | (2.706) | |
| Centrality$^2$##d_proximate | | | 2.562 | *** |
| | | | (0.596) | |
| Constant | -12.540 | *** | -14.085 | *** |
| | (3.572) | | (3.681) | |
| Year dummies | YES | | YES | |
| Industry dummies | YES | | YES | |

| | | |
|---|---|---|
| N | 337 | 337 |

The dependent variable is a dummy variable that indicates a value of 1 if the company received financing, and 0 otherwise. For a description of the variables see Table 1. Industry and year dummies are included in the estimates (coefficients are omitted in the Table). Estimates were derived from probit estimates with robust standard errors. In Column I only the direct effect of geographical proximity is included, while, in Column II we add the interactions between geographical proximity and centrality variables. Standard errors in round brackets. *, **, and *** indicate significance levels at 0.10, 0.05 and 0.01, respectively.

## Table 9. Panel B. Role of centrality according to the moderator effect of geographical proximity

| | *No proximity (d_proximate=0)* | |
|---|---|---|
| Centrality | 2.424 | *** |
| | (0.914) | |
| Centrality$^2$ | -0.451 | ** |
| | (0.186) | |
| | *With proximity (d_proximate=1)* | |
| Centrality | -8.144 | *** |
| | (2.516) | |
| Centrality$^2$ | 2.111 | *** |
| | (0.557) | |

Coefficients of centrality variables, according to model with interactions (Column II) are reported. We report both coefficients of centrality when there is NOT geographical proximity between the BA and a company searching for investments (i.e. b1 and b2, respectively for Centrality and Centrality$^2$, according to equation [2]) and the coefficients of centrality when the BA is proximate to the company searching for investments (b1+b4 and b2+b5, respectively for Centrality and Centrality$^{2.}$ according to equation [2]). Standard errors in round brackets. *, **, and *** indicate significance levels at 0.10, 0.05 and 0.01, respectively.

# FIGURES

**Figure 1. Network of BA investment in 2007**
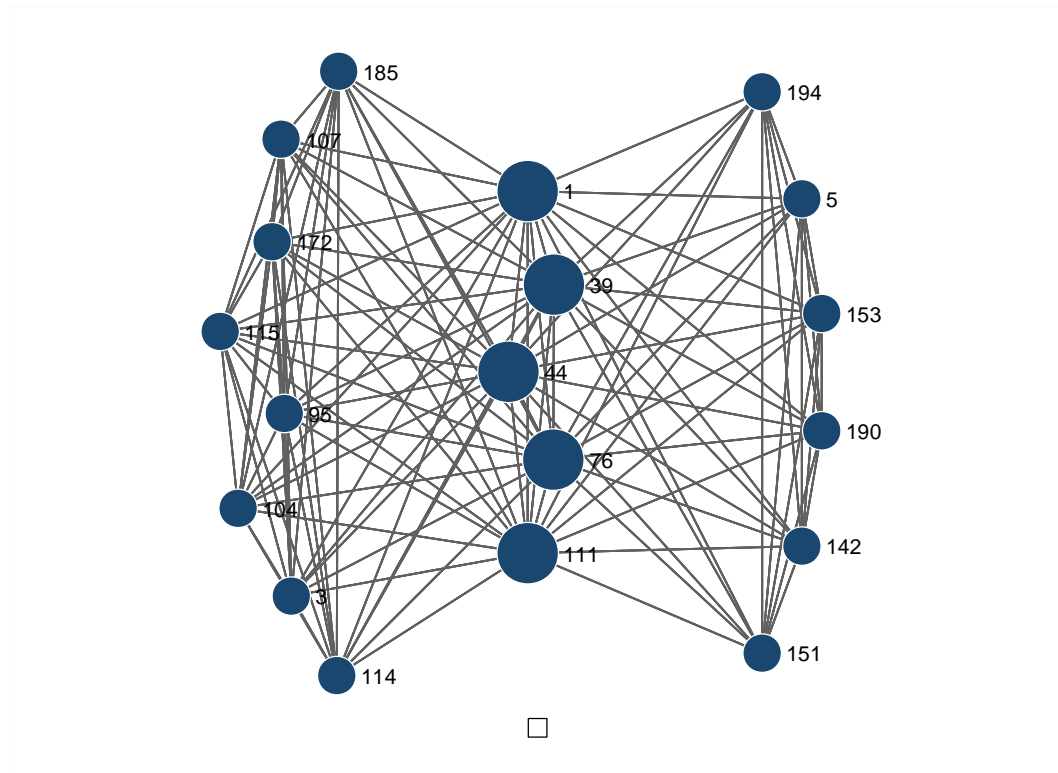


The Figure shows the network of IAG members in 2007. The nodes in the graph represent IAG members and the arrows represent the relationships among them. The size of the nodes represents the number of multiple co-investments with the same partners. For the sake of clarity, BAs with no links in 2007 have been excluded from the graph.

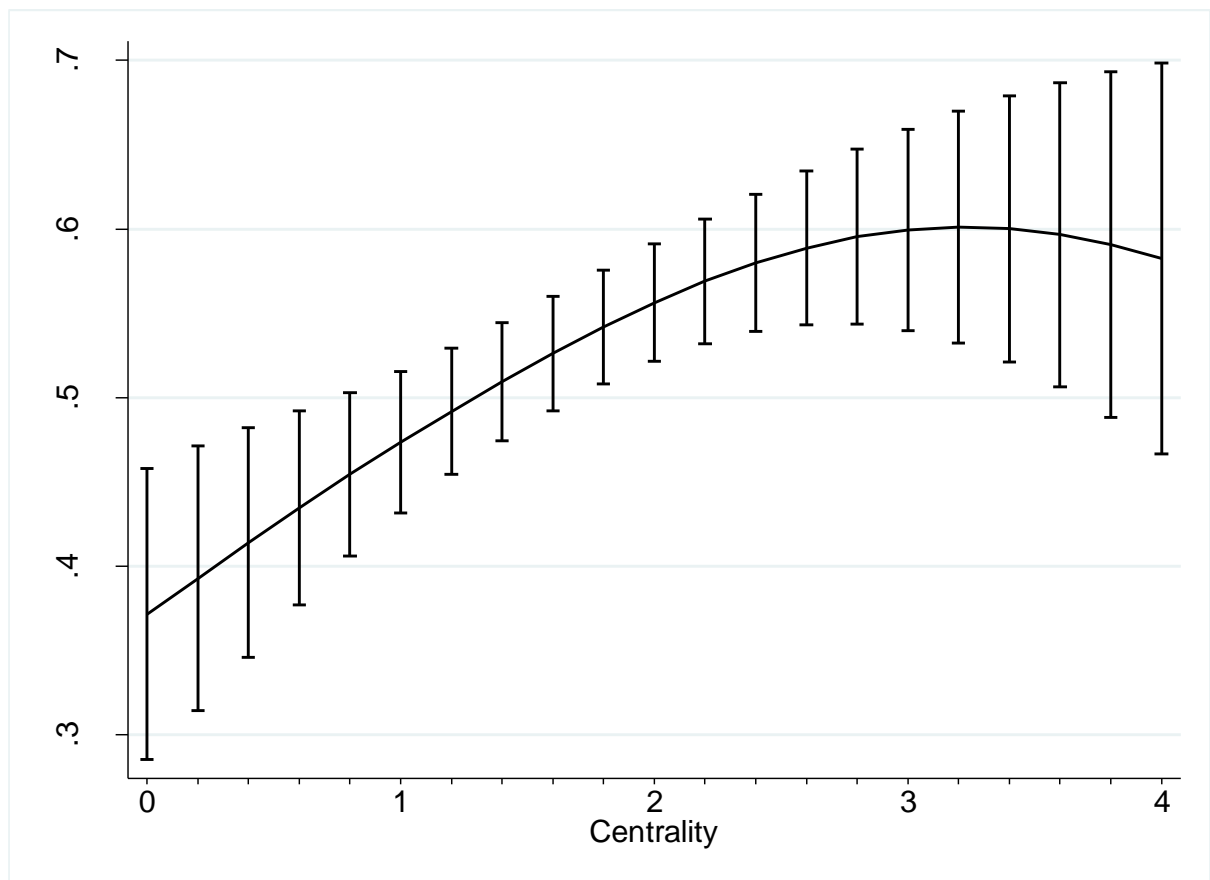**Figure 2. Predictive probability of investing at different levels of centrality**

**Figure 3. Predictive probability of investing at different levels of centrality according to the BA's prior investment experience**
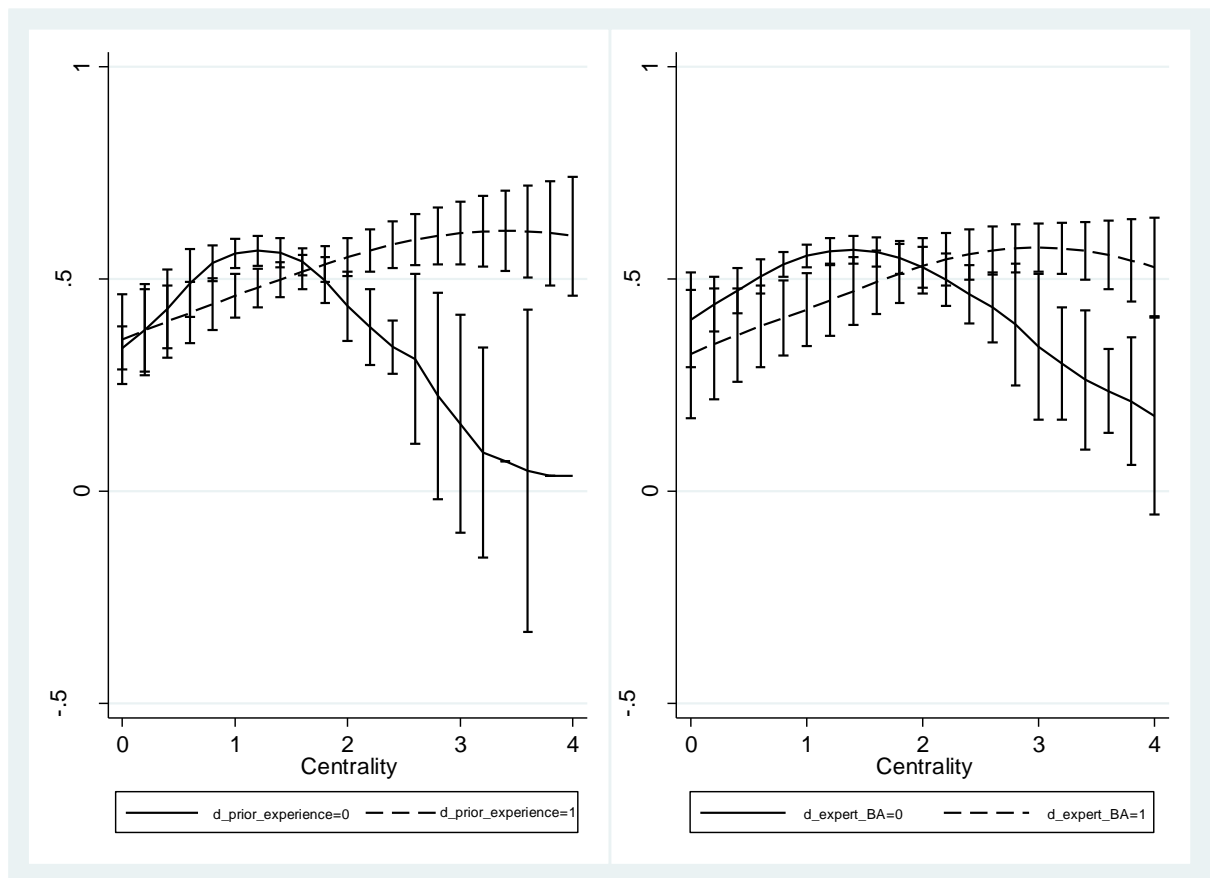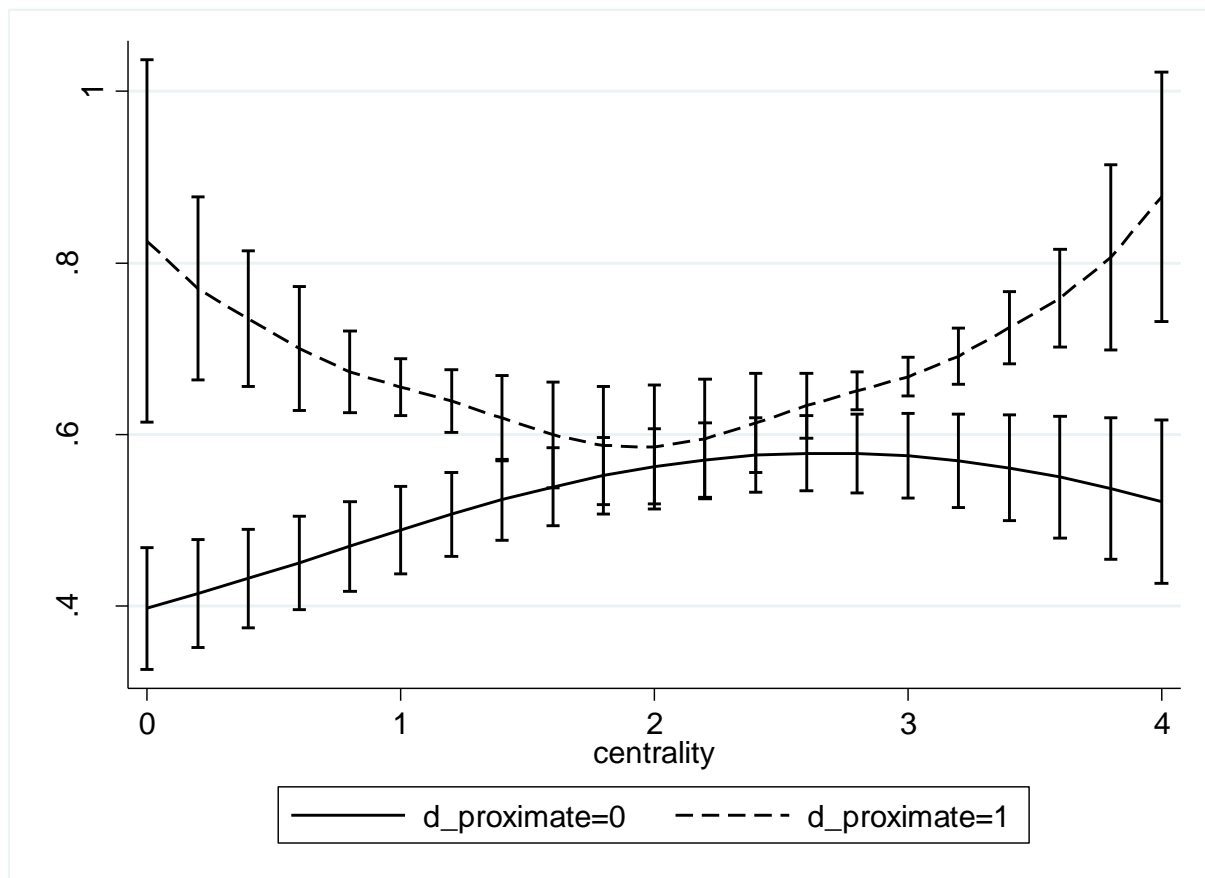
**Figure 4. Predictive probability of investing at different levels of centrality according to the geographical proximity between a company that has received investments and the BA**

# APPENDIX

**Table A1. Marginal effects of centrality.**

| centrality values | marginal effects on the probability to be invested | | |
|---|---|---|---|
| | coeff | | st.error |
| 0 | 0.372 | *** | 0.044 |
| 0.2 | 0.393 | *** | 0.040 |
| 0.4 | 0.414 | *** | 0.035 |
| 0.6 | 0.435 | *** | 0.029 |
| 0.8 | 0.454 | *** | 0.025 |
| 1 | 0.474 | *** | 0.021 |
| 1.2 | 0.492 | *** | 0.019 |
| 1.4 | 0.509 | *** | 0.018 |
| 1.6 | 0.526 | *** | 0.017 |
| 1.8 | 0.542 | *** | 0.017 |
| 2 | 0.556 | *** | 0.018 |
| 2.2 | 0.569 | *** | 0.019 |
| 2.4 | 0.580 | *** | 0.021 |
| 2.6 | 0.589 | *** | 0.023 |
| 2.8 | 0.595 | *** | 0.027 |
| 3 | 0.599 | *** | 0.030 |
| 3.2 | 0.601 | *** | 0.035 |
| 3.4 | 0.600 | *** | 0.040 |
| 3.6 | 0.597 | *** | 0.046 |
| 3.8 | 0.591 | *** | 0.052 |
| 4 | 0.582 | *** | 0.059 |
| 4.2 | 0.572 | *** | 0.066 |
| 4.4 | 0.560 | *** | 0.073 |
| 4.6 | 0.546 | *** | 0.080 |
| 4.8 | 0.530 | *** | 0.087 |
| 5 | 0.514 | *** | 0.093 |

**Table A2. Marginal effects of centrality. Model with interactions for BA prior investment experience.**

| centrality values | marginal effects on the probability to be invested | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Without investment experience (d_prior_experience=0)* | | | *With investment experience (d_prior_experience=1)* | | | *Without investment experience (d_expert_BA=0)* | | | *With investment experience (d_expert_BA=1)* | | |
| | coeff | sign. | st.error | coeff | sign. | st.error | coeff | sign. | st.error | coeff | sign. | st.error |
| 0 | 0.337 | *** | 0.026 | 0.358 | *** | 0.054 | 0.404 | *** | 0.057 | 0.323 | *** | 0.077 |
| 0.2 | 0.380 | *** | 0.055 | 0.379 | *** | 0.050 | 0.440 | *** | 0.033 | 0.346 | *** | 0.067 |
| 0.4 | 0.429 | *** | 0.048 | 0.400 | *** | 0.043 | 0.472 | *** | 0.027 | 0.368 | *** | 0.056 |
| 0.6 | 0.490 | *** | 0.041 | 0.420 | *** | 0.037 | 0.505 | *** | 0.021 | 0.388 | *** | 0.049 |
| 0.8 | 0.537 | *** | 0.022 | 0.440 | *** | 0.031 | 0.534 | *** | 0.015 | 0.408 | *** | 0.045 |
| 1 | 0.559 | *** | 0.018 | 0.460 | *** | 0.026 | 0.554 | *** | 0.014 | 0.428 | *** | 0.044 |
| 1.2 | 0.566 | *** | 0.018 | 0.479 | *** | 0.023 | 0.565 | *** | 0.015 | 0.449 | *** | 0.043 |
| 1.4 | 0.561 | *** | 0.018 | 0.498 | *** | 0.021 | 0.568 | *** | 0.017 | 0.471 | *** | 0.041 |
| 1.6 | 0.540 | *** | 0.016 | 0.516 | *** | 0.021 | 0.563 | *** | 0.018 | 0.492 | *** | 0.038 |
| 1.8 | 0.497 | *** | 0.028 | 0.534 | *** | 0.021 | 0.550 | *** | 0.020 | 0.512 | *** | 0.036 |
| 2 | 0.436 | *** | 0.042 | 0.551 | *** | 0.023 | 0.527 | *** | 0.025 | 0.530 | *** | 0.033 |
| 2.2 | 0.386 | *** | 0.046 | 0.567 | *** | 0.025 | 0.497 | *** | 0.031 | 0.545 | *** | 0.032 |
| 2.4 | 0.339 | *** | 0.032 | 0.580 | *** | 0.028 | 0.464 | *** | 0.035 | 0.558 | *** | 0.030 |
| 2.6 | 0.311 | *** | 0.102 | 0.592 | *** | 0.031 | 0.432 | *** | 0.042 | 0.567 | *** | 0.029 |
| 2.8 | 0.224 | * | 0.124 | 0.601 | *** | 0.034 | 0.393 | *** | 0.073 | 0.572 | *** | 0.029 |
| 3 | 0.159 | | 0.131 | 0.608 | *** | 0.038 | 0.340 | *** | 0.088 | 0.573 | *** | 0.029 |
| 3.2 | 0.090 | | 0.126 | 0.612 | *** | 0.043 | 0.300 | *** | 0.067 | 0.571 | *** | 0.031 |
| 3.4 | 0.070 | *** | 0.000 | 0.613 | *** | 0.048 | 0.262 | *** | 0.084 | 0.565 | *** | 0.035 |
| 3.6 | 0.048 | | 0.194 | 0.611 | *** | 0.055 | 0.236 | *** | 0.050 | 0.556 | *** | 0.041 |
| 3.8 | 0.035 | *** | 0.000 | 0.607 | *** | 0.063 | 0.212 | *** | 0.077 | 0.543 | *** | 0.049 |
| 4 | 0.035 | | . | 0.600 | *** | 0.072 | 0.177 | | 0.118 | 0.527 | *** | 0.059 |

**Table A3. Marginal effects of centrality. Model with interactions for geographical proximity.**

| centrality values | marginal effects on the probability to be invested | | | | | |
|---|---|---|---|---|---|---|
| | *Without proximity (d_proximate=0)* | | | *With proximity (d_proximate=1)* | | |
| | coeff | | st.error | | | |
| 0 | 0.397 | *** | 0.036 | 0.825 | *** | 0.108 |
| 0.2 | 0.415 | *** | 0.032 | 0.770 | *** | 0.054 |
| 0.4 | 0.432 | *** | 0.029 | 0.735 | *** | 0.040 |
| 0.6 | 0.450 | *** | 0.028 | 0.700 | *** | 0.037 |
| 0.8 | 0.469 | *** | 0.027 | 0.673 | *** | 0.024 |
| 1 | 0.488 | *** | 0.026 | 0.655 | *** | 0.017 |
| 1.2 | 0.507 | *** | 0.025 | 0.639 | *** | 0.019 |
| 1.4 | 0.524 | *** | 0.024 | 0.619 | *** | 0.025 |
| 1.6 | 0.539 | *** | 0.023 | 0.600 | *** | 0.031 |
| 1.8 | 0.552 | *** | 0.023 | 0.587 | *** | 0.035 |
| 2 | 0.563 | *** | 0.022 | 0.585 | *** | 0.037 |
| 2.2 | 0.570 | *** | 0.022 | 0.595 | *** | 0.035 |
| 2.4 | 0.576 | *** | 0.022 | 0.613 | *** | 0.030 |
| 2.6 | 0.578 | *** | 0.023 | 0.634 | *** | 0.019 |
| 2.8 | 0.578 | *** | 0.023 | 0.651 | *** | 0.011 |
| 3 | 0.575 | *** | 0.025 | 0.667 | *** | 0.012 |
| 3.2 | 0.569 | *** | 0.028 | 0.691 | *** | 0.017 |
| 3.4 | 0.561 | *** | 0.031 | 0.725 | *** | 0.021 |
| 3.6 | 0.550 | *** | 0.036 | 0.759 | *** | 0.029 |
| 3.8 | 0.537 | *** | 0.042 | 0.806 | *** | 0.055 |
| 4 | 0.521 | *** | 0.049 | 0.877 | *** | 0.074 |