Journal of Corporate Finance xxx (2018) xxx–xxx

Contents lists available at ScienceDirect

Journal of Corporate Finance

journal homepage: www.elsevier.com/locate/jcorpfin

Angel network affiliation and business angels' investment practices

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ARTICLE INFO

Article history:
Received 19 October 2016
Received in revised form 18 December 2017
Accepted 27 December 2017
Available online xxxx

JEL classification:
G24
G32
M13*Keywords:*
Business angels
Business angel networks
Venture capital

ABSTRACT

This paper provides preliminary evidence on the effects of membership in a business angel network (BAN) on the investment decisions of the members. Using a novel dataset containing qualitative and quantitative information on 810 angel or angel-group backed investments in 619 companies by 330 unique business angels from 2008 to 2014, we show that BAN membership generates valuable information, networking, monitoring, and risk reduction effects, which ultimately affect the share of personal wealth committed by each angel investor and their equity stake in the targeted company. These results extend our knowledge of the investment behavior and characteristics of business angels, a relatively opaque funding source that is rapidly gaining prominence in support of new ventures and the development of the global economy.

1. Introduction

In the past few years, both academics and practitioners have devoted increased attention to understanding the dynamics of business angel (BA) investments. Market data for both the US and Europe show that business angels[1] have become a major segment of the capital market industry, comparable to professional venture capitalists (US ACA, 2015; EVCA, 2014; EBAN, 2015; Kraemer-Eis et al., 2015; OECD, 2016). As such, BAs have become crucial enablers of the development of new firms and a driving force of growth (Lahti and Keinonen, 2016; OECD, 2016, Mason, 2009). Despite this recent attention, our understanding of the BA investment is still limited. In particular, little is known about the investment practices of BAs once they join semi-formal organizations such as BA networks (BAN) and angel groups (AG). This study aims to fill this gap.

BAs are: "*high net worth individuals who invest their own money in small unlisted companies, with no family connections, typically assuming a minority equity stake as well as active involvement in portfolio companies*" (Mason, 2008). BAs are among the most appealing actors in the ecosystem for entrepreneurial businesses, considering their capability to fill the so-called "funding gap" between the demand and supply for early-stage equity capital (Mason and Harrison, 2000; Johnson and Sohl, 2012; Capizzi, 2015). First, BAs satisfy a certain size investment need (usually in the range of 100 k–300 k euros) that is not typically considered interesting or profitable for venture capitalists because of the relatively high costs of due diligence, contracting, and monitoring

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[1] Additionally called "informal investors" (Wetzel, 1986; Freear et al., 1992; Landstrom, 1993; Harrison and Mason, 1996; Van Osnabrugge, 2000), to differentiate them from venture capitalists and other financial intermediaries who invest capital raised from third parties.

https://doi.org/10.1016/j.jcorpfin.2017.12.029
0929-1199/

associated with very early-stage businesses (Jeng and Wells, 2000; Carpenter and Peterson, 2002; Mason, 2009). Second, alongside capital injection, BAs provide valuable non-monetary resources such as industrial knowledge, management experience, mentoring, and personal networks (Harrison and Mason, 1992; Landstrom, 1993, Politis, 2008).

Over time, angel investors have increasingly organized into associations—also referred to as groups, networks, or clubs, depending on the level of their internal structure (Mason, Botelho and Harrison, 2013)—usually on a geographic or industrial basis. The objectives of such organizations range from increasing the deal flow by sharing presentation pitches from potential entrepreneurs to performing joint due-diligence work on potential investment opportunities, ultimately reducing transaction costs (Mason, 2006; Sohl, 2007; Paul and Whittam, 2010; Gregson et al., 2013; Lahti and Keinonen, 2016). These associations have grown to regional, national (for instance, ACA in the US, BBAA in the UK, and IBAN in Italy), and even continental proportions (among them, EBAN and BAE in Europe), increasingly differentiating among each other in terms of rules of engagement, internal structure, quality, variety, and cost of the services provided. Thanks to BANs and AGs, the informal venture capital market is currently much more visible and, hence, easier to access on both the demand and supply sides (Mason, Botelho, and Harrison, 2013; Cumming and Zhang, 2016).

Despite their growing sophistication and importance as capital providers, there is very little evidence on the impact of BANs on the investment process of BAs. Most existing research is based on anecdotal evidence or case studies (May 2002; Payne et al., 2002; Mason, 2006; Johnson and Sohl, 2012; Ibrahim, 2008; Brush et al., 2012; Kerr et al., 2014; Collewaert and Manigart, 2016; Croce et al., 2017).

In this study, we focus on BA investment choices, trying to isolate the differential role played by BAN or group membership on BA investment practice. In particular, we investigate whether and how being members of semi-formal organizations affect the share of angel personal wealth invested in a given deal or the amount of equity stake in portfolio companies. Looking at a unique dataset that encompasses qualitative and quantitative information on 810 investments for 619 unique companies by 330 unique Italian BAs from 2008 to 2014, our study, for the first time, provides evidence of significantly different investment practices by angels who participate in BANs compared to unaffiliated angels investing as single, independent investors. We find that being part of an angel network has a significant effect on investment practice, increasing angels' propensity to invest more of their wealth. Furthermore, BAN membership generates sizeable diversification benefits for angels: a larger deal flow and access to network screening and monitoring skills affect angel portfolios by reducing the individual stake in each company in a classical diversification exercise. When we control for the possibility of co-investing within a BAN, both angel capital committed and investment deal size decrease. Finally, BAN membership mitigates the effects on investment practices of certain angel-specific factors such as post investment hands-off approach and non-contractual based monitoring.

Given the possible endogenous nature of the choice of joining an angel network, we perform a host of robustness checks including a set of two-stage instrumental variable regressions and propensity score matching regressions. Results are qualitatively unchanged, thereby providing support to our research design and our conclusions.

Our findings have interesting normative implications that may be useful for policymakers in creating new and effective measures aimed at stimulating entrepreneurship and contributing to the development and growth of economic and social systems (Baldock and Mason, 2015; Kraemer-Eis et al., 2016).

The remainder of the paper is structured as follows: the second section derives the research hypothesis to be tested from the literature dealing with BAs and informal venture capital. The third section presents the dataset and specifies the variables used to perform the empirical analysis, the results of which are shown and discussed in the fourth section. The final section addresses concluding remarks and suggestions for future research.

2. Hypothesis development and related literature

Our research program adopts as its main unit of analysis the amount of own risk capital invested by individual business angels. Prior literature on both venture capitalists (Lerner, 1998; Jeng and Wells, 2000; Cumming and Johan, 2013) and informal investors has commonly operationalized this measure as either the overall amount of capital invested (Maula et al., 2005; Wiltbank and Boecker, 2007; Lahti, 2011; Collewaert and Manigart, 2016) or the amount invested in a single deal as a share of a given BA's personal wealth (Harrison and Mason, 2002; Mason, 2006; Sohl, 2007; De Gennaro and Dwyer, 2014; Landström and Mason, 2016). These metrics try to capture the extent of the commitment of BAs to financing new ventures. In light of these results, in this study, we adopt as a first metric, the percentage of wealth invested ("*Wealth%*").

However, we believe that a second measure can provide insights useful for identifying the perceived risk drivers and their impact on the asset allocation decisions of informal investors. Accordingly, following prior research referencing mainly private equity and venture capital (Gompers and Lerner, 2000; Hellman and Puri, 2002; Kaplan and Schoar, 2005; Cumming and Walz, 2010), we add a second proxy for BA invested capital that measures the amount of capital invested as a share of the post-financing equity capital of the targeted company ("*Participation%*").

Building on these measures as the main dependent variables, we develop the expected effects of BAN participation as follows.

2.1. BAN membership and investment decisions

One major evolutionary trend observed in the informal venture capital market over the past two decades addresses the growing relevance of associations of BAs, either structured or semi-structured, ranging from loose networks of individual investors to

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formal angel syndicates (Ibrahim, 2008; Mason, 2009; Paul and Whittam, 2010; Johnson and Sohl, 2012; Gregson et al., 2013; Lahti and Keinonen, 2016).

Despite such heterogeneity, the forms of association have converged towards two main forms: BANs and AGs. The main difference between these two forms is in the less stringent obligations and engagement rules for membership such as limited or no fees, no minimum participation requirements, and no obligation to share due diligence costs (Mason, Botelho, and Harrison, 2013). BAN members can join through a solicited or unsolicited basis and collaborate in organizing pitching events, training, and mentoring activities, and coordinated lobbying efforts. Entrepreneurs are solicited to submit their proposals to the BAN through websites and other networking activities taking place inside the community. There is no (or limited) organized deal group processing, and the association does not make investments or recommend investments to members; rather, each member decides whether to invest on a deal-by-deal basis, typically finding co-investors (within or outside the BAN) and sharing due diligence, negotiations, and term sheets.

In this study, we exploited data obtained from the Italian federation of business angel associations (IBAN), a trade association that allows repeated sampling of a large pool of angels, obtaining reliable information via their affiliation to a network. In this respect, the survey structure treats networks and groups as interchangeable. While we acknowledge the previously discussed differences between these, we believe that our results extend to more structured and formal organizations, such as the AGs, thus, widening this research stream.

A few recent papers have tried to shed more light on the investment practices of such associations. However, the research methodologies have been restricted to case studies due to the lack of aggregate data. Kerr et al. (2014) exploit data provided by two AGs to study their internal structures and investment practices. Following a similar approach, Collewaert and Manigart (2016) and Croce et al. (2017) look at the type of services and contributions provided to the targeted companies, whereas Mason (2008) and Paul and Whittam (2010) focus their attention on the advantages provided by the BAN to its members. Ibrahim (2008), Brush et al. (2012), and Mason, Botelho, and Harrison (2013) argue that being a BAN member benefits the angel investor mainly through the information and knowledge sharing taking place inside the community. The possibility for less experienced angels to get in touch with more experienced angels is particularly important inside the BAN, improving new investors' human capital and knowledge about how to implement effective value-creating investment decisions (Shane, 2000). In addition, the role of so-called "gatekeepers," individuals who control access to and manage much of the day-to-day operations of the BAN (Paul and Whittam, 2010), is crucial in the sharing of information among BAN members.

Therefore, investments made by BAN members, even if not in syndication with other co-investors, should be more informed and efficient, leading to capital allocation decisions more focused on angel investments. In other words, because of the services and contributions provided by the BAN to its members, we hypothesize that BAN members, once they have selected an investment opportunity and undertaken the investment decision-making process, will invest in companies belonging to this peculiar asset class more of their personal wealth than non-BAN members.

Accordingly, we formulate our first research hypothesis as follows.

H1a. BAN membership has a positive impact on the share of the business angel's personal wealth invested in each deal.

BAs joining a BAN benefit from the deal flow disclosed inside the network and, therefore, are provided with a higher number of investment opportunities compared to unaffiliated angels, leading to a higher number of deals.

However, given that the impact of BAN membership on BA investments should not necessarily lead to structural changes in either their risk aversion or their historical asset allocation choices, at least in the short run, we expect that BAN members, in order to maximize the benefit provided by the network in terms of both wider and better quality investment opportunities, offset the increase in the number of deals with a decrease in the equity stake acquired in each single targeted company. Furthermore, as pointed out by Sohl (2007), the deal flow process inside the angel network involves bigger sized companies due to the higher equity capital injection potentially available than that for unaffiliated angel investors.

As such, an alternative research hypothesis to test is the following.

H1b. BAN membership has a negative impact on the size of business angels' equity stake acquired in a given target company.

2.2. Co-investment, activism, monitoring, and investment decisions

Among the many options available to BAs when valuing a given investment opportunity, there is the possibility to make the deal either as an individual investor—the "solo angel"—or to co-invest with other angel investors. The latter strategy can be implemented through different degrees of formal structures ranging from formal angel syndicates to informal so-called "club deals" and, more importantly, can significantly affect the amount of capital provided by each investor. On the one hand, by co-investing in a given deal, investors can reduce their individual equity stakes in the target company while maintaining active involvement and providing value-added contributions. In fact, the sum of the single equity positions of all of the co-investors in a given deal increases the possibility of playing an active role in target companies, which can require larger contributions than those available to solo angels (Paul and Whittam, 2010). On the other hand, consistent with modern portfolio theory (Elton and Gruber, 2005), the co-investment option is a completely rational diversification strategy aimed at reducing the risk from a given equity investment opportunity. As a direct implication, BAs choosing to share the

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risk of a given deal by co-investing with others can benefit from more diversified investment portfolios (Harrison and Mason, 2002; Mason, Botelho, and Harrison, 2013), as well as from the possibility of gaining access to risk-reducing information (Aernoudt, 2005).[2]

This leads to the following research hypothesis.

H2. Both the amount invested by the BA and the size of the equity stake in the angel-backed companies are negatively affected by the numbers of co-investors in a given deal.

As previously discussed, BAs often exhibit interest in seeking active involvement with their portfolio companies to support them in the value creation process through a hands-on approach. Politis (2008) identifies four different types of value-added contributions coming from angel investors: a "sounding board" role, a "monitoring" role, a "resource acquisition" role, and a "mentoring" role. However, a number of surveys disclosed on a yearly basis by research centers (EIF, OECD) and country federations of angel associations (IBAN, EBAN) report the existence of investors not willing and/or able to play such an "active" role in the target companies. Rather, they are more attracted by potential capital gains and by the portfolio diversification benefits associated with investing in such an asset class, normally uncorrelated with their security portfolios. Such "passive" investors may leverage the benefits offered by participating in a BAN and consequently exhibit a structurally different investment pattern. Therefore, we expect a negative relationship between passive investors and the amount invested among non-BAN members. In contrast, for BAN members, the opportunity of either co-investing or benefiting from trust, information, and experience shared inside the network could generate a possibly weaker negative outcome. This leads to the following research hypothesis:

H3. The intention to play a passive role in a given deal has a negative impact on BAs' investment decisions in terms of both the amount invested and the size of their equity stakes. Such effect is stronger for non-BAN members.

The finance literature has extensively investigated the role of monitoring as a way to reduce asymmetric information and moral hazard problems stemming from any type of securities investment (Jensen and Meckling, 1976; Diamond, 1984; Aghion and Bolton, 1992).

As far as private equity investments are concerned, many scholars have investigated how institutional investors—venture capital organizations among them—monitor target companies and the major contingent contracts, clauses, and mechanisms used to reduce potential conflicts and incentives for opportunistic behavior by entrepreneurs (Sahlman, 1990; Triantis, 2001; Kaplan and Stromberg, 2003; Gompers and Lerner, 2004; Chemmanur et al., 2008; Cumming, 2008; Wong et al., 2009; Cumming and Johan, 2013; Erenburg et al., 2016).

Dealing with BAs, specific contributions showed that they seldom adopt the typical control and governance provisions of venture capital investors (Van Osnabrugge, 2000; Wiltbank and Boecker, 2007; Goldfarb et al., 2012; Bonini and Capizzi, 2017), implementing monitoring mechanisms "*non aggressive and striking in their informality*" (Ibrahim, 2008). The major substitutes for contractual monitoring are represented by angels' knowledge of the industry from previous investments or managerial experience, existing interactions with entrepreneurs, and geographic proximity with the target company (Wong et al., 2009).

Consistent with our previous arguments, we believe that the type of monitoring taking place in the informal venture capital market is a "soft" one, not based mainly on contractual mechanisms but rather on close involvement in the relevant company through company visits, interactions with entrepreneurs, and other control techniques based on trust. Therefore, similarly to the well-known impact of "hard" contractual monitoring in the private equity industry, we expect that the higher the soft monitoring effort, the lower the investment risk perception by BAs in their investment decision-making process.

Given the possibility to investigate the role of soft monitoring for both of our sub-samples of BAs—BAN members and non-BAN members—we expect different magnitudes of the causal relationship between monitoring and angel investment. BAN members benefit from the screening support provided by BANs to their members as well as from the information and knowledge sharing effects stemming from inside the BAN, lessening the need for higher monitoring effort over investments that are perceived as truly riskier. This leads to less informationally opaque investments when compared to those realized by non-BAN member BAs, who do not benefit from the soft information produced inside the angel community and must compensate for greater information asymmetry by imposing a higher level of soft-monitoring. In this case, higher monitoring should not necessarily be associated with higher investment risk, but rather with the need for realigning the incentives of entrepreneurs and/or executive directors of the target company.

We, therefore, hypothesize the following.

H4. BAs soft monitoring has a positive impact on their investment decisions in terms of both the amount invested and the size of their equity stakes. This effect is stronger for non-BAN members.

2.3. Controls

Following the extant literature, we test our hypotheses introducing a set of control variables that are known to have a causal effect on the investment decisions of BAs. Mason and Harrison (2000), Van Osnabrugge (2000), and Macht (2011) explained the role of experience, whereas Shane (2000) and Paul et al. (2007) showed the effects of age, education, and previous background,

[2] Assuming that the share of their personal wealth devoted to investments in early-stage companies remains constant.

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which could be managerial, entrepreneurial, or financial in nature (Maula et al., 2005; Sudek, 2006; Morrissette, 2007; Sudek et al., 2008; Collewaert and Manigart, 2016). Following Samuelson's (1997) and Forsfalt's (1999) results on intertemporal portfolio choices, it is likely that BA risk aversion increases with age, leading to a decrease in the share of wealth allocated to early stage ventures. In contrast, experience gained through past investments, education, and personal wealth could act as counterbalancing factors on capital allocation investment decisions.

Additionally, we expect the equity stake in the target company acquired by a BA to be negatively affected by the size of the company itself (Mason and Harrison, 2000; Van Osnabrugge, 2000), as well as by its stage in the life cycle (Wiltbank et al., 2006), and its proximity to the BA (Sudek, 2006).

Finally, consistent with the above-mentioned contributions, we consider in our model industry fixed effects as well as time fixed effects in order to take into account the role of both industry-specific features and time-varying macroeconomic variables that may affect angel investment practices.

3. Sample data and variables

Our data are obtained from sequential surveys administered by the IBAN to its associates and other unaffiliated BAs. IBAN is the national trade association for angels and angel groups/networks.

A known problem in BA research is estimating the "true" population. Some investors, in fact, strive for anonymity creating an "invisible market" that is difficult to detect using simple survey techniques (Mason and Harrison, 2000; Landström and Mason, 2016). To circumvent this issue, IBAN adopted a strategy of integrating the "visible market"—represented by BAs and networks/groups affiliated to IBAN—with an estimation of the "invisible" component. The estimation is done by supplementing traditional "snowball sampling" (Schuessler, 1979)—based on the identification of people believed to be BAs through their connections with the surveyed BAN members—with an inferential approach based on the results of a domestic research program (private equity monitor, PEM) aimed at identifying and analyzing private equity and venture capital investor activity. PEM collects information on PE and venture capital (VC)-backed companies. Focusing on the segment of VC-backed company investments, IBAN researchers collected complete ownership data[3] from the Bureau Van Dijk-AIDA and identified individual shareholders whose investment patterns were consistent with that of a BA (Mason 2006). In particular, researchers classified as BAs shareholders that exhibited the following characteristics: repeated investment in new companies, non-executive role, and non-majority ownership.

While acknowledging possible sample biases in the survey data, the rigorous sampling method and the repeated nature of the survey over a seven-year period appear to be strong mitigating factors that justify confidence in the sample representativeness.

The survey structure is designed to collect information on the previous year's operations and is conducted through a four-step process: at the beginning of January, IBAN forwards the survey's website link to its associates and other known or estimated BAs.[4] Responses are collected by the first week of March (step 1). Non-responding BAs are contacted by email and phone to solicit survey completion (step 2) while an IBAN team reviews the data to identify incomplete, wrong, or unverifiable answers (step 3), which are further checked through direct follow-up calls (step 4). This process is a common survey technique called sequential mixed mode (Snjikers et al., 2013). Evidence shows that a mixed mode survey approach significantly improves the response rate (De Leeuw, 2005; Dillman et al., 2009).

Survey statistics are reported in Table 1.

IBAN administered 3000 questionnaires to 929 affiliates and 2071 non-affiliates from 2009 (2008 investment data) through 2015 (2014 investment data).

The overall response rate over the full sample period was 41.7%. The response rate was higher (about 47.2%) for the subsample of BAN members than for non-BAN members (39.2%), who are less likely to respond because of anonymity concerns or possible erroneous estimated identification.

Out of the 1250 responses, the researchers discarded: a) surveys with material inconsistencies and b) surveys reporting zero investment. This led to a final sample of 439 responses reporting an aggregate of 810 deals, for 619 unique companies, by 330 unique investors during the 2008 to 2014 time period. BAN membership was acceptably balanced (246 vs. 193 or 56% vs. 44%), a desirable feature when conducting empirical tests on the differential network affiliation role on BA investment practices.

In Table 2, we present the temporal and industry distribution of the final sample data distinguishing BAN from non-BAN respondents through a dummy variable (*BAN_membership*) taking a value of one for BAN members.

The investment distribution is reported in Panel A. We observe a large drop in reported investments the last two years of the sample. This figure is the result of a tightening of the survey exclusion conditions highlighted above following the transition of IBAN to a new gatekeeper. Although this problem is certainly a potential concern, we believe that the validity of our results will be only limitedly affected because in all of our regressions we introduce year fixed effects, which absorb a significant portion of such heterogeneity.

Looking at the industry distribution of investments reported in Panel B, deals are spread out across several industries, with an unsurprising dominance of "traditional" sectors for early stage investments, such as information and communication technology (ICT), electronics, and biotech, which collectively attract approximately half of the aggregate investments. Interestingly, a

[3] Italy, as numerous European countries, requires a relatively high level of disclosure of financial and ownership information that is publicly available through the government and third-party sources such as BVD-Aida.

[4] See the IBAN website (www.iban.it) for the survey questionnaire.

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Table 1
IBAN Survey - Sample coverage and response rates
This table report sample coverage and repsonse rates for our survey data. The first column reports the number of surveys administered over the period 2008–2014. The second column reports the number of surveys received after the follow-up rounds described in section 3; the third column reports the number of surveys that have been kept after discarding: a) surveys with material inconsistencies and b) surveys reporting zero investments; the fourth column indicates the number of deals reported by the survey respondents; given that the same investor can be surveyd multiple times and the same companies cna be invested by more tha one angel in the fifth and sixth column we finally report the number of unique investors and unique companies.

	Surveys sent	Surveys received	Final surveys sample	# of deals reported	Unique investors	Unique companies
Overall sample	3000	1250 (41.7%)	439 (14.6%)	810	330	619
BAN members	929	438 (47.2%)	246 (26.5%)	438	150	334
Non-BAN members	2071	812 (39.2%)	193 (9.3%)	372	180	285

meaningful 13% of investment is directed at cleantech-related ventures, consistent with a rising global trend of activity in this market. BAN membership affects industry distribution as indicated by the Pearson Chi-squared test. Non-BAN members seem to invest less in ICT companies, allocating more resources to biotech and media-related investments.

Data reported in Panel C show that investors have portfolio sizes ranging from one investment to >10, without a clear prevalence of any portfolio cluster. Interestingly, there is a strong difference when controlling for BAN membership. Whereas almost 50% of BAN members have portfolios in excess of five companies, this is true for only 18% of non-BAN members (Chi-squared 32.02, $p < .001$). This evidence provides preliminary support for our argument about the structural effects of BAN membership on the investment behavior of BAs.

Table 2
Sample distribution
This table reports summary statistics of the investment sample. Panel A reports the year distribution of the investments for the overall sample and by BAN membership status. Panel B reports the industry distribution of the investments for the overall sample and by BAN membership status. Panel C reports the portfolio size distribution of the angels included in the sample.

PANEL A – Year distribution

Year	Investments	Percentage	
	Whole sample	BAN members	Non-BAN members
2008	95	62.11%	37.89%
2009	142	59.86%	40.14%
2010	137	62.04%	37.96%
2011	159	63.52%	36.48%
2012	162	30.25%	69.75%
2013	58	63.79%	36.21%
2014	57	38.60%	61.40%
Total	810	54.07%	45.93%

PANEL B – Industry distribution

Industry	Percentage		
	Whole sample	BAN members	Non-BAN members
Biotech	17.06%	15.44%	18.97%
Cleantech	13.08%	12.90%	13.28%
Commerce and distribution	10.09%	12.44%	7.32%
Electronics	9.34%	12.90%	5.15%
Financial services	3.36%	4.15%	2.44%
Food & beverage	2.86%	3.00%	2.71%
ICT (SW and HW, app web and mobile)	20.80%	17.05%	25.20%
Mechanical engineering	7.47%	8.53%	6.23%
Media & entertainment	9.96%	8.76%	11.38%
Telecommunications & similar services	2.86%	2.53%	3.25%
Textile & apparel	3.11%	2.30%	4.07%
$\chi 2$		32.08***	

PANEL C – Angels investment intensity

Business angel total deals	Percentage		
	Whole sample	BAN members	Non-BAN members
>10	17.90%	18.26%	9.13%
6–10	26.05%	28.32%	9.14%
2–5	33.46%	35.16%	51.34%
1	22.59%	18.26%	20.38%
$\chi 2$ (portfolio > 5)		32.02***	

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Table 3
Dependent variables: summary statistics
This table reports summary statistics for two dependent variables: Wealth% is measured as the amount of capital invested as a share of the individual business angel's personal wealth; Participation% is the amount of capital invested by an individual business angel expressed as a share of the equity capital of the investee company. *, **, *** indicate statistical significance at the 10%, 5% and 1% levels, respectively for one-tailed t-test for means and Wilcoxon ranksum z-test for medians.

Dependent variable = *Wealth%*	Total sample	BAN members	Non-BAN members
Mean	15.48	17.09***	13.67
Median	14	14***	8
Maximum	60	60	60
Minimum	5	5	5
Standard deviation	11.8	13.13	9.8
Observation	669	354	315
Dependent variable = *Participation%*			
Mean	14.74	14.87	14.59
Median	8	8***	4
Maximum	100	100	100
Minimum	1	1	1
Standard deviation	19.54	18.3	20.93
Observation	808	436	372

Table 3 reports summary statistics on participation in groups and networks and the conditional distribution of the two dependent variables: *Wealth%*, which is the share of a BA's financial wealth invested in all BA-like deals and *Participation%*, which is computed as the amount invested in a venture as a share of the venture's equity capital.

The descriptive statistics related to the dependent variables show that the relative incidence of BA investment varies widely in the sample in terms of both participation in the venture and the personal wealth of the BA.[5] Looking at the percentage of wealth invested, we noticed a significant difference conditional on BAN members. BAN members, on average, invest 24% ($p < .01$) more of their disposable wealth in new ventures than their non-BAN peers. Remarkably, this figure is affected by large values observed in the non-BAN member subsample, as shown by the significant difference in medians (14 vs. 8). This difference becomes less robust when testing the second dependent variable. BAN members seem to invest more in each single venture, but the means are not significantly different from zero. The medians, however, are significant, suggesting the presence of a few extremely small values in the BAN member sub-sample.

Table 4 describes the proxies used to operationalize the main dependent variables and controls, and presents the summary statistics.

Co-investor data are winsorized at the 95% level due to the presence of extreme observations that are most likely due to data entry errors. The figures show that co-investments are frequent, with an average (median) number of co-investors of 4.3 (2), which yields an unconditional number of investors on any deal equal to five or more. Unreported percentiles show that >70% of the investments have at least one co-investor and nine or more investors back 25% of the deals. This behavior is sharply different from that exhibited by formal venture capitalists, who on average syndicate their deals with a very limited number of additional investors due to coordination problems and conflicts of interest characterizing large syndicates (Lerner, 1994; Manigart et al., 2006; Tian, 2012).

Leveraging a specific question in the survey, we address and test our third research hypothesis by modeling a dummy variable (*Passive Investor*) that takes a value of one if the respondent states that the investment decision was driven exclusively by capital gain motivation and not by other private benefit reasons that would suggest the willingness to play an active role in the target company.

The survey also offers evidence regarding the role played by BAs in the monitoring of the target firms, allowing us to test the last research hypothesis (H4). We built an ordinal variable (*Soft-Monitoring*) that graduates the frequency of the visits a BA made to a target venture, from one to five, where one means very limited involvement (no or very few visits) and five means very high involvement (a constant presence at the firm). Although the survey collects this information ex post, asking about the effective involvement in the invested firms by BAs, we believe that they already know the future degree of involvement in a venture at the time that the investment decision is made. Moreover, this self-declared willingness is likely that it influences the amount invested. In particular, a higher degree of monitoring is expected to decrease the investment risk perceived by a BA. As a consequence, we are reasonably confident that the variable *Soft-Monitoring* successfully captures the degree of monitoring effort estimated when the investment decision was made. Following our hypothesis, we expect a positive sign for this variable, particularly for non-BAN members, given their larger concerns regarding information asymmetry underlying their investments compared to BAN members.

Turning to angel-specific control variables, *Age*, *Low Education*, and *Wealth* are self-reported demographic items obtained from specific survey items. An additional survey item required angels to identify his/her prevalent background outside the portfolio companies. Responses identify managerial and entrepreneurial backgrounds as opposed to a coarse group of other jobs. We have accordingly modeled three dummies: *Entrepreneur*, *Manager*, and *Other*. In all of our tests, we will assume "Other" as the

[5] Notably, a recent research commissioned by the Europea Union and based on a survey of a sample of European angels obtained comparable figures: survey participants reported that, on average, BA investments represents 10% of their wealth (Inova+, 2017).

Please cite this article as: Bonini, S., et al., Angel network affiliation and business angels' investment practices, J. Corp. Finance (2018), https://doi.org/10.1016/j.jcorpfin.2017.12.029

Table 4
Independent variables: descriptive statistics
This table reports descriptive statistics of the main independent variables and three sets of Angel-specific, firm-specific and market-wide controls. The variables Co-investors, Wealth and Net asset Value are winsorized at the 95% level.

	Description	Obs.	Mean	Median	Std.Dev.	Min	Max	Dummy = 1 percentage
BAN_membership	Dummy = 1 if the BA is a BAN member	810	–	–	–	–	–	54.1
Co-investors	Number of co-investors	809	4.3	2	4.99	0	15	–
Passive investor	Dummy =1 if the investment is exclusively driven by capital gain motivations	668	–	–	–	–	–	22
Soft-monitoring	Ordinal variable ranging from 1 to 5, where 1 means monitoring very low or absent and 5 means monitoring very high, with a constant presence in the firm	668	2.75	2	1.12	1	5	–
Angel specific controls								
Age	Age of the BA	668	48.32	45	9.4	28	71	–
Education	Dummy = 1 if the BA holds a high school diploma or a lower educational qualification	668	–	–	–	–	–	6.7
Wealth (in euro)	BAs' financial wealth in the year of the investment	669	1,480,682	1250,000	1,515,290	250,000	7,500,000	–
Entrepreneur	Dummy = 1 in case of prevalent working occupation as entrepreneur (excluding his/her involvment in the invested companies)	668	–	–	–	–	–	37.7
Manager	Dummy =1 in case of prevalent working occupation as manager (excluding his/her involvment in the invested companies)	668	–	–	–	–	–	16.8
Experience	Number of BA' investments in lifetime	668	6.36	7	4.01	0	26	–
Firm specific controls								
Net_Asset_Value (in euro/th.)	Enterprises' net asset value in the year of the BA's investment (pre-money)	806	1389.67	497.70	2281.66	20.08	8928.57	–
Seed	Dummy = 1 if the BA has invested in a seed enterprise	810	–	–	–	–	–	35.7
Foreign	Dummy = 1 if the BA has invested in a foreign enterprise	711	–	–	–	–	–	12.1
Industry controls								
Industry PBV	Industry price-to-book value, in the investment year	810	3.05	2.67	1.36	0.71	8.62	–
Net capex/sales	Industry net capital assets to sales, in the investment year	810	0.8	−0.16	3.18	−4.47	22.96	–

baseline to highlight the differential effect of a specific background on the investment behavior of business angels. *Experience* is modeled as the number of investments made in the past, consistent with Hsu et al. (2014) and Capizzi (2015). More experienced BAs should exhibit greater investment selection skills identifying superior investment opportunities. Their successful track records can induce greater self-confidence, thereby increasing the size of their investments relative to less experienced angels. We expect to observe this effect for both dependent variables.

Looking at firm-specific control variables, we obtain *Net_Asset_Value* from a survey item where respondents were required to indicate the net asset value at the time of (but prior to) their investment. Firms fit the profile of newly funded companies with average (median) assets of approximately 1.4 m/euro (0.5). Given the existence of a few, very large outliers, we winsorized the data at the 95% level. The minimum value of 20,000 euro, and, more generally, the (unreported) lowest decile asset values indicate that BAs invest in a non-negligible number of companies that are most likely paper companies or newly formed shell vehicles with essentially no assets. This evidence supports the view that BAs provide much needed funding to companies in stages of their life cycle that would hardly elicit interest from formal VC. This view is corroborated by the standard deviation and maximum value figures, which return a view of the angel-backed companies being very small and young. Our statistics are consistent with previous studies on BA activity in Italy (Croce et al., 2017) and other countries such as the US (DeGennaro and Dwyer, 2014; Lerner et al., 2018), Belgium (Collewaert and Manigart, 2016), Canada (Carpentier and Suret, 2015), China (Li et al., 2014), and Finland (Lahti, 2011).

Approximately 36% of the investments mapped in the dataset are directed at projects in the *Seed* phase. In the other cases, the target firms are start-ups or later stage investments. Because investing in a seed enterprise is likely to be riskier than investing in a well-established entrepreneurial project, there is a negative expected relationship between the dummy *Seed* and both dependent variables, *Wealth%* and *Participation%*.

Dealing with the geographic location of the target companies, foreign ventures represent only 12% of the financed projects. Cumming and Dai (2010) show that venture capitalists have a preference for investments that are closer to them. Distance is measured from a geographical perspective but is argued to also be a proxy for cultural and social differences. Following these arguments, we expect a negative sign for the survey dummy *Foreign*, which identifies investments by an angel in a country other than his/her country of residence.

Looking at the financial wealth of BAs, the minimum reported value is 250,000 euro, the lowest end of the survey brackets. This figure is smaller than the level adopted in the US to identify accredited investors, a condition of operating as a BA in the US. However, this concern is mitigated by the fact that there is no specific minimum wealth requirement under Italian – and,

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to a similar extent, European – regulation. Additionally, the mean (median) wealth is higher at approximately 1.5 million euro (1.25) and the highest decile in excess of 3.5 million euro. These figures are consistent with the reported values in individual wealth and deal size of other empirical analyses investigating BAs in different countries as well as in the US (Collewaert and Manigart, 2016; De Gennaro and Dwyer, 2014; EBAN, 2015; Inova+, 2017; Kerr et al., 2014; Lahti, 2011; Mason, Harrison, and Botelho, 2013; Sohl, 2007; Wiltbank et al., 2009).

Because our data are collected annually and there is no disclosure about the month of investment, we account for economic conditions and the equity-market performance through year fixed-effects. Finally, we add a set of industry controls that have been shown to drive the overall volume of investments. In particular, we control for industry-specific characteristics through the industry price-to-book value ratio (*Industry_PBV*) and the industry capital intensity (*Capital Intensity*), measured as the ratio of capital expenditures to sales.

4. Methodology and results

4.1. Personal wealth invested

The first analysis investigates the determinants of the share of personal wealth invested in a venture by a BA. To this end, we run a battery of ordinary least squares (OLS) regressions between the dependent variable *Wealth%* and a set of explanatory variables related to the venture, the investor, and the investment decision. We also add to some model specifications time and industry fixed effects. We address potential heteroskedasticity concerns in two ways: first, because our dependent variable and the main continuous independent variables cannot assume negative values, we perform a logarithmic transformation of the dependent variable and of the explanatory variables *Net_Asset_Value*, *Wealth*, and *Experience*[6]; second, we compute Huber-White heteroskedasticity-consistent standard errors.

Our baseline Eq. (1) is a fully balanced model with time fixed effects.

$$y = \alpha + \beta_1 x_1 + \beta_2 x_2 + \Phi FirmControls + \Gamma IndustryControls + \tau + \theta + \varepsilon \quad (1)$$

where:

$y = \text{Wealth}\%$
$x_1 = \text{BAN\_membership}$
$x_2 = \text{Co-investors}$
$\text{FirmControls} = \text{Net\_Asset\_Value}, \text{Seed}, \text{Foreign}$
$\text{IndustryControls} = \text{Industry PBV}, \text{Net capex/Sale}$
$\tau = \text{Year of investment}$
$\theta = \text{Industry}$

Eq. (2) adds to the previous model investor-level explanatory variables.

$$y = \alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_1 x_1 + \beta_3 x_3 + \beta_4 x_4 + \Lambda InvestorControls + \Phi FirmControls + \Gamma IndustryControls + \tau + \theta + \varepsilon \quad (2)$$

where:

$x_1 = \text{BAN\_membership}$
$x_2 = \text{Co-investors}$
$x_3 = \text{Passive Investor}$
$x_4 = \text{Soft-Monitoring}$
$\text{InvestorControls} = \text{Age}, \text{Education}, \text{Wealth}, \text{Entrepreneur}, \text{Manager}, \text{Experience}$

Because the two-group mean comparison test on the dependent variable *Wealth%*, presented in Table 3, shows that being a member of an angel community affects the share of wealth invested in a venture, we also run Eq. (2) for the sub-samples of BAN members and non-BAN members separately.

Table 5 presents the results of the analysis. The model is significant in all of the specifications and shows an R-squared of 14% for the base model in column (1) and above 35% for the two angel sub-samples, reported in columns 3 and 4.

The results show that being a member of an angel community increases the share of wealth invested by approximately 16%, which provides support for our first research hypothesis (H1a). Other conditions being equal, a one-unit increase in the number of co-investors reduces the percentage amount of BAs' personal wealth invested in a single deal by 2%. However, by comparing BAN members with non-BAN members, we observe some interesting differences, highlighting the differential role played by co-investing in the investment decision. More specifically, the BAs' wealth allocation is affected by the presence of co-investors only for the sub-sample of the BAN members, implying that there could be a positive effect played by the trust established inside a given angel community. We interpret the absence of an effect for non-BAN members as the result of a lack of knowledge of

[6] Because experience may take a value of 0, the transformation is done as ln(experience + 1). We also perform an alternative transformation taking the cube root of experience and using it in a set of robustness regressions, obtaining qualitatively similar results.

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Table 5
Regression Results (dependent variable: *Wealth%*)
This table reports OLS regressions on the effects of BAN membership on angels' asset allocation decisions. The dependent variable, Wealth%, is the share of one angel's wealth invested in each BA-backd company. Eq. (1) estimates a fully balanced model with time and industry fixed-effect. Eq. (2) includes all the explanatory variables described in Table 2. We also run Eq. (2) for the two sub-samples originated by grouping BAs on the basis of the BAN_membership dummy (Models 3 and 4). Huber-White heteroskedasticity-consistent standard errors are reported in parentheses under each coefficient. *, **, *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

	Whole sample		BAN Member	Non-BAN member
Independent variables	(1)	(2)	(3)	(4)
BAN_membership	0.125**	0.155***		
	(0.05)	(0.05)		
Co-investors	−0.021***	−0.017***	−0.035***	−0.007
	(0.00)	(0.01)	(0.01)	(0.01)
Passive Investor		−0.064	−0.023	−0.163**
		(1.08)	(0.25)	(2.08)
Soft-Monitoring		0.054*	−0.053	0.154***
		(1.92)	(1.62)	(4.60)
Age		−0.015***	−0.011***	−0.018***
		(5.70)	(3.02)	(3.91)
Education		0.031	0.19	−0.213**
		(0.40)	(1.56)	(2.02)
Wealth		−0.062**	−0.044	−0.114***
		(2.09)	(1.00)	(3.21)
Experience		0.041***	0.059***	0.030***
		(6.57)	(5.82)	(3.51)
Entrepreneur		0.098*	0.053	0.158**
		(1.90)	(0.72)	(2.37)
Manager		0.071	0.300***	−0.098
		(1.17)	(2.81)	(1.36)
Net_Asset_Value	0.000	0.004	−0.013	0.031
	(0.02)	(0.02)	(0.03)	(0.02)
Seed	0.021	−0.074	−0.038	−0.170**
	(0.06)	(0.06)	(0.07)	(0.08)
Foreign	−0.009	−0.007	0.018	0.041
	(0.08)	(0.07)	(0.12)	(0.09)
Industry P/BV	0.039	0.028	0.037	−0.004
	(0.04)	(0.04)	(0.04)	(0.05)
Capital intensity	0.006	0.011	−0.001	0.028
	(0.01)	(0.01)	(0.01)	(0.02)
Intercept	1.966***	2.826***	2.846***	3.234***
	(0.27)	(0.34)	(0.57)	(0.43)
YEAR F.E	YES	YES	YES	YES
INDUSTRY F.E.	YES	YES	YES	YES
R^2	0.14	0.27	0.35	0.37
Observations	570	569	292	277

other investors' profiles and characteristics. Such opaqueness may lead investors to avoid or reduce their co-investments because of potential freeriding and/or opportunistic behavior risks. These results confirm our second hypothesis for an angel investor member of a network and provide interesting novel evidence of the differential investment practices of BAs within and outside of a BAN.

Confirming our third hypothesis, we find a negative relationship with percentage wealth invested for BAs acting as passive investors. Such a relationship, however, is statistically significant only for non-BAN member angels. We argue that, in the case of BAN members, the possibility of benefitting from co-investing with other angels, the possibility of leveraging other angels' experience, and the mentoring and information provided by the BAN gatekeepers may provide incentives that ultimately positively affect the investment decisions of passive angels interested mainly in capital gains, as highlighted by industry and association surveys (OECD, EBAN, IBAN).

The variable *Soft-Monitoring* shows a positive significant sign for the group of BAs not affiliated with an angel community and a negative sign for the BAN members, though the parameter is not significant. This evidence is consistent with H4 and seems to be further proof of the quality of the contribution in terms of the deal flow and screening provided by BA networks to their members. In fact, it is likely that BAN members impose a higher level of monitoring only on ventures that are more opaque. If this is true, the negative sign is related to the perceived investment risk (which requires more monitoring). In contrast, because non-BAN members do not benefit from the soft information provided by angel communities, they probably compensate for this greater information asymmetry by imposing a high level of monitoring more extensively. In this case, higher monitoring is not necessarily associated with higher risk. In fact, looking at the preferred asset class chosen, the earlier the stage in the life cycle of the target firms – emerging by considering the significance of the control variable *Seed* – the lower the amount invested by non-BAN members, who arguably tend to invest more in ventures with shorter time to market.

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Looking at the set of control variables, the percentage amount of BAs' personal wealth invested in a single venture depends on the personal characteristics of the BA, whereas it is not influenced by almost any of the target firms' characteristics, except for the investment stage variable *Seed*.

First, we find a negative and significant parameter for the *Wealth* variable. However, breaking down the analysis between BAN members and unaffiliated angels, we show that the evidence holds only for non-BAN members. This result lends support to the notion that BAN membership offers valuable services to angels that provide incentives to invest more. Such services translate into a powerful incentive to investing. In other words, wealthier non-BAN members will allocate less of their own capital to early stage investments, possibly due to the absence of the benefits available to BAN members (high quality deal flow, risk-reduction, co-investment, information sharing, decreased need for soft monitoring).

BAs' backgrounds play an opposite role conditional on BAN membership: former managers are keener to invest more if they participate in a BAN group, whereas entrepreneurs tend to invest more of their personal wealth when they go solo. This is not inconsistent with anecdotal evidence on the generally more independent investment profile of former, successful entrepreneurs, as opposed to high-caliber managers used to acting within organizations.

Interestingly, we observe different investment behaviors between BAN members and non-BAN members when the education of the investor is considered. Non-BAN members invest substantially less than similarly educated but affiliated angel investors. We interpret this evidence as an indication that the information and knowledge sharing effect taking place inside a community can compensate for the limited education of a given angel investor who otherwise would have been prevented from investing more capital.

Table 6

Regression Results (dependent variable: *Participation%*)

This table reports OLS regressions on the effects of BAN membership on angels' asset allocation decisions. The dependent variable, Participation %, is the amount invested in a venture as a share of the investee net-asset-value. Eq. (1) estimates a fully balanced model with time and industry fixed-effect. Eq. (2) includes all the explanatory variables described in Table 2. We also run Eq. (2) for the two sub-samples originated by grouping BAs on the basis of the BAN_membership dummy (Model 3 and 4). Huber-White heteroskedasticity-consistent standard errors are reported in parentheses under each coefficient. *, **, *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

	Whole sample		BAN member	Non-BAN member
Independent variables	(1)	(2)	(3)	(4)
BAN_membership	−0.163**	−0.139*		
	(0.07)	(0.07)		
Co-investors	−0.089***	−0.067***	−0.075***	−0.069***
	(0.01)	(0.01)	(0.01)	(0.01)
Passive investor		−0.186**	−0.262**	−0.264***
		(0.08)	(0.13)	(0.09)
Soft-monitoring		0.214***	0.116**	0.287***
		(0.04)	(0.05)	(0.06)
Age		−0.009**	−0.007	−0.014*
		(0.00)	(0.01)	(0.01)
Education		0.340**	0.536***	0.136
		(0.13)	(0.19)	(0.18)
Wealth		0.044	0.053	0.084
		(0.04)	(0.05)	(0.06)
Experience		0.019**	0.032**	0.017
		(0.01)	(0.01)	(0.02)
Entrepreneur		0.356***	0.350***	0.348***
		(0.08)	(0.10)	(0.11)
Manager		0.335***	0.547***	0.228*
		(0.10)	(0.17)	(0.13)
Net_Asset_Value	−0.226***	−0.250***	−0.268***	−0.211***
	(0.03)	(0.02)	(0.04)	(0.03)
Seed	−0.06	−0.135*	−0.058	−0.212*
	(0.07)	(0.08)	(0.11)	(0.12)
Foreign	−0.342***	−0.321***	−0.292*	−0.398**
	(0.10)	(0.11)	(0.17)	(0.15)
Industry P/BV	−0.042	−0.052	−0.033	−0.098
	(0.06)	(0.06)	(0.07)	(0.10)
Capital intensity	0.023	0.024	0.047*	0
	(0.02)	(0.02)	(0.03)	(0.02)
Intercept	4.203***	3.675***	4.036***	3.373***
	(0.33)	(0.45)	(0.66)	(0.64)
YEAR F.E	YES	YES	YES	YES
INDUSTRY F.E.	YES	YES	YES	YES
R^2	0.49	0.56	0.51	0.67
Observations	700	569	292	277

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4.2. Equity stakes in participated companies

The second part of the empirical analysis explores the factors affecting the amount invested by the BA as a share of the post-financing equity capital of the venture. For this purpose, we estimate the relationship between the dependent variable *Participation%* and the same set of explanatory variables used in Table 5.

Similarly to the approach used for the dependent variable *Wealth%*, we manage heteroskedasticity, first, by performing a logarithmic transformation of the dependent variable *Participation%* and of the explanatory variables *Net_Asset_Value*, *Wealth*, and *Experience*; and second, by estimating Huber-White heteroskedasticity-consistent standard errors.

Table 6 presents the results of the OLS regressions run on Eqs. (1) and (2), replacing the dependent variable *Wealth%* with *Participation%*.

In contrast to the univariate tests in Table 3, when controlling for a number of covariates, BAN membership returns significant parameter estimates, indicating that it is a material factor affecting the capital allocation decisions of BAs. BAs are cognizant of the risks of their investments, and, thus, they rationally manage their risk exposure by exploiting the benefits of affiliating to an angel network. In particular, other conditions being equal, BAN membership reduces the size of the equity stake in the investee venture by approximately 14%, which provides support for hypothesis H1b.

Our tests also provide support for H2 investing alongside another angel decreases the individual participation by an economically significant 7%; therefore, co-investing appears to be an effective way to pursue risk-minimizing investment decisions while enjoying the upside of portfolio diversification.

On the other hand, when the main motivation appears to be capital gain (i.e., when the dummy *Passive_Investor* is equal to one), the dependent variable shows an 18% reduction, consistent with H3.

Dealing with H4, the data show that the share of participation in a given target company increases by >20% as the degree of soft monitoring increases, once again confirming the relevance of monitoring mechanisms, even if non-contractual based, as is usually agreed upon between entrepreneurs and BAs (Ibrahim, 2008). This effect is markedly different across the two groups. The parameter for BAN members is 0.116, whereas that for unaffiliated angels is 0.287. This difference is significant at the 1% level, as computed through a (unreported) standardized Z-test.

Looking at angel-specific control variables, the model results display a progressive reduction in the amount invested in a venture as the age of the investor increases. It also emerges that less-educated BAs show greater risk exposure. The parameter estimate for the degree of experience in BA investments is positive, as expected, although the statistical significance of the estimate is very low or null. The absolute level of financial wealth is not significantly different from zero. On the contrary, we obtain strongly significant estimates supporting the impact of prior experience as an entrepreneur or a manager on the magnitude of the stake acquired by the angel. This effect is quantitatively similar across the two groups for angels showing prior experience as entrepreneurs but is significantly larger for BAN members with a managerial background. Looking at firm-specific controls, not surprisingly, we find a significant inverse relationship between the size of the company measured through the Net Asset Value metric and the share of participation in a venture. Similarly, as expected, participation diminishes by >30% if the target company is located abroad.

4.3. Endogeneity

Our results, thus far, show that BAN membership affects BA investment practices. This is robust to time and industry fixed-effects that control for any time-invariant and industry-specific variables, and to a host of controls that have been previously identified by the literature to determine capital investments by BAs. However, it is possible that our results are driven by endogeneity in the form of reverse causality and/or simultaneity and sample selection. Given the absence of natural experiments, we address the first possible source of endogeneity by performing a set of instrumental variable regressions and address selectivity biases by running regressions on a treatment group of BAN members matched by propensity scores with a control group of otherwise similar non-BAN members.

4.3.1. Two-stage least-squares IV regression

The survey nature of the data constrains the selection of usable instruments for variables not included in the main regressions. We identify in the survey two additional variables that are plausibly exogenous to the amount invested, except through their relation to our BAN membership variables of interest, and therefore allow us to run two-stage least square instrumental variable regressions. Specifically, we select the following variables: the presence of a given investor in previous surveys ("*Past surveys*") and the number of investments evaluated (but not necessarily financed) by the respondent prior to the current survey ("*Past projects*").

The rationale for the two instruments is that a very active angel (i.e., one that responded to past prior surveys and one that evaluated many projects) is more likely to appreciate the benefits of BAN membership and eventually join the network. At the same time, however, it is unlikely that such actions anticipate a change in investment practices two or more years in the future.

The two instruments are uncorrelated with each other ($\rho = 0.04$) and the first-stage regression results reported in Table 7 support the instrument choice. The two instruments are strongly and positively correlated with BAN membership. The regressors are correlated with the possibly endogenous variable as shown by the Lagrange multiplier (LM) test that strongly rejects the null of no correlation. The weak identification test shows an F-value of 31.10, which compares favorably with the Stock-Yogo 10% critical value of 19.93, suggesting that the instruments are not weak.

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Table 7
Instrumental Variable regression
In this table we present results of Instrumental Variable regressions to control for endogeneity where we instrument the potentially endogenous variables BAN membership with two variables: "Past surveys" that captures the presence of a given investor in previous surveys and "Past projects" that captures the number of investments evaluated (but not necessarily financed) by the respondent prior to the current survey. Column 1 reports results for the first-stage regression, Column 2 for the Instrumental Variable regression. The dependent variable in the first stage regression is BAN membership, while the dependent variable in the IV regression are Tables 5 and 6 dependent variables (Wealth % and Participation%) respectively. Both first and second stage regressions include angel-specific, firm-specific and industry-specific controls described in Table 4. All regressions include year and industry fixed-effects. Huber-White heteroskedasticity-robust standard errors are reported in parentheses. Durbin-Wu-Hausman test p-values in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Wealth %		Participation %	
Dependent variable	First stage regression	IV regression	First stage regression	IV regression
BAN membership		0.362**		−0.356*
		(0.16)		(0.20)
Past surveys	0.359***		0.359***	
	(0.05)		(0.05)	
Past projects	0.024**		0.024***	
	(0.01)		(0.01)	
Coinvestor	−0.013***	−0.017***	−0.013***	−0.056***
	(0.00)	(0.01)	(0.00)	0.01
Passive investor	−0.082	−0.042	−0.082	−0.307***
	(0.05)	(0.06)	(0.05)	(0.09)
Soft-monitoring	0.066***	−0.013	0.066***	0.221***
	(0.02)	(0.03)	(0.02)	(0.04)
Angel-specific controls	YES	YES	YES	YES
Firm-specific controls	YES	YES	YES	YES
Industry specific controls	YES	YES	YES	YES
Year F.E.	YES	YES	YES	YES
Industry F.E.	YES	YES	YES	YES
N	431	431	431	431
Underidentification test				
(Kleibergen-Paap LM statistic)	57.75***		57.75***	
Weak identification test				
Cragg Donald Wald F-test	31.10		31.10	
Stock-Yogo 10% critical value	19.93		19.93	
Durbin Wu Hausman endogeneity test		(1.68)		(0.86)

The coefficients for the second-stage regression are consistent with the OLS results for both variables in terms of significance and sign and are larger in terms of magnitude. Interestingly, the Durbin-Wu-Hausman test rejects the hypothesis that BAN membership is endogenous.

Overall, these results indicate that our main results are robust and our conclusions on the effects of BAN membership plausible.

4.3.2. Propensity-score matching regressions

In our research design, we observe the investment decisions of angels that may or may not belong to a BAN. A critical concern with this approach is that the sample may not be properly randomized, namely, it may not be representative of the population, and therefore, results may be biased. In our case, the decision to join the BAN might be driven by the specific investment that an angel is considering. Given that the variable suspected to generate selection bias is binary, a solution to this problem is to match each treated observation (i.e., BAN member) to a specific control observation (i.e., non-BAN member) with similar characteristics. We, therefore, perform a set of regressions after matching observations of BAN members with observations of non-BAN members selected by propensity-score matching (PSM) based on the following variables: age, education, wealth, prior investment experience, background, and year of investment. Results obtained using the "nearest neighbor" score-matching algorithm[7] (Rosenbaum and Rubin, 1983) are reported in Table 8.

Panel A presents post-estimation matching diagnostics. As required, the covariates do not exhibit significant difference in the means with the exception of Manager and Year. However, these are both discrete variables and t-tests results are less problematic. Looking at percentage bias, it is well below both the 10 and 5% conventional levels, with the exception of the same two variables. The overall model bias drops from 10.6 to 2.5% suggesting that the matching strategy achieves acceptably balanced results. As a (unreported) robustness test we have repeated the tests excluding the two poor variables from the covariates list. Results are marginally more robust and qualitatively unchanged.

Panel B presents matched regression results. The sign, magnitude, and significance of the parameter estimates in both specifications are qualitatively similar to those obtained in both the OLS and the 2SLS IV regressions. To ensure that our results were not driven by the specific matching technique we repeated our tests by adopting alternatively: *k*-neighbor matching with k = 2

[7] Given that a 1:1 nearest neighbor matching might yield matches with very different scores, we impose a maximum distance of half a standard deviation between the treated and the matched observations.

Please cite this article as: Bonini, S., et al., Angel network affiliation and business angels' investment practices, J. Corp. Finance (2018), https://doi.org/10.1016/j.jcorpfin.2017.12.029

Table 8
Propensity score matching
This table reports OLS regressions on the effects of BAN membership on angels' asset allocation decisions using propensity score matched observations. The treatment group is given by BAN affiliated angels whereas the control group is obtained by propensity score matching based on the following observable covariates: age, education, wealth, prior investment experience, background, and year of investment. Panel A reports after-matching diagnostics. Difference in means between treatment and control group is reported conventionally by the control group mean. Panel B reports regression results. The dependent variable in Model 1 is Wealth %, the share of one angel's wealth invested in each BA-backed company. The dependent variable in Model 2 is Participation %, the amount invested in a venture as a share of the investee net-asset-value. Regressions include angel-specific, firm-specific and industry-specific controls described in Table 4. All regressions include year and industry fixed-effects. Huber-White heteroskedasticity-robust standard errors are reported in parentheses under each coefficient. *, **, *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

PANEL A - After-matching diagnostics

	Treatment	Control	% bias
Age	48.27	48.244	0.2
Education	0.06	0.07	−2.5
Wealth (log)	6.89	6.87	0.8
Experience	6.52	6.55	−0.6
Entrepreneur	0.39	0.35	7.9
Manager	0.14	0.21*	−11.5
Year	2011	2011**	−14.7
Mean Bias before matching			10.6
Mean bias after matching			2.5

PANEL B - PSM regressions

Independent variables	Wealth %	Participation%
	(1)	(2)
BAN_membership	0.145***	−0.143*
	(0.05)	(0.07)
Co-investors	−0.017***	−0.066***
	(0.01)	(0.01)
Passive investor	−0.068	−0.195**
	(0.06)	(0.08)
Soft-monitoring	0.058**	0.215***
	(0.03)	(0.04)
Angel-specific controls	YES	YES
Firm-specific controls	YES	YES
Industry specific controls	YES	YES
Intercept	2.645***	3.656***
	(0.33)	(0.47)
Year F.E.	YES	YES
Industry F.E.	YES	YES
R^2	0.28	0.56
Observations	561	561
Age	−0.014***	−0.009**
	(0.00)	(0.00)
Education	0.193*	0.352*
	(0.11)	(0.18)
Wealth	−0.036	0.052
	(0.03)	(0.04)
Experience	0.053***	0.033***
	(0.01)	(0.01)
Entrepreneur	0.059	−0.195***
	(0.05)	(0.02)
Manager	0.076	−0.033
	(0.07)	(0.08)
Net_Asset_Value	0.042**	−0.135
	(0.02)	(0.08)
Seed	−0.084	−0.064
	(0.06)	(0.06)
Foreign	0.002	0.036*
	(0.07)	(0.02)
Industry P/BV	−0.015	0.333***
	(0.04)	(0.07)
Capital intensity	−0.008	0.360***
	(0.01)	(0.10)

and k = 3 and radius matching. We also matched on firm-specific covariates, even if this led to significant reduction in sample size. Results were unchanged.

While conclusively ruling out endogeneity concerns in survey data is challenging, we believe that the coherence of the main OLS results with the IV and PSM tests provides robust support for our conclusions.

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5. Conclusion and suggestions for future research

In this paper, we provide novel evidence of the effects of BA participation in a BAN on BA investment decisions. Looking at a unique dataset that contains qualitative and quantitative information on 810 investments from 2008 to 2014, we contribute to the extant literature by providing preliminary evidence of the existence of significantly different investment practices influenced by BAN membership. Affiliation with an angel group generates valuable information and risk reduction effects that ultimately increase the amount of capital that angels invest in new ventures. Similarly, BAN members enjoy significant diversification benefits, larger deal flows, and access to network screening and monitoring skills. These factors causally affect angels' portfolios by reducing the individual stake in each company while expanding the relative size of their portfolios devoted to early stage investments, thereby implementing a classical diversification strategy. In an extensive set of multivariate tests, we also show that the possibility to co-invest appears to be a factor that significantly affects their investment decisions, giving them the possibility, on the one hand, to benefit from risk-reduction effects and, on the other hand, to continue playing an active role in the target company.

The unique characteristics of the dataset allow us to control for novel factors such as the stated willingness to play an active/passive role and to closely monitor the company through soft, non-contractual based mechanisms. The results are markedly different conditional on participation in an informal investor organization: non-BAN members invest less capital if they plan to play a passive role, but angels counterbalance this effect through a stronger monitoring effort. In other words, BAN members can reduce direct, individual monitoring efforts through superior networking skills and shared monitoring of portfolio companies. Angel communities thus seem to be able to decrease and distribute the need for individual monitoring while increasing member confidence in the investments.

Interestingly, past experience as an entrepreneur or a manager has strong effects on capital allocation decisions conditional on being affiliated with a group. Past managers who are also BAN members invest 30% more capital and acquire almost twice the stake in a portfolio company than non-BAN members. However, BAN membership has no effect on entrepreneurs who exhibit a preference to invest alone.

Policymakers have increasingly supported the role of BAs in stimulating entrepreneurship as a crucial driver of economic growth, promoting the development of the angel community through dedicated government-sponsored programs. Our results provide valuable information to further such development—which has proven to be one of the major enablers of new ventures and a crucial precursor to formal venture capital (Baldock and Mason, 2015; Kraemer-Eis et al., 2016) —by improving the economic efficiency of the policy design, and ultimately, stimulating social welfare.

Our contribution opens up numerous avenues of additional research. First, obtaining more specific data on BAN and AGs may help highlight possible variations in the effects of these different forms of association on angel investment practices. Second, fruitful insights can come from extending the analysis to an international level through worldwide-based BA samples. Third, the relative role of angels as a complement to or substitute for venture capital (Hellman et al. 2015) could be tested by exploring the long term survivorship and performance of companies backed by angels, BANs, and AGs. Finally, little is still known about the internal dynamics of knowledge generation and dissemination across BAN members and its effects on the support and survivorship of the invested companies.

Acknowledgements

We are indebted to Colin Mason, Douglas Cumming, Peter Wirtz, and Mike Wright for their invaluable suggestions. We are grateful to Stuart Gillan, the Guest Editors of the Special Issue, two anonymous referees, the participants at the 2017 FMA European Conference, 2017 Emerging Trends in Entrepreneurial Finance Conference, 2016 Lyon Entrepreneurial Finance Conference, the BAE Conference on Angel Investment Research 2016, and the 2015 and 2016 IBAN annual conferences for their comments. We thank IBAN for generously providing the data. We thank Università del Piemonte Orientale, Stevens Institute of Technology and SDA Bocconi for financial support. The ideas expressed in this paper are those of the authors and do not necessarily reflect the position of the authors' respective institutions. Any errors remain our own.

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Please cite this article as: Bonini, S., et al., Angel network affiliation and business angels' investment practices, J. Corp. Finance (2018), https://doi.org/10.1016/j.jcorpfin.2017.12.029

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