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Have you been served?
The impact of university entrepreneurial support on start-ups' network formation

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ABSTRACT

University-based entrepreneurial support organizations devote increasing efforts to create a context and opportunities for interaction among start-up firms. The basic assumption behind these efforts is that networks facilitate access to knowledge and resources and increase the chances of success for start-ups. However, the mechanisms that facilitate the creation of business ties with other members of the same community are yet to be identified and empirically tested. This paper leverages the social network and firm incubator literatures to hypothesize and test mechanisms that create the context and opportunity for business interaction among member firms within one university-based entrepreneurial support organization. The study uses the empirical setting of a large, university based support organization and the sample includes firms with different levels of membership-support. This empirical context allows us to compare different levels of membership-support and identify the dimensions that have greater impacts on a firm's opportunity to establish ties with other members. The results reveal that geographical proximity, ad-hoc service support including shared space, and a larger community of member and graduate firms to which network ties may be formed increases the chance of connecting with other past or current member firms.

INTRODUCTION

Universities, governments, and foundations devote considerable attention to servicing and supporting start-up companies. The past decade has seen a variety of new organizational forms of entrepreneurial support such as accelerators and coworking spaces. Older organizations are adapting to new service models in attempts to remain competitive as they find more efficient, impactful ways to support start-ups (Bruneel et al. 2012; Moriset 2014). Entrepreneurial support organizations (ESO) are one avenue by which firms may access the resources they need. Studies discuss the opportunities that membership in ESOs such as incubators and research parks afford new ventures (Aernoudt 2004; Lewis et al. 2011; Leyden et al. 2008; Link & Scott 2003; Yang et al. 2009). University incubators in particular provide important access to university resources (e.g., knowledge, talent, and equipment) that help promote the growth of member firms (Battelle 2007; Link & Scott 2005, Löfsten & Lindelöf 2005; Mian 2011).

Access to a network and the ability to capitalize on it are validated as important for start-up firm growth and survival (Bruderl & Preisendorfer 1998; Elfring & Hulsink 2003; Havnes & Senneseth 2001; Zhao & Aram 1995). Brüderl and Preisendörfer's (1998) analysis of business founder networks in Munich, Germany confirmed a "network success hypothesis" – that firms with entrepreneurs who have "broad and diverse social network[s]" have stronger survival and growth rates. New firms with greater access to network capital are better able to innovate and acquire knowledge through securing resources that enable them to develop and succeed (Aldrich et al. 1986, 1987; Hoang & Antoncic 2003; Huggins & Thompson 2015; Tello et al. 2012). ESOs such as incubators foster this access as membership provides new ventures with connectivity to other firms (Lasrado et al. 2016) and act as a "mechanism for embedding the company in (entrepreneurial) networks" (Bøllingtoft 2012, pp. 304).

Although there is an assumption that ESOs play an important role in supporting new ventures in building network ties (Lasrado et al. 2016), our understanding of the mechanisms supporting tie formation among members of the same organization is scant. Despite this wealth of knowledge on incubators and business networks we find limited empirical work investigating the mechanisms that enable member entrepreneurs to establish and grow a network of business relationships within an incubator. This paper addresses this gap in the literature by bringing together insights from existing studies of ESOs and social networks, and extending the literature to consider the mechanisms used within ESOs that facilitate linkages among member firms.

Our study responds to the call of using the social network size as a dependent variable (Ebbers 2013) when attempting to understand how networks emerge (Hoang & Antoncic 2003; Slotte-Kock & Coviello 2010) and which mechanisms underlie tie formation (Stuart & Sorenson 2007). To investigate effective ESO mechanisms, the analysis focuses on three questions: First, to what extent does firm-ESO

proximity matter? Second, how can ESOs promote the creation of business ties? Here we focus on the service offered to firms at different levels of membership at the support organization and evaluate its impact on their entire social network. We also investigate whether geographical proximity to other member firms or the support services within the ESO, including shared space, are more relevant for establishing formal ties. Lastly, does the size of the entire membership base and the group of more successful members matter for network formation? The data leveraged to address these questions comes from a sample of member firms at the Georgia Institute of Technology's Advanced Technology Development Center (ATDC), a longstanding and highly recognized university-based ESO and incubator that offers different levels of membership and support to all Georgia-based start-ups.

Results of the analysis illustrate that proximity and participation in multiple programs has a positive effect on the establishment of connections with other firms in the community. Moreover, the size of the whole network of entrepreneurs has a positive effect on the establishment of connections with other member firms of the organization. The study contributes to the literature on the role of university-based entrepreneurial support organizations in developing social capital as a way of supporting entrepreneurial success. In addition, the findings have implications for building entrepreneurial communities and specifically for the design of business centers, suggesting that formal collaborative behavior is shaped primarily by mechanisms of proximity, both social and geographical.

LITERATURE AND HYPOTHESES

One of the most important forms of support ESOs claim to offer their start-ups is the opportunity to become part of a community, or in other words part of a network of other firms (Feld 2012; Feldman et al. 2005). The assumption is such a community will benefit the start-up and that without the ESO the entrepreneurs would not be able to access or would have more difficulty accessing the community and its benefits. New ventures face external and internal "liabilities of newness" (Stinchcombe 1965) and smallness (Aldrich & Auster 1986), which makes difficult for them to attract potential partners. Liabilities of newness include barriers to entry and the difficulties of creating new structures for an organization and attracting employees, while liabilities of smallness include difficulties raising finance and satisfying regulations compared to larger firms, as well as facing competition from larger firms (Aldrich & Auster 1986).

Network ties help small, young firms overcome these challenges (Aldrich & Kim 2007; Bøllingtoft 2012). They are considered essential for the success of a start-up and the volume of such ties is important for innovation (Freel & de Jong 2009; Sarkar et al. 2001). In a pilot business incubator evaluation Sherman and Chappell (1998) found close to a quarter of the firms they surveyed in 50 U.S. incubators had initiated formal connections with other incubated firms. Uzzi (1999) and Aldrich et al.

(1987) found that the size of a firm's network has a positive correlation with the firm growth. Accordingly, Smilor (1987, pp. 152) suggests that: "The stronger, more complex, and more diverse the web of relationships, the more the entrepreneur is likely to have access to opportunities, the greater his chance of solving problems expeditiously, and ultimately the greater the chance of success for a new venture." Moreover, "[b]eneath most formal ties, then, lies a sea of informal relations. Many alliances-no matter what their ostensible function -reflect a relationship that carries benefits beyond the particular exchange designated in a formal agreement" (Powell et al. 1996, pp. 120). However, networks of this kind are not necessarily easy to cultivate (Alter & Hage 1993). Literature on networks and interorganizational relationships finds that relationships between organizations are based on expectations, obligations (norms), and trust (Granovetter 1985; Gulati 1998; Powell 1990). Bøllingtoft and Ulhøi's (2005) analysis of an incubator in Denmark suggests that trust, physical location, a bottom-up organizational structure, joint activities, and incubator size influenced relationships among firms in the same incubator. As trust relations take time to develop with peers in their network, entrepreneurs' ability to create relationships is limited (Kim & Aldrich 2005).

Repeated interactions enable the creation of trust, in turn influencing reciprocal actions and opportunities for bonding (Granovetter 1985, 2005; Ostrom 1998). By providing members with access to services and access to a social context and space for interaction (Soetanto & Jack 2013; Hansen et al. 2000), ESOs impact start-ups' abilities to develop business ties among each other. Carayannis and von Zedtwitz (2005) argue effective incubators will facilitate network activities for start-ups. They offer physical infrastructure such as offices and shared spaces for interaction with other members (Lyons 2000). Bøllingtoft & Ulhøi (2005) argue incubators institutionalize networks and find even the configuration of incubation space influences collaboration patterns among tenants. ESOs also serve as a primary source of social capital as they offer access to ESO member, manager, and advisor external networks (Hansen et al. 2000; Vedovello 1997). Soetanto and Jack (2013) found that internal incubator networks are most used by their members to access intangible resources and that more innovative firms are more engaged in these networks. With its set of programs and routines the ESO facilitates repetitive, informal interactions and information flows. Networking activities and the ability of ESOs to enable affiliated companies to develop a network has become a central part of the discussion on the ESOs' effectiveness. Still, the exact influences of ESOs on network tie proliferation are less clear. The next sections outline our hypotheses regarding the mechanisms that promote network growth.

The ESO's cumulated membership base

An important dimension network studies indicate as relevant in shaping interaction among organizations is the role of bridging ties (Aldrich & Kim 2007). ESOs can act as network bridges for

member firms by enabling affiliated companies to gain preferential access to a network of companies for which the ESO acts as an anchor tenant/organization (Hansen et al. 2000; Dutt et al. 2016). In this respect, ESOs serve as bridges connecting current members with other current and past members. Furthermore, the organization's ties to past and current members constitute a pool of potentially more experienced companies, which can act as mentors and resource providers to early stage firms. The ability of an ESO to act as a bridge is, however, related to the cumulated size of its membership. This membership size identifies the social context in which members of the ESO are embedded (Larson 1992). As the number of members grow, it allows the ESO to bridge more opportunities between startups.

Beyond the importance of the critical mass of member firms with which to connect is the importance of the types of firms to which connections could be made. It is highly unlikely a firm would seek a tie with a company they saw as unsuccessful, unless they had a strategic reason for so doing. An important consideration for new ventures is their lack of legitimacy, resources, and experience. Resource dependence theory suggests that firms with more resources are better able to form network ties (Hallen & Eisenhardt 2012). Connecting with more established companies that can support a firm's attempt to overcome these barriers can provide a real advantage. Being members of the ESO community, graduated members are a category of firms that may play such a role and are considered members of the ESO community. Aernoudt (2004, pp. 130) argues networking between tenants and graduates is important for incubation and "[w]ell-run technology incubators not only stay in contact with their alumni firms (tenants which have graduated) but also encourage those firms to provide advice to the current tenant". Often the terms of graduation from an incubator include that the company has obtained a certain level of resources or funding. Reaching higher stages of development may influence how firms network. Shan et al. (1994) found that when a firm receives funding it is more likely to engage in formal partnerships with other firms. Obtaining funding also signals viability and legitimacy for new firms (Stinchcombe 1965; Fernandez-Alles et al. 2015), which could make the company more desirable as a network connection for other companies. Several studies discuss the impact of receiving funding on embedding companies into local regions and bringing them into local networks (Bresnahan et al. 2001; Breznitz & Taylor 2014; Whittington et al. 2009). Building on these findings we propose:

Hypothesis 1: The size of a ESO's member firm's network will be positively influenced by the ESO's total (cumulated) number of member firms.

Geographic proximity

Geographic proximity is an important consideration for growing networks (Bøllingtoft & Ulhøi 2005; McAdam & McAdam 2008). Proximity's enabling role in knowledge sharing is evidence of a positive effect on networks (Broekel & Boschma 2012). The role of geography in innovation networks is

well documented. Owen-Smith and Powell (2004) found that information transfer through informal networks and labor mobility in Boston was hindered when firms were located further from each other and knowledge was viewed as propriety because it caused formal network ties to be more closed. They also found that when a firm was even loosely connected to the main component of a local knowledge network they were able to access "geographically bounded information spillovers", which had a positive impact on the firm. If the ESO is viewed as an anchor organization, bridging ties to other firms, member firms' closer location to the ESO should influence their ability to access such networks.

The physical location of a firm effects its level of innovation, but this effect is influenced by the other types of organizational structures in a region, for example whether they are competitive or more cooperative public research organizations (Whittington et al. 2009). Furthermore, Whittington et al. (2009, pp. 116) found "geographically distant ties are more likely to be characterized by less frequent or intimate connections, thus embodying traditional characteristics of weak ties." Weak ties are not unimportant, though, rather they convey different kinds of benefits to firms than strong, formal ties (Elfring & Hulsink 2003).

Geography influences the entry of new network members and how new connections are sought (Glückler 2007). Cooper et al. (2012) found that proximity can encourage communication among organizations by increasing the potential for organization members to naturally cross paths. However, proximity may not be a sufficient precursor to network formation. Broekel and Boschma (2012) identify a "proximity paradox" where geographic proximity enhances knowledge sharing, but too much proximity could have the opposite effect. However, the difference between these two opposite outcomes of proximity lies in the fundamental distinction between cooperative and competitive mode of network formation and greater proximity should theoretically not cause negative outcomes if cooperation is the norm/goal (Laumann et al. 1978). In the case of a biotechnology community, for example, Owen-Smith and Powell (2004) found that proximate firms benefitted from innovation spillover, because of the open science norms of the public research organizations in the local entrepreneurial community. Furthermore, Whittington et al., (2009) emphasized the importance of proximity by illustrating the effect local business norms can have on shaping firm behavior.

The conflicting findings of the literature make investigation into this concept important. If an ESO was explicitly formed to facilitate knowledge flow among firms through facilitating interactions, then the effect of proximity of start-up firms to ESOs should be consistent with the earlier work of Owen-Smith and Powell (2004) and Whittington et al. (2009). Therefore, we expect member firms to grow their business ties when they are geographically closer to the ESO. To summarize the effect of proximity on firms affiliated with an ESO, we pose the following:

Hypothesis 2*: Member firms located in the same city as the ESO will have higher number of business ties than members who are not located in the same city.*

Tenancy and service support

ESOs support the creation of business ties for member companies programmatically and through ad hoc services. Networking with other tenant companies is an important aspect of the incubation process (Aernoudt 2004). Incubators, specifically, serve many functions that ultimately add value to new firms when effective (Hughes et al. 2007). Von Zedtwitz and Grimaldi (2006) delineate five types of services that can be present to varying degrees in any individual incubator: physical infrastructure, office support, access to capital, process support, and networking. Some of these services specifically aim to facilitate information flows and repeated interactions among firms (Soetanto & Jack 2013; Hansen et al. 2000), which can enhance the probability of network ties forming. Formal network ties may also form through informal mechanisms.

One of the most important services of ESOs such as incubators and accelerators is the provision of physical infrastructure where tenants co-locate. Shared office space and office support provided at a lower cost than typical office space alleviates a vital business concern for start-ups and allows entrepreneurs to better focus their capital and time on firm development and growth (McAdam & Marlow, 2007; McAdam & McAdam 2008; Phan et al. 2005; Smilor 1987). Furthermore, co-location within an ESO and incubator creates opportunities for interaction among participating member firms. Occupying the same office space leads to informal introductions, providing an opportunity for persons to interact and discover commonalities (Homan 1950).

Again, the question of whether firms locating close to one another becoming a problem arises in this context. Co-located firms may encounter issues of conflict and competition with neighboring organizations (McAdam & Marlow 2007), which could hinder network formation. This is especially true if firms are attempting to guard new intellectual property (Ahmad & Ingle 2011) or competing for the same scarce resources (Provan et al. 2004). Schwartz and Hornych (2008, 2010) found that while proximity is helpful for knowledge transfer between incubator members, it is not sufficient for network tie formation. Furthermore, too many firms in close proximity may negatively impact networking patterns. As the number of firms in an incubator grows, new tenants may have a more difficult time joining into the community and "networking might become more of a slogan than a reality" (Bøllingtoft & Ulhøi 2005, pp. 283). These contingencies warrant further investigation of the topic of tenancy.

Apart from the added benefits and services of ESO tenancy, program participation within an incubator is another avenue for repeated interaction where networks can be built. Discrete programs within an incubator create opportunities for interaction among participating member firms. Increased

program participation leads to increased exposure to other firms with similar barriers, profiles, or contingencies that can lead to the formation of a network relationship. A recent study argued that university incubators provide more resources to member companies than other incubators and provide "greater connectivity and legitimacy with respect to important contingencies associated with key industry and community stakeholders" (Lasrado et al. 2016, pp. 217). These resources matter, as Lasrado et al. (2016) found university incubated firms outperformed a matched sample of non-university incubated firms in terms of employment and sales.

ESOs provide an array of programs and services including networking events, competitions and expos, expert panels, mentorship, and grant-writing services. Some offer entrepreneurial education programs. While the main objectives of educational services are to help entrepreneurs understand how to run a company and extend the business outside the incubator (Smilor 1987, pp. 152), these also offer a context for interaction with other entrepreneurs, increasing the potential for business ties. Another service often provided by incubator managers is connections to sources of finance (McAdam & McAdam 2008; Smilor 1987). Intuitively, tenancy and participation in a larger number of programs should lead to more opportunities for network tie formation. Prior studies outlined support this assertion. Thus, we test the following hypotheses:

Hypothesis 3: Member firms who participate in ESO services and programs will have a higher number of ties (higher centrality) than non-tenant firms.

EMPIRICAL SETTING

Georgia Institute of Technology (Georgia Tech) has a mandate to provide services to all startups in the state of Georgia including spinouts from the university itself. The service is provided through the university's Advanced Technology Development Center (ATDC). ATDC provides a range of entrepreneurial and commercialization services through different initiatives and subunits. It provides assistance to firms in writing business plans and SBIR grants, designing a financing strategy, locating finance, and recruiting employees. It also provides educational programs and access to entrepreneurs-in-residence (Tornatzky & Rideout 2014). Because the ATDC is fully funded by the State of Georgia, it offers these services to all Georgia firms.

ATDC members receive services that depend on their membership type. The membership levels are: ATDC Basic members, tenants, and VentureLab members. Regular ATDC members pay $50 quarterly fees and receive access to many services that aim to help the company grow and become profitable. These services include: admittance to Lunch-N-Learn education and coaching, Entrepreneurs in Residence (EIR) office hours, a mentor program, Cowork@ATDC, startup circles, sponsor office

hours, the monthly Entrepreneurs' Night, and invitations to ATDC's annual Holiday Party and Spring Showcase.

Tenants are companies that in addition to benefiting from these services also rent an office in the ATDC building allowing them opportunities for closer interaction with other start-ups than non-tenants. The Tenant category includes within it two levels of membership: Accelerate and Signature.   Accelerate members receive shared space and access to more services than basic members, while Signature members receive larger, dedicated space, and custom services that in particular include connections to other firms. VentureLab is a Georgia Tech incubator that helps Georgia Tech researchers, faculty, and students develop their ideas into startup companies (VentureLab 2013). Even prior to VentureLab and ATDC's 2009 merger, companies that went through VentureLab often subsequently joined ATDC (Toon 2013). VentureLab and ATDC have both ranked first or second in incubator ratings like the Stockholm-based UBI Index of incubators and *Forbes* magazine (Tornatzky & Rideout 2014). ATDC members may graduate when they meet certain targets. These targets have changed over time, but consistently require firms to either raise $1 million or obtain it "in recurring revenue" (Hughley 2013). Graduating members refers to the firms' economic status. Hence, graduating firms remain basic members and can participate in any program or event geared toward basic members.

Figure 1 Here

The ATDC Nework. ATDC member firms interact with each other in formal and informal ways that constitute a small world network. A small world network is characterized by nonrandom clusters of ties that develop based on social context and constraints where clusters are connected through shortcuts called bridging ties (Aldrich & Kim 2007). In this setting, ATDC is a bridging tie for its member firms. Different types of network ties also exist within a network (Elfring & Hulsink 2003, 2007). Elfring and Hulsink (2003) find that a mix of strong and weak ties is useful for gaining legitimacy and uncovering opportunity, while strong ties are primarily needed for resource acquisition. Strong ties are more long-term and binding and less diverse than weak ties. Both could be considered formal or informal depending on the tie's context.

Table 1 Here

DATA

The data was compiled from the ATDC membership database from its inception in 1980 until mid-2013. The dataset contains a list of companies that have participated in ATDC's programs. For each participant, the dataset identifies the name of the company, the start date and the end date of the membership, the type of membership distinguishing between ATDC basic members, VentureLab, and tenant members. We then added additional primary data for all firms through extensive database and

Internet searches.[1] Data on executives, founders, advisory board members, other board members and key organizational information such as company age, status as open or closed, physical address, and membership length were collected. Finally, we used information such as news articles and other reports available on ATDCs website and documents from ATDC to validate and complement the data regarding company membership length and type.

Our initial database consisted of 942 observations whose affiliation to ATDC covered the period from 1980 until end of March 2013. Those were listed as varying categories of member firms, administrative staff, investors, and partners of ATDC. We then narrowed our dataset to focus on technology-based firms. Technology firms are the largest category of firms served at ATDC and are fundamentally different than other kinds of firms served within the ESO. Technology firms include industries such as telecommunications, software, hardware, Internet services, biotechnology, etc. Non-technology firms include lawyers, banks, venture capital, plumbers, etc. We also excluded administrative staff and professional service firms such as accounting or law firms. This selection was performed manually by reviewing each firm and its business scope. This left us with a population of 895 firms. The dataset indicates the date of start and of end of membership for each firm, which we used to build measures of density of the ATDC network at each point in time.

To assess the role of proximity and support services as mechanisms that support tie formation we focused our analysis on the subsample of firms that was most appropriate to capture those effects. In particular, we focused on the 766 firms that were listed as members of ATDC from August 2009 until March 2013. In August 2009 there was a shift in the scope of services provided by ATDC and at that time ATDC started to serve all Georgia firms. This created a natural experiment allowing us to examine the various impacts on network formation by distinguishing between tenant and non-tenant firms, and among those between those located in Atlanta versus those located in Georgia but outside Atlanta. We then searched for formal ties each of those firms had established over time with other firms members of the ATDC. In this search we considered as potential network ties not only the 766 firms, but the whole list of 895 technology firms.[2] We excluded firms for which no information could be retrieved. We also excluded firms for which it was not possible to assess their existence or whether any formal link was established with other members of the incubator. The newness of some member companies means some may not

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[1] Search included: company websites, Dunn and Bradstreet Million Dollar Database, Hoover's Company Profile (ProQuest), Factiva, Mergent Online, Business Source Complete (EBSCO), Reference USA, Business Insights Global (Gale), LexisNexis "Corporate Affiliations", www.corporationwiki.com, and www.marketvisual.com, Georgia Secretary of State corporation database.

[2] The entire sample is from 1980 to 2013 and represent 896 firms. The year ATDC opened its gate to the entire state of Georgia technology firms was 2009. Hence, to evaluate the differences we focused on the years 2009-2013.

have actually ended up actually operating. This resulted in a reduction of 436 firms. Thus the final sample on which the analysis is performed consists of 330 firms. One distinctive feature of our data is that it includes a large sample of start-up firms that have less than 10 employees—a group of firms that most publicly available data sources tend to discard.

For the 330 technology firms remaining in our sample, we constructed each company's network from the 895 potential network tie partners. Board interlocks, or interlocking directorates, may be considered a type of formal, strong network tie. Mizruchi (1996, pp. 271) defines interlocking directorates as occuring "when a person affiliated with one organization sits on the board of directors of another orgnaization," further stating they "have become the primary indicator of interfirm network ties." Board members imitate the actions of other board members, influencing corporate activity through social networks (Haunschild 1993; Westphal et a. 2001). Board interlocks influence information provision, signal firm quality, and enahnce the likelihood of entering R&D alliances (Gulati & Westphal 1999; Sullivan & Yang 2013). The interlocking directorate is the basis of the ATDC member firm network we investigate. As outlined next in the data section, we expand the network to include founders and executives operating in the same positions or as board members in other companies. The names of the founders, executives, board members, and scientific advisory board members of each company that were collected through our database and Internet searches were used to analyze connections between firms. We coded the lists to indicate when a firm's founders, executives or board members are founders, executives, or board members of other ATDC companies in the dataset to create a two-mode network representing a focal firm and all possible individual level links to other ATDC firms (organizations to individuals).

Variables

Dependent variable. The dependent variable is the network centrality of firm X_i, '*Network Size*', indicating the cumulated number of linkages formed until June 2013 with other firms through individuals. A tie is identified when an executive, the founder(s), or board member(s) is or has been involved in one of these functions in other company member of ATDC. As each tie identifies a contractual relationship it is assumed to be a reciprocal tie.

Independent variables. To test Hypothesis 1, the effect of the ESO network's size and the role played by the ESO as anchor tenant of a network of relationships, we used the original full-size dataset of 895 firms. Here we considered the ESO to be the central node in a network of relationships, where each node is a past or a current member firm of the ATDC. We created a variable called '*Cumulated ESO Members-Total Firms*' which identifies the number of total connections (memberships) to ATDC in each point in time. This measure includes the total number of firms connected to the ESO as members up to the moment of end of the membership or end of the observation period (the year 2013) for each firm in the

sample. The sample of the total network includes a sub-sample of graduated companies, which may be considered more successful. By graduating these firms reached a milestone in terms of financial resources gained from the market, which might make them more attractive business ties for early start-ups.

To assess the role that geographic proximity plays in facilitating new relationships among firms (Hypothesis 2) we created a dummy variable, '*All Members-Atlanta Based*', assuming value 1 if the company is located in the city and value 0 otherwise. Identifying the effect of tenancy and service support played by ATDC (Hypothesis 3) required a more careful operationalization able to parse out proximity from service effects. To do so, we first operationalized the programs and services offered at ATDC with a set of indicator variables. Our dataset categorized companies as Basic, Tenant, and VentureLab members. Each membership type, as described previously, affords different services. Therefore dummies were created for types '*Tenant*' and '*VentureLab', leaving basic member as the comparison group*. The original database we received did not include the distinction between Accelerate and Signature tenants, therefore, for the purpose of our analysis we use one Tenant category. Figure 1 describes how both Accelerate and Signature memberships at ATDC provide access to a wider variety of services than a Basic membership. Thus, tenancy in our dataset indicates access to additional services. Moreover, after graduating from VentureLab some companies had the opportunity to join ATDC as tenant members. We identify those with a dummy variable for '*Tenant & VentureLab'*. While tenant and VentureLab identify two different support service types, both tenant and VentureLab firms benefited from office space at ATDCs Midtown location. Moreover, they both had access to higher level of service support than Basic Members. Finally, as Basic members could be located in Atlanta or outside it we also created a dummy variable '*Basic Members-Atlanta Based*' equal to one for Basic members located in Atlanta and zero otherwise to include in the full model to control for proximity. Table 2 describes those categories and their frequency in our sample.

Table 2 Here

Control variables. The sample included company-members of the ESO from 2009 until 2013 at different points in time and for different lengths of time (see Table 3). Moreover, as companies join the ESO at different development stages we introduced three variables to control for potential confounding effects related to these differences. First, because the length of membership can impact a firm's network within a community, we observe the length of time the company has been an ATDC member in days ('*Membership Length*'). Second, company age, a standard organizational level variable, is included. The variable '*Firm Age*' is operationalized as the number of days between the date of incorporation or the date of ATDC membership, whichever was earlier, and the earliest date between the end of June 2013 (end of data collection) and the date of closure. Third, a variable indicating a broad industry categorization was created. A firm might require more or less contact with other firms depending on its industry and the

existing resources of the firm (Ahmad & Ingle 2011), its critical contingencies, and core technologies (Thompson 1967). Moreover, since homophily is a strong natural pressure in small world networks (Aldrich & Kim 2007), start-ups belonging to industries with greater representation in ATDC may have larger business networks by nature of having access to more individuals in the same industry. Using the ATDC's membership database categorization of firms by industry, we identified the main industries and classified the companies into five clusters: *'Internet Industry', 'Software, 'Biotechnology/Life Science Industry', 'Mobile/Telecommunications Industry',* and *'Other Industry'*.

Table 3 Here

METHODOLOGY

We used a zero inflated negative binomial (ZINB) model to test our hypotheses. The ZINB model is a mixed model - a model that incorporates two distributions - and is well suited to the context of the present analysis. Our dependent variable, the number of formal network ties of a new venture, has a non-negative discrete distribution and is characterized by a long right tail. While both these characteristics are typical of a Poisson process, the over dispersion of the distribution and the large number of observed zeros, likely causing the overdispersion, make Poisson and mixed Poisson models such as the Negative Binomial and Zero Inflated Poisson inadequate for our estimations (Gurmu & Trivedi 1996). To confirm that a Poisson distribution did not provide the best fit for our dependent variable we estimated our model with all the predictors using a Poisson model and performed a goodness of fit post-estimation test. The high value of the chi-squared further confirms the presence of overdispersion.

The ZINB model fits the data on the assumption that two processes generate the observed values of the count variable: one process that generates positive values and "random zeroes" and another process that generates only "structural zeroes". For the ZINB model to be appropriate we must satisfy this assumption. We argue two different scenarios can explain the observed zeroes of our network density variable, i.e. those firms that lack connections among members of the entrepreneurial community, satisfying this assumption. The first scenario concerns those firms that were unable to form formal linkages with others in the community. For firms in this category, the observed zero is a structural characteristic of their situation. The second scenario concerns companies that have the characteristics and resources that could, in principle, lead them to connect with other firms, but have not. In other words, there are companies with some probability of establishing a network and other companies with no probability of establishing a network.

To estimate these different situations the ZINB model incorporates two models. A negative binomial (Wennberg et al. 2011) model explains the factors affecting the size of the network while a logit model estimates the likelihood a firm falls into the "structural zero" category. We argued previously that

the crucial dimensions for establishing a connection within a community are the length of time an entrepreneur spends within the community and the age of the firm. We assume that the longer the length of time spent as a member the more likely the entrepreneur will not fall into a situation of being unable to connect with other members, being a structural zero. Similarly we expect that the younger the firm the more likely it will not have enough need for or resources to acquire a business network tie. These firms will always have a zero network size, whereas other firms will have a zero network size with varying degrees of probability. With these assumptions, we use the variables '*Membership Length*' and '*Firm Age*' as explanatory variables in the logit model of the propensity to be in the "random zero" or "structural zero" groups. To validate the use of the ZINB model we compared the ZINB against the zero inflated Poisson using the likelihood-ratio (LR) test. The significant LR indicated the ZINB model was preferred.

Table 4 Here

Limitations

Before presenting our results we acknowledge a few limitations of our study. First, one of the preliminary steps in cleaning our dataset was the exclusion of firms for which we could not find social network information. Taking this step meant we could not account for these firms, thereby introducing possible selection bias. Second, the analysis examines firms within one ESO. We therefore acknowledge the possibility of selection bias because the firms that chose to be part of this organization may be systematically different from other firms. This limits our ability to generalize our findings to firms outside ATDC. Third, our data set includes the pooled formal ties between firms at ATDC from 2009-2012. As such we have the total number of ties in a specific time frame but we have no knowledge of ties before 2009 or how they have developed after 2012. However, as the companies joining the business support center are early stage start-ups, we assume that at the time of the start of their membership they had not yet established a formal structure and formal ties with other members of the community.

RESULTS

We find confirmation for all of our hypothesized effects. In particular, we find service support and geographical proximity have a strong impact on the size of member firms' networks. On the other hand, though positive, the impact of the size of the ESOs cumulated network (its cumulated membership size) is relatively small. Estimation results are reported in Table 5.

The baseline model in column two of Table 5 introduces our control variables. Interestingly, in none of the models did the industry of the focal firm have an effect. Model 1 introduces the variables related to the ESO cumulated membership. Model 2 introduces the effect of proximity. Model 3 in the

fourth column of Table 5 reports the effects of tenancy and service support on network centrality. Column five of Table 5 specifies the full model where all variables are included simultaneously. After estimating the full model we calculated the predicted probabilities of the number of ties for each category of members –holding the rest of the continuous predictors to their mean and the other dummies to zero. The results indicate that a Basic Member not in Atlanta has on average 0.12 ties, a Basic Member in Atlanta and who participated in VentureLab has on average 0.4 ties, a tenant firm has 1.8 and being a Tenant and a VentureLab company will have on average 1.5 ties. The logit/inflated results at the bottom of Table 5 for the ZINB models predicts for all the models except Model 2 that as the length of the membership increases member firms will be less likely to fall in the structural zero category. The age of the firms instead is not significant in the logit part in any of the models estimated.

Effect of the Cumulated Membership Base (Hypotheses 1). Model 1 tested the hypothesis that the anchor organization, the ESO, facilitates the creation of business ties by managing the membership, and therefore the potential pool of connections, cumulated over time. We find statistically significant effects of ATDC's cumulated membership size on the network size of individual firms. As the cumulative number of member firms increases, members are more likely to have a larger network. While the effect is positive and statistically significant, they are not large effects. Holding all other variables constant, the marginal effect of a one firm increase in the size of the cumulated ATDC membership is an increase in the size of a firm's individual formal network of 0.003 ties. Still, it provides support for Hypothesis 1. This positive, significant effect is confirmed in the full model.

Effect of Proximity (Hypothesis 2). The results in Model 2 indicate the importance of locating within the ATDC's city. The estimated coefficient for the ESO's member firms located in Atlanta is positive and statistically significant, indicating that member firms located in Atlanta will have larger business networks than members located outside of Atlanta. These results therefore confirm our second hypothesis that member firms located in the same city as an ESO will have higher number of business ties than members not located in the same city.

The marginal effect - computed at the mean of all continuous variables and at the median of all dummy variables and fixing the expected probability of being an excess zero at its mean- indicates that firms located in Atlanta are associated with an average increase of 0.9 ties compared to those not located in Atlanta. Finally, in the full model we account for this effect by identifying those firms that are based in Atlanta, as split into Basic, Tenant, VentureLab, and Tenant & VentureLab members. The results in the fifth column of the Table 5 show that even after taking into account the effect of the cumulated membership size, those Atlanta-based firms have positive and significant coefficients. This confirms that proximity is a strong predictor of a firm's network.

Effect of Support Services (Hypothesis 3). In Model 3 we compared how different types of memberships, each benefiting from a different service level, influences the opportunity to establish formal ties among the ESOs' members. As mentioned above, office space within the same location of the ESO is part of the enhanced support service, this enable close interaction with other member firms and with ESO's staff. The group of member firms receiving this higher level of support (codified as Tenant, VentureLab, and Tenant & VentureLab) are compared to firms with only Basic Membership (independently from their geographic location). The results from Model 3 show those firms that were Tenant and Tenant & VentureLab have positive and significant coefficients, which indicate that members who benefit from a higher level of support have larger networks than Basic members. To gain insight on the predicted number of ties we calculated the marginal effect comparing Tenant, VentureLab, and Tenant & VentureLab companies to Basic Members. The estimation of the marginal effect suggests that a Tenant firm has on average 0.9 ties more than a firm with Basic Membership, holding all other variables constant. Finally, a firm that has been in VentureLab and a tenant in the ESO has 1.0 predicted ties more than a Basic member, holding all other variables constant. Companies that are only participants of VentureLab do not have a significant benefit in term of business ties compared to Basic members. This finding makes sense in light of the fact that VentureLab companies are earlier stage and therefore may be less likely to have already created official boards, making interlocks less likely.

Full model. Finally, the last column of Table 5 provides the results of the full model. The results show the effect of enhanced service support when the effect of the membership size and the effect of proximity is taken into account. As noted previously, to account for the effect of proximity in the full model we added an indicator variable to the full model, '*Basic Members-Atlanta Based*', that allowed us to split Basic members into two categories: Atlanta based Basic members and non-Atlanta based Basic Members. In other terms, in this model the comparison group includes member firms not located in Atlanta and the impacts of all the other membership categories (Basic Members in Atlanta, Tenant, VentureLab, Tenant & VentureLab) in firm tie formation are assessed in relation to it. The full model allows us to gain further insight into the effect of service support by assessing it in relation to the effect of proximity. By comparing the predicted number of ties for Basic members in Atlanta, VentureLab members, and Tenant & VentureLab members to Basic members not located in Atlanta we were able to discern the relative impacts of service and location. The results show that all the different categories have positive and significant coefficients, which indicate that Basic Members in Atlanta, Tenants, VentureLab and Tenant & VentureLab companies have higher predicted number of ties than Basic Members not in Atlanta. Moreover, the marginal effects show that Basic members in Atlanta and VentureLab firms have roughly the same marginal effect equivalent to 0.6 more ties compared to Basic members not located in Atlanta. The combination of going through VentureLab and also being a tenant has a positive and

significant effect on firms' network size. However, the benefit in terms of network size for Tenant & VentureLab companies compared to Basic Members not located in Atlanta is equivalent to the benefit that Tenant companies have compared to Basic Members not located in Atlanta (1.1 more ties), which suggests that the support received by tenants firms is the main factor driving the creation of business ties.

To conclude, according to our results, locating as a tenant within the incubator, whether at the "Accelerate" or "Signature" level, is the most important factor influencing members' network size. When we look at the full model, the results indicate that even when controlling for the effect of the ESO's cumulated membership size the effect of the tenancy persists. Overall these results indicate that service support is an important predictor of network size.

Table 5 Here

Robustness checks and further analysis

To test the robustness of our results we re-estimated our model using alternative specifications. First, we tested our hypotheses using Poisson and negative binomial models. The results confirmed the significance of geographical proximity, service support, and ESO's network size. Further, we considered a logit specification. This alternative approach required the dichotomization of our dependent variable, i.e. assigning value 0 to firms with no ties and value 1 to firms with one or more ties. Though the dichotomization reduced the level of accuracy of the information provided by the variable such an approach is often used to simplify estimation when a variable has a highly skewed distribution characterized by a large number of zeroes (MacCallum et al. 2002). Such estimation aims to predict the likelihood of tie formation focusing on the differences between the group of firm with ties and the group of firms with no ties, rather than on the individual differences among firms. In this sense, it is based on a different set of assumptions than the zero inflated negative binomial. These differences imply that the results from a zero inflated negative binomial and a logit model are not completely comparable, however the logit specification allows us to gain different insight into the determinants of tie formation.

We used a robust logit estimation to estimate the model. The logit estimation indicated positive and significant effects of geographical proximity and service support on the likelihood of establishing a tie. In particular, all member types with offices located at ATDC - tenant, VentureLab, and tenant/VentureLab firms - are more likely to form ties than non-tenants (the Basic Members). Moreover, the results indicate Basic Members located in Atlanta are more likely to form ties than Basic Members not located in Atlanta. However, contrary to our results the logit showed no effect of the size of the community on tie formation.

We also considered the effect of possible outliers. As the dependent variable is a cumulated centrality of firms' networks, dropping information related to nodes can have important implications for the results. In our dataset, three firms were identified as possible outliers as they had a greater number of

cumulated connections over time with other members of the ESO community. We re-estimated the ZINB model by dropping those firms and found support for all our hypotheses with the exception of the ESO's cumulated membership size (Hypotheses 1). The coefficient is positive, but not significant at the p-value < 0.05 level, though it is significant for the p < 0.10 level. As another robustness check we added a variable to the model for the size of each firm's network that included only connections to firms that were members at the same time as the focal firm. Our main analysis, as stated previously, includes all past and present ATDC members as connections in each firm's network. This variable was not statistically significant and subsequently dropped from the estimation. The variable's insignificance confirms that our findings are not driven by firms connecting to other firms that were members of ATDC at the same time, rather that the support services at ATDC actually influences network size.

In addition to performing some robustness checks we considered gaining further understanding of the role of the ESO network by focusing on a specific subsample of the total network: the network of graduated companies. i.e. those companies that have been members of the incubator and have achieved some important milestones in their growth. To account for their role we calculated the size of this network as the cumulated number of graduated companies up to the moment each focal firm left the ESO. As this represents a subsample of the total network, not surprisingly, it has a pairwise correlation coefficient with ESO's total network of 0.9. We then re-estimated model 1 substituting the variable 'Cumulated ESO Members-Total Firms' with a variable for the cumulated number of graduated firms, 'Cumulated ESO Members-Graduate Firms'. The results showed a positive and significant effect (coefficient of 0.09, p<0.01). We then substituted the cumulated graduates variable for the cumulated member firms variable in the full model and also found a positive and significant effect. However, the marginal effect of the cumulated number of graduate firms in the full model indicated that the cumulated network of graduates increases the number of ties only by a factor of 0.02. Therefore, we find the effect of cumulated network size is small, whether considering the entire membership base or just the most successful subset of members.

DISCUSSION

There exists an extensive literature on the role of universities in technology transfer and local economic development. Within this literature are a significant number of studies reviewing the role of universities in technology transfer and academic spin-off activities. Missing from these is an empirical analysis of the mechanisms that allow universities' entrepreneurial and commercialization support organizations to contribute to the development of members' networks. This study opens and looks into the black box of the relationship between the ESO and the network to examine some of the correlates of incubators and the resultant firm ego network. With this analysis we are able to speak to the underlying

mechanisms that have an effect on the establishment of network ties among member firms. We build on the current literature by empirically supporting existing studies' findings regarding the general importance of universities. We extend the literature by elucidating the specific mechanisms of network tie formation among firms in an entrepreneurial community. In particular, the results of this analysis point to the importance of the services offered at the ESO. Service to firms, including a small workspace and office support, educational programs, and network building has an extensive impact on young companies' network formation. In an environment where incubators and accelerators are becoming a common public policy, this study highlights the need to expend our knowledge on what is happening within incubators/accelerators.

Our results for Hypothesis 1 support existing literature on the impact of embeddedness into a network of entrepreneurs. Entrepreneurial support organizations with a large membership base may have an advantage in fostering network ties (larger network of past and present members, more graduates). Similar to Hallen and Eisenhardt (2012), we find the social network itself can lead to more ties by facilitating access to other potential partners.

Our second finding that proximity of members in the same city results in a higher number of business ties indicates the importance of geographical proximity and confirms existing studies on the importance of geographical proximity and knowledge transfer (Whittington et al. 2009; Owen-Smith & Powell 2004). On the other hand, Broekel and Boschma's (2012) "proximity paradox" is not confirmed in our data.

These findings also support what we know about the importance of universities, in general, and universities' incubators in particular as source of social capital. Universities provide a physical meeting space, but they are also an anchor organization that facilitates ties by managing their pool of historical network of member firms. Importantly, as stated by Feld (2012), it is not necessarily the interaction with other members of the incubator itself that impacts firms' ties, rather it is the benefits received through the connection and affiliation with the anchor organization. At ATDC tenancy means locating on campus and obtaining access to multiple resources. Moreover, it means close proximity and access to the city of Atlanta's innovation district, Technology Square in which ATDC is located. The district hosts the Georgia Department of Economic Development, the Georgia Tech Business School, and the university's Enterprise Innovation Institute all within several blocks from one another. The plethora of events, companies, and individuals that ATDC tenant members have the potential to meet and exchange knowledge with is undoubtedly beneficial to them.

Our final finding indicated the importance of program participation, i.e. incubator services. First, we found an increase in the focal firm's network size through a comparison of basic members and tenants. While in hypothesis 2 we found locating within the same city is important, here we confirm that

membership levels providing either a small workspace or a dedicated, larger space allowing firms to constantly being in contact with other ESO members increases the chances that a firm will develop strong business ties. The uniqueness of the empirical context where different membership levels could be identified and the impact of proximity and tenancy could be assessed comparatively, i.e depending on the type of membership - make these results particularly relevant. Second, we examined the impact of participating in multiple programs (Tenant and VentureLab membership), finding a positive impact of multiple program participation on firms' network centrality. There is limited literature explaining the impact of service offerings within an incubator. Partly, this is due to incubator selection process and the specific firms choosing to be member of such an organization, it is difficult to find studies that can identify a direct causal link between incubator programs and network formation. In this analysis, we evaluate how different levels of service and support are associated with the likelihood of establishing a business network with other members. Firms that have matriculated through VentureLab and then stayed on at the incubator as tenants have more ties than basic members or firms that have gone through only the VentureLab program. Participation in different programs introduces firms to both other members but also to additional resources, which results in more ties. While our results cannot delineate the impact of any one specific program, it does support our hypothesis that exposure to other member companies and resources have a positive impact on firms' networks.

In summary, our analysis finds that geographical proximity and in particular co-location within the same space has a strong impact on members' network. The analysis expands our knowledge on co-location and highlights the importance of ESO service. By examining firms within the city and controlling for tenancy, we can see the value added in the location within the incubator/accelerator. In addition, the study finds that participating in multiple entrepreneurial support organization programs has a positive impact on firms' network. Lastly, we find that the characteristics of the community itself (network size cumulated over time and share of graduates) have a positive impact on members' networks. These results contribute to theory on the role of universities in entrepreneurship and economic development as well as the literature on social networks by uncovering the mechanisms by which ESOs contributes to firms' development. Proximity and co-location, programming, and a large past and present membership base increase opportunities to establish business ties with other member firms.

CONCLUSION

This study peers into the black box of the relationship between the ESO and the network to examine the impact of incubators on member firm ego networks. With this analysis we are able to speak to the underlying mechanisms that have an effect on the establishment of network ties among member firms. We build on the current literature by empirically supporting existing studies' findings regarding the

general importance of universities. We extend the literature by looking at the specific mechanisms of network tie formation.

To our knowledge this paper presents one of the first empirical analyses of the mechanisms of business network formation among start-ups in an entrepreneurial community. The results confirm the importance of proximity, program participation, and number of firm members. They also encourage us to look further at the question of start-up support services. ATDC is a unique case where a university provides commercialization services to a larger, state-wide base of firms. Though some public universities in the USA and abroad may have a similar wide service base, most university ESOs provide services only to university students, faculty, and staff. As such, we must be carious with the generalization of the Georgia Tech case. That said, this case still emphasizes the importance of higher education in promoting new ventures, transferring knowledge to the community, and contributing to local economic development. By peering into the "black box" of incubator programming, this paper also sheds light on the role government institutions can play in supporting such efforts. Understanding that an incubator's ability to impact local economic development and entrepreneurial ecosystems through the incubation process rests on its available stocks of resources and network capital can help policy makers decide whether to support incubators and how to make the investment. Future research is called for to answer the following questions: What features in the ESO programming contributes to the increase in network size? How many events do members need to attend? What kind of events? How much impact does the ESO's management expertise and experience level have on the firms' network? Data limitations meant we were not able to evaluate these questions in this paper. In future research we would also like to investigate whether the network size as moderated by the ESO services has an impact on firm outcomes such as firm size, growth, and financial status.

Implications

The study also has a number of practical implications for policymakers, entrepreneurial support organizations, entrepreneurs, and university administrators. For policy makers, this research raises finance questions. When evaluating incubators and accelerators, the ability to understand the impact of the ESO's success is based on firms' ability to graduate from the incubator, grow their firms, and create jobs and new products. Hence, it may be beneficial to challenge publicly funded ESOs to disclose their impact measures. Understanding how often and how long firms require to graduate and survive or successfully exit into the marketplace can indicate the ESO's ability to make a positive impact. Thus, policy makers may want to consider funding ESOs by the breadth of programming and the ability to provide tenancy, as an evidenced way to facilitate impact. Second, ESOs ought to focus on programs that foster community building. The results from this study indicate that embedding start-ups into a network of firms rather than

silos of start-ups is important for network size. This paper illustrates a strong effect of program participation and ESO strategy. Hence, not all such organizations will have a positive impact. Their management and selection strategy and their ability to provide the resources members need has an impact on firms' network and as such on their ability to develop and grow. Lastly, for start-up firms, this study highlights the question of which ESO to choose. Not all firms have an option. But for those that may choose, they should evaluate ESOs, and particularly university ESOs, based on more than their service and programmatic offerings and the size of the membership base. Furthermore, they should consider joining local ESOs and locating on-site if tenancy is an option. For university administrators, the question of investment in an ESO is still unanswered. This study does not evaluate the benefits of these kinds of programs for the university itself. However, most higher education institutions receive government funding and as such are required to be a "contributing citizen" for their region and country. Considering the ability of an ESO to increase firms' network and as such to have a positive impact on these firms' growth, ESOs provide an avenue for universities to serve both their faculty and students but also the community in which they reside.

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TABLES

Table 1. Membership Types

Member Category*	ATDC Residence?	In Atlanta?	Membership Features
Basic	No	Yes/No	Members firms which pay basic membership fee to access ATDC program and services but do not have shared offices in ATDC
Tenant (Signature and Accelerate)	Yes	Yes	Members with office space in ATDC allowing them preferential access to incubator type services
VentureLab	Yes	Yes	Firms which deal with technology created in Georgia Tech and are supported with a tailored program for early stage start-ups. Those companies can, after graduating from VentureLab, move to the next level of support and join the ATDC as members or tenants.
Graduate	Yes/No	Yes/No	Members that reached some milestones (revenues or capital raised). After graduating a firm leaves ATDC location but retain basic membership

Table 2. Membership Categories and Location

Membership Type	Frequency	Percent	Cumulative
Tenant	25	7.58	7.58
VentureLab	22	6.67	14.24
Tenant & VentureLab	18	5.45	100.00
Basic Member – Atlanta Based	133	40.30	54.55
Basic Member – Not Atlanta Based	132	40.00	94.55
Total	330	100.00	

Table 3. Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Network Size	330	0.48	1.72	0	19
All Members-Atlanta Based	330	0.60	0.49	0	1
Basic Members-Atlanta Based	330	0.42	0.49	0	1
Tenant	330	0.08	0.27	0	1
VentureLab	330	0.07	0.25	0	1
Tenant & VentureLab	330	0.05	0.23	0	1
Cumulated ESO Members-Total Firms	330	784.95	118.61	466	897
Firm Age	330	1817.49	1151.62	20	6575
Log(Firm Age)	330	7.31	0.65	3.00	8.79
Membership Length	330	527.08	347.57	89	2707
Log(Membership length)	330	6.02	0.77	4.49	7.90
Internet Industry	330	0.22	0.41	0	1
Software Industry	330	0.26	0.44	0	1
Biotechnology/Life Science Industry	330	0.17	0.38	0	1
Mobile/Telecommunications Industry	330	0.12	0.33	0	1
Other Industry	330	0.22	0.42	0	1

Table 4. Correlation Table

	Number of Ties	All Members - Atlanta Based	Basic Members – Atlanta Based	Tenant	VentureLab	Tenant & VentureLab	Cumulated ESO Members - Total Firms	Internet Industry	Software Industry	Biotechnology/Life Science Industry	Other Industry	log(Membership Length)	log(Firm Age)
Number of Ties	1												
All Members -Atlanta Based	0.174	1											
Basic Members – Atlanta Based	-0.0251	0.688	1										
Tenant	0.179	0.234	-0.148	1									
VentureLab	0.00990	0.218	-0.225	-0.0765	1								
Tenant & VentureLab	0.196	0.196	-0.202	-0.0688	-0.0642	1							
Cumulated ESO Members - Total Firms	0.152	0.160	0.00430	0.209	-0.034	0.178	1						
Internet Industry	0.0184	0.0270	0.151	-0.0403	-0.141	-0.0623	-0.110	1					
Software Industry	0.0404	-0.101	-0.0854	0.0366	0.0055	-0.0831	0.0102	-0.316	1				
Biotechnology/Life Science Industry	-0.00220	-0.036	-0.0759	0.0207	0.0064	0.0314	0.0967	-0.241	-0.273	1			
Other Industry	-0.00500	0.137	-0.0194	-0.0146	0.150	0.194	0.0625	-0.282	-0.319	-0.244	1		
log(Membership Length)	0.0859	0.064	-0.218	0.132	0.161	0.225	-0.146	0.0183	0.148	-0.106	-0.0134	1	
log(Firm Age)	-0.0336	-0.119	-0.0775	-0.100	0.0080	-0.00780	-0.206	-0.144	0.130	0.0994	-0.0655	0.229	1

Table 5. Zero Inflated Negative Binomial Estimation Results

	Baseline Model	Model 1 (Cumulated Members)^	Model 2 (Proximity)	Model 3 (Service Support)	Full Model
Network Size Coeff.					
Cumulated ESO Members-Total Firms (H1)		0.006*** (0.002)			0.003* (0.001)
All Members-Atlanta Based			1.801*** (0.382)		
Tenant (H3)				1.931*** (0.556)	2.389*** (0.630)
VentureLab (H3))				0.484 (0.427)	1.310* (0.524)
Tenant & VentureLab (H3))				1.969** (0.649)	2.351*** (0.640)
Basic Members-Atlanta based (H2)					1.218** (0.389)
Log(Membership Length)	0.023 (0.275)	-0.007 (0.251)	0.059 (0.276)	-0.596 (0.275)	-0.418 (0.244)
Log(Firm Age)	0.030 (0.205)	0.342 (0.180)	0.007 (0.237)	0.081 (0.218)	0.204 (0.212)
Industry (Mobile/Telecomm. = reference)					
Internet	1.100 (0.732)	.660 (0.792)	0.0840 (0.652)	0. 383 (0.643)	0.322 (0.364)
Software	1.264* (0.595)	0. 284 (0.792)	1.271 ** (0.557)	0. 804 (0.648)	0.434 (0.649)
Healthcare	0.739 (0.555)	-0.069 (0.828)	0.788 (0.606)	1.106 (0.683)	-0.058 (0.751)
Other	0.945 (0.692)	0. 124 (0.826)	0. 657 (0.641)	-0.035 (0.642)	-0.276 (0.678)
Constant	-0.864 (2.302)	-7.327** (2.489)	-2.435 (2.365)	2.787 (2.339)	-0.628 (2.121)
Logit (Inflated) Model					
Log(Membership Length)	-0.711* (0.329)	-0.691* (0.284)	-0.627 (0.327)	-0.882** (0.308)	-0.819** (0.304)
Log(Firm Age)	0.549 (0.307)	0.523* (0.257)	0.439 (0.336)	0.468 (0.344)	0.385 (0.323)
Constant	-1.163 (2.475)	-1.311 (2.012)	-1.118 (2.869)	2.703 (2.559)	2.706 (2.652)
N. observations	330	330	330	330	330
Non-zero observations	57	57	57	57	57
Wald chi2	7.50	24.65***	31.85***	25.45**	42.34***
Pseudo log likelihood	-247.383	-240.209	-238.050	-236.424	-229.977

*p<0.05, ** p<0.01, *** p<0.001. Robust standard errors in parentheses.

^ Cumulated number of firms that have been members of or graduated the business center up until the focal firm's membership end-date (excluded the focal firms).
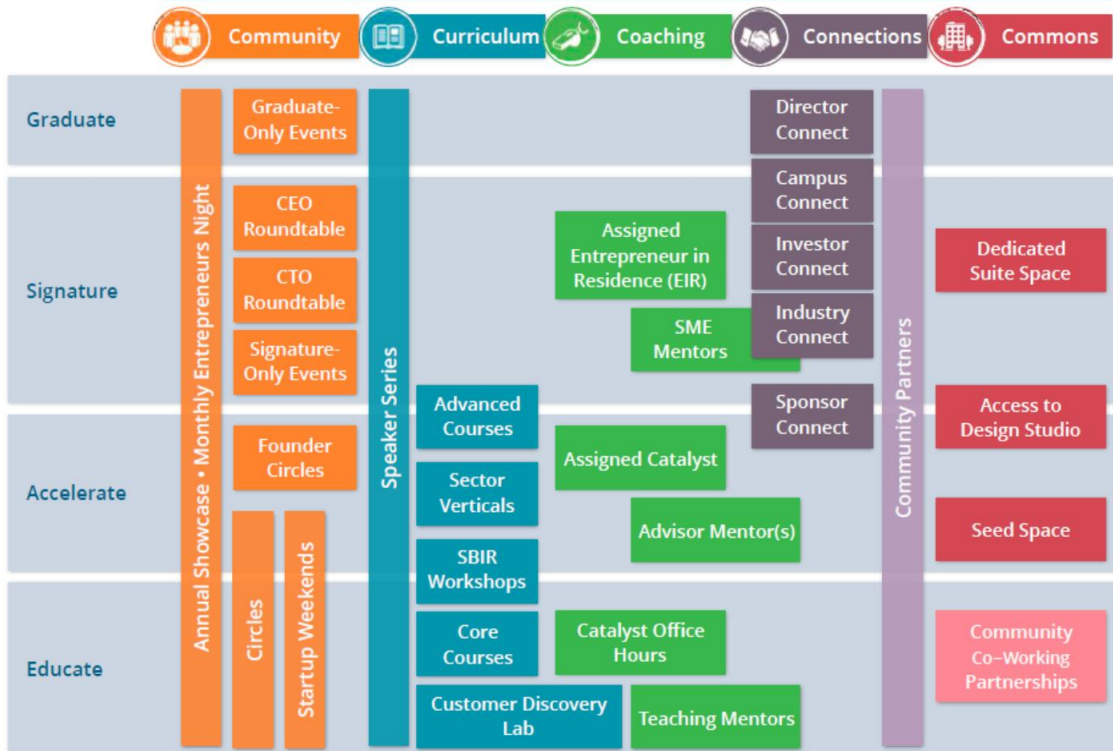
Figure 1: ATDC Service Offering. The figure breaks down the different services avilable to firms at the ATDC. Source: Stephen Fleming 2016.