

Social Networks: Mechanisms for Building Academic Entrepreneurs' Social Capital

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Abstract

The present paper examines social networks and their impact on academic entrepreneurs' social capital. Academic entrepreneurs (AEs) face unique challenges associated with commercialising their research. Social capital results from building relationships that serve to facilitate and support a common goal. Social networks are the framework created by personal, professional, and business relationships and can serve a mechanism for increasing AEs' social capital by compensating for AEs' social skill deficiencies. A systematic review of evidence revealed that social networks increased AEs' social capital. Findings from cross case analysis of relevant evidence are synthesized and presented according to identified common themes. The final sections present conclusions, scholarly and practical implications, and limitations of this review.

Keywords: Social Networks, Academic Entrepreneurs, Social Capital

Background

Commercialisation of academics' research substantially increased with the passing of Bayh-Dole Act in 1980, which provided protection of intellectual property generated under federal grants and supported universities' ownership of such, pushing them to adopt entrepreneurial strategies (Etzkowitz, 1998). Etzkowitz (1998) described transformational changes that occurred between academia and industry throughout the 1980s and 1990s that resulted in "the growth of a commercial ethos within academia" (p. 824) and coined the term "entrepreneurial university." Concurrently, academic scientists realised the possibilities of gaining financial support for conducting and receiving personal financial benefits from commercialising their research (Etzkowitz, 1998). Consequently, academic scientists pursued a variety of pathways to commercialise

their research and expanded their roles in business through the creation of spin-off companies, technology transfer activities, and licensing innovation (Shane & Venkataraman, 2000).

More recently, Meek and Wood (2016) stated that "a plethora of basic research is conducted on university campuses" (p. 1093), a subset of which could lead to commercially viable innovation. The ability for universities to capitalise on innovation depends on academic scientists' recognising opportunity for innovation, disclosing their research results, and participating in the commercialisation process (Bercovitz & Feldman, 2008; Meek & Wood, 2016).

Evidence has shown that academic entrepreneurs face challenges that hinder commercialisation of their research results. Literature has described a failure to recognise opportunities for innovation, focusing on the publication of research rather than innovating, and a lack of social skills required for obtaining necessary resources and building social capital as specific challenges academic entrepreneurs face (Vohora, Wright, & Lockett, 2004). As academic scientists are essential for creating new knowledge and advancing science for the benefit of health and regional economic development, failure to successfully commercialise scientific innovation precludes advances for their personal and societal benefit (Siegel, Veugelers, & Wright, 2007).

Social networks are the mechanisms by which entrepreneurs access knowledge, resources, and specific competencies. Social networks also provide a framework for improving social skills and increasing social capital (Greve & Salaff, 2003). They provide access to and control of information and support innovation (Granovetter, 2005).

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Social capital refers to the goodwill that is engendered by the fabric of social relations that can be mobilised to facilitate action (Adler & Kwon, 2002). Social capital accelerates entrepreneurship and is the product of social skills such as perception, impression, and adaptation management (Baron & Markman, 2000; Chong & Gibbons, 1997; Walker, Kogut, & Shan, 1997).

This paper provides a review of literature related to academic entrepreneurs, social networks, and social capital for answering the question, “In what ways might social networks assist in building social capital to compensate for social skill deficiencies of academic entrepreneurs?” A proposed conceptual framework provides a foundation for review and interpretation of the evidence and findings. Next, thematic analysis and synthesis of results follow a description of systematic review methodology. Lastly, the review discusses conclusions, implications for research, practice, and limitations.

Literature Review

Academic Entrepreneurs

Academic entrepreneurship describes activities that result in the identification of commercialisation opportunities originating from faculty research that has revenue-generating potential (Wood, 2011). Academic entrepreneurs must overcome challenges associated with the newness of ventures, which can include competing goals of scientists, universities, and industry partners, and academic entrepreneurs’ lack of social skills necessary for commercialising their research results (Aldrich & Fiol, 1994).

Gaining Legitimacy through Trust and Social Context

Entrepreneurs face unique challenges associated with gaining legitimacy for their innovations and new ventures. Aldrich and Fiol (1994) conducted some of the earlier work relating to entrepreneurs’ strategies for launching innovation and establishing new industries. They stated that innovating entrepreneurs face challenges when developing new ventures that are different from those supported by established organisations. Aldrich & Fiol (1994) recognised that pioneers of new businesses lack cognitive and sociopolitical legitimacy, which is a critical need that can impact whether a new venture fails to move beyond early stages of development or succeeds

as a commercial product. Cognitive legitimacy refers to the extent of knowledge regarding a new venture, and sociopolitical legitimacy relates to the level of acceptance that stakeholders and others hold for the venture (Aldrich & Fiol, 1994).

The authors indicated that social contexts provide a framework for entrepreneurs to construct favourable environments for gaining legitimacy. This framework begins with building trust, which was stated to be essential for all social connections in the context of uncertainty, and continues as reliability and reputation are established (Aldrich & Fiol, 1994). The authors argued that establishing trust, reliability, and reputation are the first steps in constructing a connection between individual entrepreneurs and organisational formation. Therefore, new organisations must be built on entrepreneurs’ existing skills or establish relationships through which they gain essential competencies (Aldrich & Fiol, 1994).

Further, Aldrich & Fiol (1994) proposed that entrepreneurs need to develop skills in communicating their innovations to potential investors and stakeholders using prior knowledge and framing their innovation to convey its credibility. The authors stated that entrepreneurs’ communication and issue framing skills influence their capacity to champion their innovations through demonstration of their confidence, vision, and innovative actions (Aldrich & Fiol, 1994).

Academic Entrepreneurs’ Unique Challenges

AEs are important actors for disseminating new knowledge, recognising opportunities for knowledge innovation, and commercialising scientific discoveries for the societal benefit (Miller et al., 2015; Siegel et al., 2007).

Wood (2011) described a multi-stage process model of academic entrepreneurship designed to increase chances of sustaining a commercialised innovation’s revenue generation. Wood (2011) proposed that the first stage of academic entrepreneurship begins in the laboratory and is much earlier than the literature suggests, which is at disclosure of intellectual property to the Technology Transfer Office (TTO). A challenge associated at this stage of development was scientists’ failure to disclose innovations or discoveries due to their lack of motivation, incentives, or university policies requiring disclosure. Additional challenges associated with this stage of intellectual property protection included high costs related to regulatory and patenting requirements and the unknown viability of innovation at this juncture. The author

suggested that academic scientists may not be interested in developing their discoveries beyond the publication of their research results, which provides them with the reputation capital they seek, but denies the university an opportunity for the maximum financial benefit.

The second stage described the need for attracting industry partners able to develop and market innovation. Wood (2011) suggested that establishing a network of relationships across industries is essential for success in commercialising research. Determining the commercialisation potential of university scientists' innovations was identified as the next stage of academic entrepreneurship and occurs early in the innovation's development. This determination requires an accurate understanding of the potential market value, which may not be possible at that stage (Wood, 2011). Further, Wood (2011) proposed that in the fourth stage, commercialisation, academic entrepreneurs face challenges associated with securing key resources, sustaining research and development, establishing markets, actively marketing their innovation, and identifying distribution channels and strategic networks.

Academic Entrepreneurs' Competencies and Deficits

AEs are a key driver of innovation but lack social skills necessary for developing entrepreneurial competencies and commercialising innovations (De Silva, Uyerra, & Oakey, 2011; Vohora et al., 2004).

Vohora et al. (2004) conducted a field study of university spin-outs and identified "critical junctures" (p. 150) related to academic entrepreneurs' characteristics that must be surmounted as the spin out moved through phases of development. A group of activities at each of the five stages moved innovation from research, opportunity framing, pre-organisation, re-orientation and sustainability (Vohora et al., 2004). The authors identified opportunity recognition, entrepreneurial commitment, credibility, and sustainability as key junctures through which ventures pass. However, deficiencies in AEs' social capital, resources, and translating resources and knowledge into value led to the ventures' failure to do so (Vohora et al., 2004). The authors proposed that increased levels of social capital through networks, partnerships, and linkages were the mechanisms that facilitated movement through critical junctures of venture development (Vohora et al., 2004). The authors argued that challenges associated with AEs' successfully spinning off ventures were due to their

inability to reconcile science and business goals and their lack of entrepreneurial capabilities, business experience, and social capital necessary for recognising innovation opportunities (Vohora et al., 2004).

Proposition 1: Academic entrepreneurs may lack social skills necessary for commercialising their research.

Social Networks

The prior research described social networks as mechanisms that provide resources, skills, and support for entrepreneurs in areas in which they are lacking.

Social Network Ties

Granovetter's (1973) seminal work depicted social networks as a configuration of relationship ties. His early model of the strength of relationship ties proposed to relate the power of interpersonal interactions to larger phenomena, including social mobility, cohesion, and diffusion. The author empirically examined network ties to test his hypothesis that strong ties (those between individuals with whom there is an existing direct relationship) and weak ties (those between persons with whom there existed an indirect relationship) are both essential components of one's network. Further, Granovetter (1973) argued that weak network ties provide connections to unique resources, ideas, information, and opportunities well beyond one's inner circle and are essential to one's network. Later, he argued the importance of establishing social networks that include a combination of relationships based on strong and weak ties to ensure diversity in perspectives and information sharing across networks (Granovetter, 2005).

Social Networks' Impact on Funding

Shane and Cable (2002) studied network ties and described their influence on venture funding decisions. The authors examined the impact of network ties and entrepreneurs' reputation on investors' decision to finance new ventures, controlling for type of investor, industry, expected market and other variables. They found that social ties predicted investment decisions in the context of controlling for other factors. Factors that significantly predicted funding decisions included the technology, business plan, and the amount of financing requested. Further, the study results demonstrated that direct and indirect ties strongly positively correlated with decisions to fund. However,

their results indicated that information received from indirect ties overruled direct ties (Shane & Cable, 2002). Interestingly, results indicated that an entrepreneur's reputation moderated the effects of direct and indirect ties. In other words, social ties had no impact on the finance decisions after public diffusion of an entrepreneur's reputation. Therefore, establishing a favourable reputation through social relationships could be substantial for entrepreneurs (Shane & Cable, 2002).

Social Network Configuration and Evolution

Greve and Salaff (2003) examined entrepreneurs' networks and how they are utilised and mobilised at different phases of enterprise establishment. These are the motivation, planning, establishment, and taking over the firm phases (Greve & Salaff, 2003). The researchers asked entrepreneurs with how many individuals they had discussed plans for starting their own business in the previous six months, how many hours they spent cultivating and maintaining those relationships, and at which entrepreneurial phase the discussions occurred (Greve & Salaff, 2003). Their findings indicated that social relationships were essential for establishing a firm and throughout each phase of development. In the early start-up phases, entrepreneurs limited the size of their social networks to their closest relations and expanded their networks for planning the startup and for building and maintaining network contacts. After establishing or taking over a firm, entrepreneurs selectively reduced the size of their networks, keeping only the most significant and helpful ties (Greve & Salaff, 2003).

Proposition 2: Social networks provide entrepreneurs with resources, information, and support necessary for commercialising their research.

Social Capital

The Value of Social Capital

Social capital refers to "the goodwill that is engendered by the fabric of social relations that can be mobilised to facilitate action" (Adler & Kwon, 2002).

Burt (1997) researched the contingent value and impact of social capital measured by network constraint on managers' early promotion within their business. He found that early promotions were associated with greater social capital. Burt (1997) described the importance of social capital as organisations moved away from bureaucratic

and hierarchical models to networked structures, improving adaptability to market changes. He argued that managers need to adapt by coordinating informal control mechanisms and communicating through interpersonal networks. Thus, successful managers were those with increased social capital (Burt, 1997).

Network Structure as a Source of Social Capital

Later, Burt (2000) proposed that network structure is a source of social capital. He posited that network structure provides a type of social capital that can lead to competitive advantage for individuals or groups (Burt, 2000). Building on Granovetter's (1973) earlier work of network ties, Burt (2000) argued that weak ties be structural holes in social structures and could be advantageous to an individual whose network spanned those holes. He further claimed that brokering information flows across structural holes provided the broker with project control and opportunity for bringing non-redundant ties together for creating competitive advantage (Burt, 2000).

Building Social Capital through Networks

Adler and Kwon (2002) argued that an individual's social network provides a means for building social capital. They defined social capital as "the goodwill available to individuals or groups. Its source lies in the structure and content of the actor's social relations. Its effects flow from the information, influence, and solidarity it makes available to the actor" (p. 23). Further, they described social capital as a "relation, not a thing" (Adler & Kwon, 2002, p. 27) and proposed including potential opportunities and resources available through an individual's social relations be considered valuable (Adler & Kwon, 2002). The authors presented a conceptual framework of social capital that included opportunity-motivation-ability. First, they proposed that an individual's network ties create opportunities for leveraging resources through network ties and their contacts. Next, the authors suggested that motivation for activities relevant to social capital originate from individuals and collective groups based on trust and the potential for generalised reciprocity on social exchange. Third, they argued that the degree to which network ties are valuable is their ability to provide the individual with essential resources. Lastly, the authors stated that the value of social capital lies in the ability of network ties to support a targeted task, how they are influenced and perceived by environmental norms and attitudes, and their complementarity with other network sources.

McKeever, Anderson, and Jack (2014) described social capital as both a process and outcome, as the term expresses social interactions and the structure and results of those interactions. They qualitatively examined how social capital works in the context of entrepreneurship. The authors posited that social capital provided a basis on which to build capacity for achieving a shared vision. They constructed a conceptual framework for examining social networks as a mechanism for building and sustaining social capital. They reported that entrepreneurship was a social process influenced by shared social norms, values, and understanding. The authors argued that social capital was essential for entrepreneurial activities and served to bond members of the network through participation and social belonging for striving for a common outcome (McKeever et al., 2014).

Proposition 3: Social capital might expand academic entrepreneurs' social networks.

Theoretical Lens

Social capital theory provides the theoretical lens through which this research views the influence of social networks on academic entrepreneurs' social capital. Extensive theoretical and empirical work has supported social capital's influences on executive compensation, workers finding jobs, and career success (Belliveau, O'Reilly III, & Wade, 1996; Burt, 1992, 2000; Granovetter, 1973). Further, social capital has been shown to accelerate entrepreneurship and start-ups (Chong & Gibbons, 1997; Walker et al., 1997). Social capital is an outcome of social skills, particularly social perception, impression management, and social adaptability (Baron & Markman, 2000). An advantage of having a high level of social capital is the accessibility of stakeholders and information in the early stages of innovation (Baron & Markman, 2000). Further, Baron and Markman (2000) proposed that superior social skills positively influence social capital.

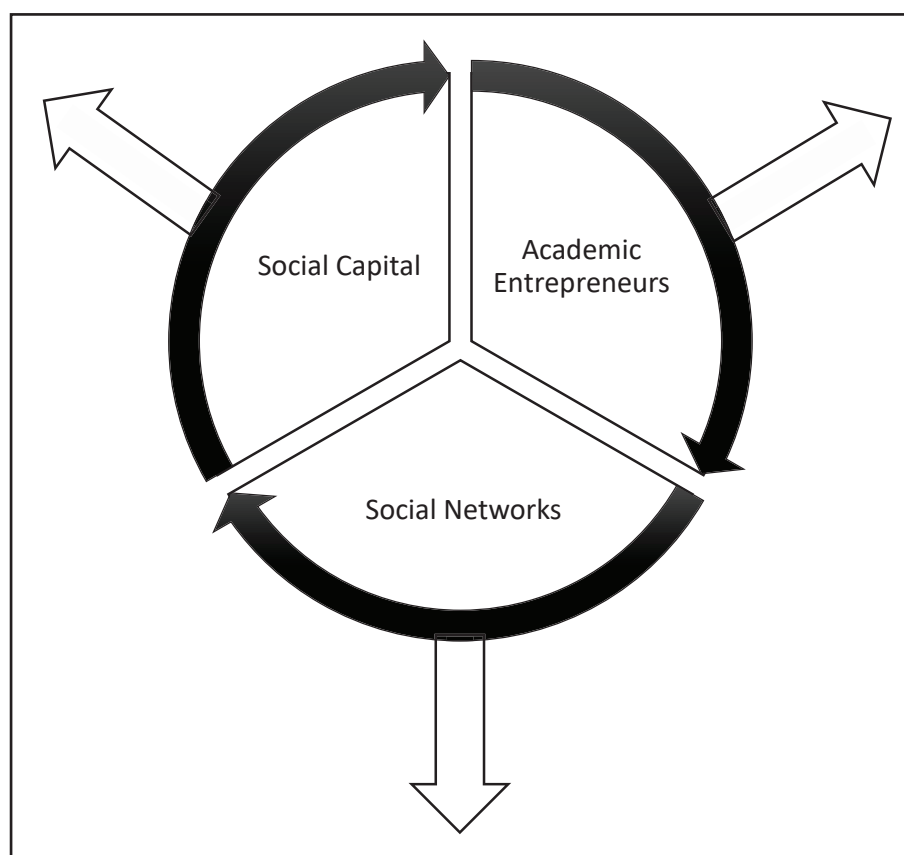


Fig. 1: Conceptual Framework

Fig. 1 depicts a continuous process of social network influence on academic entrepreneurs' social capital. Based on the literature, social networks facilitate access

to information and resources that support entrepreneurial activities. Direct (strong) and indirect (weak) network ties provide access to non-redundant information and resources

that increase entrepreneurs' social skills and enhance their social capital. Academic entrepreneurs need to acquire social skills such as communication and relationship building, which they lack and can obtain these through network ties. In turn, developing resources and social skills increases social capital and expands social networks. As academic entrepreneurs expand their social networks, they continue to develop social skills, which increases their social capital. The breaks in the connections between the three concepts in the figure above and the three arrows pointing outwards from the cycle, represent an ongoing expansion of academic entrepreneurs' social skills, social networks, and social capital.

Claim

Academic entrepreneurs can increase their social capital by deliberately configuring social networks that compensate for their lack of social skills necessary for commercialising their research.

Method

This paper implemented systematic review as the method for identifying, critically appraising, and synthesising evidence to answer the research question. The reviewer consulted with UMUC library services to identify appropriate search terms and to develop several search strings suitable for locating relevant evidence. Search terms included (“academic entrepreneur*” OR “colleg* entrepreneur*” OR “university entrepreneur*”) AND network*, which produced 83 non-duplicate, scholarly, English language articles. Title and abstract screening were conducted for the 83 sources returned from the search. Articles that focused on academic entrepreneurs and their social networks were included for review. Articles were excluded that contained relevant search terms but focused on something other than academic entrepreneurs' social networks.

Snowball technique produced additional articles for background and literature review. A total of 16 articles that focus on the influence of social networks on academic entrepreneurs' social capital are included in this review. Appendix A contains a PRISMA diagram.

This reviewer utilised a Weight of Evidence Framework (WOE), developed by researchers at The Evidence for Policy and Practice Information and Coordinating Centre

(EPPI-Centre) to appraise the articles selected for thematic synthesis critically (Gough, Oliver, & Thomas, 2012). In WOE appraisal, evaluation considers the soundness and quality execution of individual studies, including study design, analysis, and appropriateness for answering the research question (Gough et al., 2012). Individual article WOE results are presented in Appendix B.

Findings

Cross-study analysis and synthesis revealed several themes related to the research question, “In what ways might social networks assist in building social capital to compensate for social skill deficiencies of academic entrepreneurs?” Results of thematic synthesis discussed in the following pages will focus on (1) academic entrepreneurs' characteristics, (2) social network configuration and features, and (3) specific social capital impact.

Academic Entrepreneurs Characteristics

Skill Building through the Social Network

A qualitative study of eight university spinoffs by Borges and Filion (2013) explored how AEs' immersion in university networks influenced their social capital and spinoff ventures. They found that social capital changes with the size and diversity of contacts. Particularly, university-affiliated entrepreneurs have access to built-in social networks, which provide access to infrastructure, resources, and business expertise (Borges & Filion, 2013). The University's social network helped establish social capital through meeting opportunities and providing liaisons between individual entrepreneurs and network contacts. Network contacts provided consulting sessions or courses that developed the AE's communication and relationship building skills and increased their recognition of the need for social capital and how to use it best (Borges & Filion, 2013).

Academic Entrepreneurs' Competencies

Rasmussen, Mosey, and Wright (2015) stated that social networks are essential for spinning out university innovations and identified three entrepreneurial skills developed through social networks. These skills were opportunity refinement, resource acquisition, and

innovation championing. The authors found that social networks were iterative and transformed over time. They stated that AEs established social networks to build specific competencies for a stage of a startup. Weak ties facilitated opportunity recognition in early stage ventures and helped AEs change their focus from research to business (Rasmussen et al., 2015). Subsequently, an iterative process of re-purposing was seen through the transformation of weak ties into strong ties as the venture matured, which helped to secure relationships and sustain funding. The authors proposed that AEs should establish social networks that could be purposefully transformed over time, depending on desired competencies for a certain stage of innovation (Rasmussen et al., 2015).

A study by Maritz (2010) examined networking, entrepreneurship, and productivity in universities. He posited that social networks foster entrepreneurship. The author focused on three facets of social interaction: presence or absence of network ties, network configuration, patterns and density of connections. Maritz (2010) found that social network models, density, and configuration matter. He argued that network ties can be re-purposed for different needs and the frequency of social interactions influence entrepreneurial activities. Specifically, the frequency of social network interactions predicted entrepreneurs' productivity (Maritz, 2010).

Role Identity and Entrepreneurial Attitude

Social networks affect role identity and self-efficacy (Liabaers & Wang, 2012). In their study of foreign-born Ph.D. students, Liabaers and Wang (2012) reported that the students did not view themselves as entrepreneurs, but viewed themselves more as academics with entrepreneurial characteristics. The authors attributed this perception to the students' social networks and cultural distance. Further, the authors proposed that the students' cultural distance and social networks could result in less interaction with US-born colleagues, which is necessary for developing networks. Even though foreign-born students were more successful in raising funds, they were not as comfortable translating research to innovation, which the authors attributed to the nature of their social networks (Liabaers & Wang, 2012).

Bienkowska and Klofsten (2012) found that social networks positively influenced and supported academic entrepreneurship. The authors posited that Ph.D. students from entrepreneurial universities developed

positive attitudes towards commercialising their research results because of their networking through programme placements. They found that students placed at entrepreneurial firms demonstrated increased interest in commercialising their research results and students placed at other universities showed the least interest in commercialising their research results. The authors argued that external collaboration increased students' interest in commercialising research results and suggested that students with increased entrepreneurial interests could serve as role models for incoming Ph.D. students, contributing to a culture of entrepreneurship (Bienkowska & Klofsten, 2012).

Continuing the work of Maritz (2010), a later study examined the role of social ties in fostering innovativeness (Salaran & Maritz, 2013). The authors considered structural, relational, and cognitive aspects of social capital and found that the time spent with social ties increased academics innovativeness. The frequency of communication was used to measure time spent with social ties. Innovativeness was measured by the academics' presenting new research topics and presenting new ideas to business. Social interaction predicted innovativeness, as increased social interaction increased AEs innovativeness (Salaran & Maritz, 2013).

Social Network Configuration and Characteristics

Social Network Specificity

A study by Johannisson (1998) examined the content, structure, and dynamics of the personal networks of leaders from four Swedish entrepreneurial firms. He reported that young, knowledge-based entrepreneurs were more motivated in their networking activities than their senior counterparts, and developed their networks based on strong personal, professional, and business ties. Johannisson (1998) also found that knowledge-based entrepreneurs were more purposeful than traditional entrepreneurs in establishing their social networks, and created different types of social networks based on specific desired requirements, such as location. They also found that, over time, knowledge-based entrepreneurs disconnect from academic duties and associate more with business communities such as industrial science parks (Johannisson, 1998).

A longitudinal study by Mosey and Wright (2007) assessed differences in the types of network structures that nascent,

novice and habitual entrepreneurs established. They found that the social networks of nascent entrepreneurs were comprised mainly of experienced academic colleagues who could aid with opportunity recognition and access to other AEs (Mosey & Wright, 2007). Novice entrepreneurs established broader social networks that assisted in gaining credibility and provided greater access to essential financial, market and industry resources. While habitual entrepreneurs had the highest number, they were more discerning in forming their social network ties and established social ties that provided specific knowledge and skills (Mosey & Wright, 2007).

Lans, Blok, and Gulikers (2015) found that location and network type matters when attempting to increase social capital. To whom entrepreneurs are connected matters, as existing network connections may not have the resources or expertise that entrepreneurs seek. The authors posited that relationship strength does not equate to specific need or competency. They found that networks evolved over time to adapt to a firm's changing needs. In early phase ventures, faculty composed their business networks of contacts that reflected their primary professional environment as university faculty. This composition produced high capital but did not accelerate spinoff (Lans et al., 2015).

More recently, Hayter (2016) examined social networks of AEs and their relationship to entrepreneurial development. The author investigated the contacts, composition, contributions, and evolution of networks among faculty entrepreneurs. He found that AEs' social networks were loaded with other academic contacts, which generated social capital but not necessarily to accelerate spinoff development due to their lack of business knowledge (Hayter, 2016). The author also reported that AEs viewed technology transfer offices (TTOs) as the first point of contact for building networking relationships. However, he suggested that there is a major gap that university spinoffs must close between academic, social, and entrepreneurial networks. He argued that connections to contacts outside TTOs may be better for providing resources and connections needed for spinning off innovation (Hayter, 2016).

Social Network Balance

Hirai, Watanabe, and Inuzuka (2013) identified a need for optimal balance between non-redundancy and cohesiveness of social network ties. They proposed that

non-redundancy increases access to diverse sources of information and new ideas and facilitates innovation through the integration of network intelligence. The authors stated that sharing information and network intelligence is based on cooperation and trust, requiring cohesiveness in network ties. In circumstances of weak ties, non-redundant contacts may be less willing to trust and share critical, confidential information. Hirai et al. (2013) proposed that an ideal social network configuration would consist of enhanced non-redundancy in external advice networks, balanced with strong relationships to network business contacts).

Social Network Heterogeneity

Nicos and Birley (2003) assessed the influence of social networks on academic spin-outs and focused on the involvement of key scholars. They found that AEs' networks were less heterogeneous than business entrepreneurs and suggested that hybrid spinout structures would benefit AEs by exposing them to more business contacts. In hybrid structures, the AE retains a university position but holds a position within the company. Subsequently, interactions with heterogeneous networks predisposed AEs to become more involved in the innovation process (Nicos & Birley, 2003).

Social Capital

Social Networks Increase Social Capital

Mosey and Wright (2007) examined the influence of social networks on nascent, novice and habitual entrepreneurs' social capital development. They found consistent differences in the human and social capital between entrepreneurs who had previously succeeded in venture development and those who had not. Nascent entrepreneurs lacked network relationships that could assist with opportunity recognition. Novice entrepreneurs utilised network connections such as TTOs and other advisors to address opportunity recognition. However, habitual entrepreneurs had built network ties with industry partners, potential customers, financiers, and professional managers. The authors reported the longer time as an entrepreneur, the more social capital the individual acquired through social networks (Mosey & Wright, 2007).

Social Capital and Preferred Access

Borges and Filion (2013) further reported the influence of social networks on social capital. They proposed social capital changes with the size and diversity of network contacts and academic entrepreneurs build social capital by being immersed in built-in social networks associated with spinoff incubators. These networks provided access to infrastructure, resources, and business expertise. AEs' close physical proximity to network contacts facilitated increased interaction, which increased their social capital and credibility. Proximity also provided them access to preferred resources and helped to build legitimacy for their innovations. The authors stated that university social networks helped form social capital through providing opportunities for meetings and serving as liaisons between individual entrepreneurs and other network contacts. Increasing contacts through university networks developed the individual entrepreneur's social skills that assist in communication and relationship building. Further, individual entrepreneurs developed a recognition of the need for social capital and how to use it best. This recognition led to entrepreneurs developing a more business-like mindset (Borges & Filion, 2013).

AEs Attitudes and Self-Efficacy

Fernandez-Perez, Alonso-Galicia, Rodriquez-Ariza, and Fuentes-Fuentes (2015) described further development of social capital. They looked at social networks' (personal and professional) impact on academic entrepreneurs' intentions (likelihood of starting own business with five years from research results). The authors found that social networks provided information and emotional support for AEs. They stated that entrepreneurial attitudes and self-efficacy were the mechanisms through which social networks influence academic entrepreneurial intentions and positively mediated the AE's entrepreneurial intentions. The authors found that mentors positively influenced AEs' intentions as they were more likely to start a business within five years from research results. Network connections through a professional forum had less effect on AEs' intentions (Fernandez-Perez et al., 2015).

Endorsement

Hayter (2016) proposed that social networks facilitate access to knowledge and other enabling resources, building

credibility with financiers. In a study of 79 academic entrepreneurs, he reported that AEs' social networks were comprised of administrators, advisors, faculty and companies' researchers, service providers, public entrepreneurship support personnel, and TTO support staff. The composition of social networks changed with stages of the venture, and the contributions of contacts adapted as the networks evolved (Hayter, 2016). The author argued that academic and non-academic network connections provide academic entrepreneurs with an "endorsement effect," (p. 487) by reducing investment risk and increasing knowledge exchange. As AEs developed competencies and their spinoff venture matured, their role changed from founding researcher/scientific expert to chief scientific officer or advisor (Hayter, 2016).

Conclusions

This review provided evidence to answer the question, "In what ways might social networks assist in building social capital to compensate for social skill deficiencies of academic entrepreneurs?" Research supports the relationship of social networks to academic entrepreneurs and their social capital. However, research has only partially supported one of the three propositions put forth in this paper. Proposition 1, which states that academic entrepreneurs may lack social skills necessary for commercialising their research, was not fully supported. The evidence revealed that academic entrepreneurs face unique challenges associated with commercialising their research, such as having less access to a broad scope of network connections and not perceiving themselves as entrepreneurs. The evidence indicated that AEs developed communication, networking, and relationship building skills through social networks. Interaction with social network ties positively impacted AEs' attitudes towards innovation and increased their involvement in the commercialisation of research. However, the studies reviewed did not consistently identify specific social skills deficiencies of academic entrepreneurs. Therefore it is not possible to conclude that social networks compensate for specific social skills deficiencies.

The evidence on social networks supported Proposition 2, which stated that social networks provide entrepreneurs with resources, information, and support necessary for commercialising their research. Social network configurations consisted of personal, professional, and business contacts that provided access to resources, knowledge, skills, and expertise that AEs needed for

commercialising their research. AEs designed social networks with specificity and flexibility that transformed over time and adapted to changing conditions. Social networks provided emotional support and increased AEs interest in commercialising research, self-efficacy, and innovativeness.

Proposition 3 stated that social capital might expand academic entrepreneurs' social networks and has been supported in this review. The evidence demonstrated that social networks increased AEs' social capital. Social capital provided AEs with preferred access to resources and was a catalyst for AEs receiving financial support and endorsement. As social capital increased, social networks expanded, resulting in increased social capital.

Implications for Scholars and Practitioners

The literature on social networks and social capital is plentiful. However, the research that addresses these constructs with specificity for academic entrepreneurs is less abundant. There is a definite need to further explore the constructs of academic entrepreneurs, social capital, and social networks. More scholarly work is required to explore types of network relationships that academics construct and the mechanisms by which this occurs. Future research is needed to examine how social capital is developed in the context of specific social network structures. Future research aimed at examining the role of universities and their agents could serve in assisting academic entrepreneurs to build social capital would be relevant. Finally, further inquiry into the specific characteristics and deficiencies of academic entrepreneurs is needed to address them. These areas are just a few identified challenges that could benefit from further exploration.

From a practitioner perspective, this research highlighted the importance of academic entrepreneurs establishing social networks that provide information and resources necessary for improving their social capital. University managers should consider internal operations and the potential for assisting academic scientists in this endeavour. For instance, managers could help in identifying needed resources and coordinate networking activities targeted to obtaining them. Further, they could assist AEs as they reach out to external agents for attaining skills, information, and connections essential for commercialising their research. Managers should consider how they can help academic entrepreneurs to strategically constitute social networks

that are comprised of strong and weak ties and are designed to increase their social capital.

Limitations

There are several limitations of this review. Specific social skills that AEs lack were not identified in all studies. The literature described benefits of social networks and social capital, but the relationship of those constructs to specific social skill deficits remains unanswered. A deeper understanding of social capital mechanisms is needed, which has not been achieved in this review. The individual studies did not fully describe the construct of social capital, limiting the interpretation and generalizability of the conclusions. This review is based on studies with significant heterogeneity of populations, national origins, organisations, and specific contexts. In a larger sample, heterogeneity could increase the strength of findings. However, in this small study, it limits the conclusions that can be drawn. Further exploration of the concepts examined would improve the quality of this review, which could be accomplished through a full systematic review.

References

- Adler, P. S., & Kwon, S. (2002). Social capital: Prospects for a new concept. *Academy of Management Review*, 27(1), 17-40.
- Aldrich, H. E., & Fiol, C. M. (1994). Fools rush in? The institutional context of industry creation. *Academy of Management Review*, 19(4), 645-670.
- Baron, R. A., & Markman, G. D. (2000). Beyond social capital: How social skills can enhance entrepreneurs' success. *The Academy of Management Executive* (1993-2005), (1), 106-116.
- Belliveau, M. A., O'Reilly III, C. A., & Wade, J. B. (1996). Social capital at the top: Effects of social similarity and status on CEO compensation. *Academy of Management Journal*, 39(6), 1568-1593.
- Bercovitz, J., & Feldman, M. (2008). Academic entrepreneurs: Organizational change at the individual level. *Organization Science*, 19, 6-89.

- Bienkowska, D., & Klofsten, M. (2012). Creating entrepreneurial networks: Academic entrepreneurship, mobility, and collaboration during Ph.D. education. *Higher Education, 64*(2), 207-222.
- Borges, C., & Filion, L. J. (2013). Spin-off process and the development of academic entrepreneur's social capital. *Journal of Technology Management & Innovation, 8*(1), 21-34.
- Burt, R. S. (1997). The contingent value of social capital. *Administrative Science Quarterly, 42*(2), 339-365.
- Burt, R. S. (2000). The network structure of social capital. *Research in Organizational Behavior, 22*, 345-423.
- Chong, L. H., & Gibbons, P. T. (1997). Corporate entrepreneurship: The roles of ideology and social capital. *Group & Organization Management, 22*(1), 10-30.
- De Silva, L. R., Uyarra, E., & Oakey, R. (2012). Academic entrepreneurship in a resource-constrained environment: Diversification and synergistic effects. In *Technology Transfer in a Global Economy* (pp. 73-97). Springer US.
- Ding, W., & Choi, E. (2011). Divergent paths to commercial science: A comparison of scientists' founding and advising activities. *Research Policy, 40*(1), 69-80. doi: 10.1016/j.respol.2010.09.011
- Etzkowitz, H. (1998). The norms of entrepreneurial science: Cognitive effects of the new university-industry linkages. *Research Policy, 27*(8), 823-833.
- Fernández-Pérez, V., Alonso-Galicia, P. E., Rodríguez-Ariza, L., & Fuentes-Fuentes, M. M. (2015). Professional and personal social networks: A bridge to entrepreneurship for academics? *European Management Journal, 33*, 37-47. doi:10.1016/j.emj.2014.07.003
- Granovetter, M. S. (1973). The strength of weak ties. *American Journal of Sociology, 68*, 1360.
- Granovetter, M. (2005). The impact of social structure on economic outcomes. *Journal of Economic Perspectives, 19*(1), 33-50
- Greve, A., & Salaff, J. W. (2003). Social networks and entrepreneurship. *Entrepreneurship: Theory & Practice, 28*(1), 1-22. doi:10.1111/1540-8520.00029
- Gough, D., Oliver, S., & Thomas, J. (2012). *An introduction to systematic reviews*. Thousand Oaks, CA: SAGE Publications, Ltd.
- Hayter, C. S. (2016). Constraining entrepreneurial development: A knowledge-based view of social networks among academic entrepreneurs. *Research Policy, 45*(2), 475-490. doi:10.1016/j.respol.2015.11.003
- Hirai, Y., Watanabe, T., & Inuzuka, A. (2013). Empirical analysis of the effect of Japanese university spinoffs' social networks on their performance. *Technological Forecasting and Social Change, 80*(6), 1119-1128. doi: 10.1016/j.techfore.2012.10.027
- Johannisson, B. (1998). Personal networks in emerging knowledge-based firms: Spatial and functional patterns. *Entrepreneurship & Regional Development, 10*(4), 297-312.
- Lans, T., Blok, V., & Gulikers, J. (2015). Show me your network and I'll tell you who you are: Social competence and social capital of early-stage entrepreneurs. *Entrepreneurship & Regional Development, 27*(7-8), 458-473. doi: 10.1080/08985626.2015.1070537
- Libaers, D., & Wang, T. (2012). Foreign-born academic scientists: Entrepreneurial academics or academic entrepreneurs? *R&D Management, 42*(3), 254-272. doi: 10.1111/j.1467-9310.2012.00682.x.
- Maritz, A. (2010). Networking, entrepreneurship, and productivity in universities. *Innovation, 12*(1), 18-25.
- McKeever, E., Anderson, A., & Jack, S. (2014). Entrepreneurship and mutuality: Social capital in processes and practices. *Entrepreneurship & Regional Development, 26*(5/6), 453-477. doi:10.1080/08985626.2014.939536
- Miller, F. A., Painter-Main, M., Axler, R., Lehoux, P., Giacomini, M., & Slater, B. (2015). Citizen expectations of 'academic entrepreneurship' in health research: Public science, practical benefit. *Health Expectations, 18*(6), 2356-2374. doi:10.1111/hex.12205
- Mosey, S., & Wright, M. (2007). From human capital to social capital: A longitudinal study of technology-based academic entrepreneurs. *Entrepreneurship: Theory & Practice, 31*(6), 909-935. doi:10.1111/j.1540-6520.2007.00203.x
- Nicos, N., & Birley, S. (2003). Social networks in organizational emergence: The University spinout phenomenon. *Management Science, 49*(12), 1702-1725. Retrieved from <http://www.jstor.org/stable/4133979>

Rasmussen, E., Mosey, S., & Wright, M. (2015). The transformation of network ties to develop entrepreneurial competencies for university spin-offs. *Entrepreneurship And Regional Development*, 27(7-8), 430-457. doi:10.1080/08985626.2015.1070536

Salaran, M. M., & Maritz, A. (2013). The role of social ties in fostering innovation. *Journal of Enterprising Culture*, 21(02), 227-244. doi: 10.1142/S0218495813500106

Shane, S., & Venkataraman, S. (2000). The promise of entrepreneurship as a field of research. *Academy of Management Review*, 25(1), 217-226.

Shane, S., & Cable, D. (2002). Network ties, reputation, and the financing of new ventures. *Management Science*, 48(3), 364-381.

Shane, S. (2004). Encouraging university entrepreneurship? The effect of the Bayh-Dole Act on university patenting in the United States. *Journal of Business Venturing*, 19(1), 127. doi:10.1016/S0883-9026(02)00114-3

Siegel, D. S., Veugelers, R., & Wright, M. (2007). Technology transfer offices and commercialization of university intellectual property: Performance and policy implications. *Oxford review of economic policy*, 23(4), 640-660.

Vohora, A., Wright, M., & Lockett, A. (2004). Critical junctures in the development of university high-tech spinout companies. *Research Policy*, 33, 147-175. doi:10.1016/S0048-7333(03)00107-0

Walker, G., Kogut, B., & Shan, W. (1997). Social capital, structural holes and the formation of an industry network. *Organization Science*, 8(2), 109-125.

Wood, M. S. (2011). A process model of academic entrepreneurship. *Business Horizons*, 54, 153-161. doi:10.1016/j.bushor.2010.11.004

Appendix A: PRISMA 2009 Flow Diagram

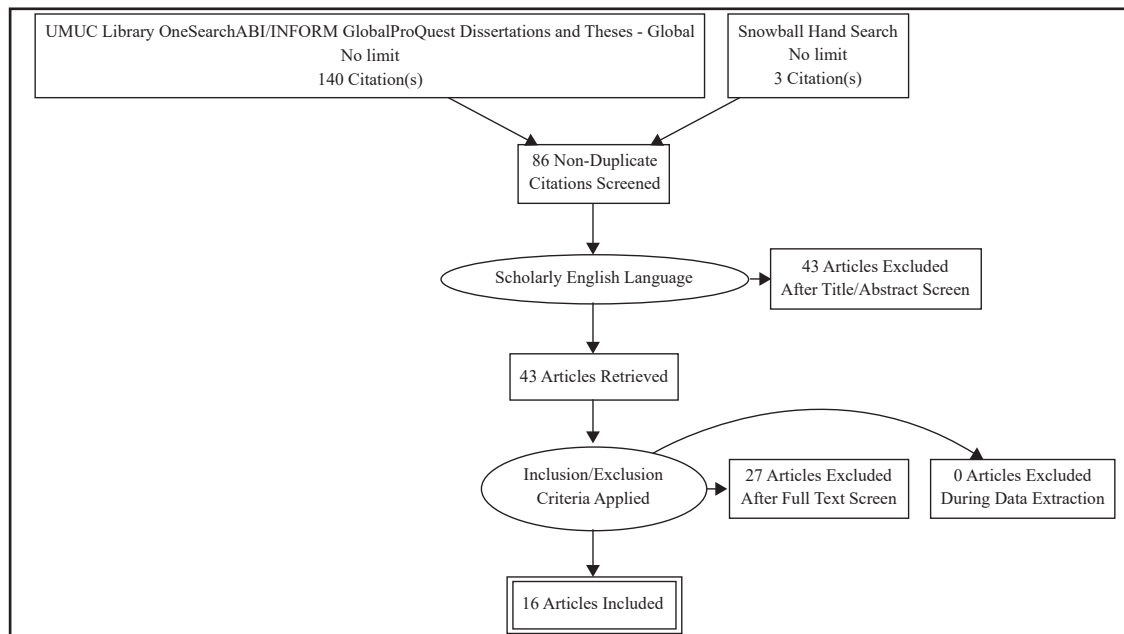


Fig. A1: PRISMA 2009 Flow Diagram

Source: Moher, D, Liberati, A, Tetzlaff, J, and Altman, DG (The PRISMA Group) (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement.

PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

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Appendix B: Study Characteristics/Weight of Evidence (WOE)

Table A1: Study Characteristics/Weight of Evidence (WOE)

Article Citation Date Chronologic Order	WOE	Type of Study/ Population	Network Characteristics	Effects/AEs/Social Capital
Johannisson, B. (1998). Personal networks in emerging knowledge-based firms: spatial and functional patterns. <i>Entrepreneurship & Regional Development</i> , 10(4), 297-312.	3	Study of leaders of young firms-avg. age 5 yr N=223 w/ ventures; Differentiating personal networking between knowledge based firms and small traditional firms	Egocentric/ sociocentric All linkages to environment; collective network; spatially concentrated; separable; serve specific purposes; dynamic	KBE more valuable than TRAD; density matters; SN build self-confidence; access to resources; KBE become detached from their academic environment over time; TRAD learn that they need to develop more personal networks
Nicos and Birley (2003). Social networks in organisational emergence: The university spinout phenomenon. <i>Management Science</i> , (12). 1702-1725.	3	45 spinouts prior to 2001; inventors N=111; survey/questionnaire; Academics roles in spinout	Instrumental/ expressive; interaction term/strength of ties	AEs exposure=less heterogeneity than business entrepreneurs; AEs limited experience in business; Networks positively influenced AEs to be more active in innovation process
Mosey and Wright, (2007). From human capital to social capital: A longitudinal study of technology-based academic entrepreneurs. <i>Entrepreneurship: Theory & Practice</i> , 31(6), 909-935. doi:10.1111/j.1540-6520.2007.00203.x	3	Longitudinal study Academic Entrepreneurs N=24; case studies; Engineer schools N=10; Applied science N=6; Heads of school N=10	Networks vary by type of entrepreneur: nascent; novice; habitual.	Nascent=research colleagues; Novice=broad social networks, reap rewards/critical resources; Habitual=most network ties, but very selective in the ties they create; Prior business experience =more social capital and venture development. Longer entrepreneur=more social capital
De Silva et al. (2012). Academic entrepreneurship in a resource-constrained environment: diversification and synergistic effects. In <i>Technology transfer in a global economy</i> (pp. 73-97). Springer US.	2	Case studies universities Sri Lanka N=13; academics N=4,215 online survey	Social networks; personal/ industrial partners;	Academics major driving force of entrepreneurship; Engaging in teaching related entrepreneurial activities enabled academics to develop network=engage in research related entrepreneurial activities; diversifying research=widened and strengthened social network; Increased diversity in social network=synergistic effects of teaching, research, venture

<p>Todorovic and Suntorpithug (2008). The multi-dimensional nature of university incubators: capability/resource emphasis phases. <i>Journal of enterprising culture</i>, 16(04), 385-410.</p>	<p>1</p>	<p>Proposed framework; Literature review academic entrepreneurs, university incubators</p>	<p>University incubator as social network</p>	<p>Network provides access to new ideas & resources to support AEs. Provided credibility and reputability; collaborators; knowledge sharing; promote learning; Incubator point of relationships; expedites social network; improves start-up efficiency/ effectiveness; COSTS</p>
<p>Maritz (2010). Networking, entrepreneurship and productivity in universities. <i>Innovation</i>, 12(1), 18-25.</p>	<p>2</p>	<p>Australian universities; academic staff N=5695; electronic survey</p>	<p>Social network=frequency of communication; network ties, density/ patterns, re-purposed</p>	<p>Social network and entrepreneurship effects on productivity and entrepreneurship; 3 facets of social interaction: network ties, configuration, integration. SN fostered innovativeness and increased productivity PREDICTS</p>
<p>Ding and Choi, E. (2011). Divergent paths to commercial science: A comparison of scientists' founding and advising activities. <i>Research policy</i>, 40(1), 69-80.</p>	<p>2</p>	<p>University scientists N=6138</p>	<p>Academic coauthors; AEs</p>	<p>Founders vs advisors; Social network helps explain commercialisation engagement; Founders benefit from task-specific social network ties; Network with other AEs = better navigating TTO, contracting, business venturing; Gender differences = negative for founding (female)</p>
<p>Libaers and Wang (2012). Foreign-born academic scientists: entrepreneurial academics or academic entrepreneurs? <i>R&D Management</i>, 42(3), 254-272.</p>	<p>3</p>	<p>Academic scientists in science & engineering N=2000; US universities N=150; Mailed questionnaires; databases, CVs,</p>	<p>Role Identity Theory; Social networks; culture</p>	<p>Foreign born & effects on grants/ productivity & entrepreneurial activity; Foreign born are more entrepreneurial- more successful raising funds; not as comfortable translating research to innovation; cultural distance & smaller social network= identity and self-view</p>
<p>Bienkowska and Klofsten (2012). Creating entrepreneurial networks: academic entrepreneurship, mobility and collaboration during Ph.D. education. <i>Higher Education</i>, 64(2), 207-222.</p>	<p>3</p>	<p>Swedish Ph.D. students N=464; web survey; Educational sciences, Arts & Humanities, Health Sciences; Science & Engineering</p>	<p>Social Network mobility and communication</p>	<p>Impact of social network on commercialisation of research results CRR; Many different potential groups of AEs-different needs; science & engineers more + attitude to CRR; mobility increase interest if placed at firms; external collaboration increases interest CRR</p>

<p>Hirai et al. (2013). Empirical analysis of the effect of Japanese university spinoffs' social networks on their performance. <i>Technological Forecasting and Social Change</i>, 80(6), 1119-1128.</p>	<p>3</p>	<p>Japanese university spinoffs; Chief decision makers N=79</p>	<p>External advice networks</p>	<p>Social networks=positive influence of non-redundancy in external advice networks but strength of ties is greater. Universities should construct nonredundant networks with specific strength of ties-strong relationships in business aspect; in the absence of strong ties, non-redundant contacts may be less willing to trust and share critical, confidential information</p>
<p>Borges and Filion (2013). Spin-off process and the development of academic entrepreneur's social capital. <i>Journal of technology management & innovation</i>, 8(1), 21-34.</p>	<p>3</p>	<p>Case studies; Academic Entrepreneurs N=8; Inductive exploratory; 2-4-year-old spinoffs; Interviews w/AEs N=22; Incubator employees N=13; secondary data sources</p>	<p>Universities' networks of relationships</p>	<p>AEs benefit from university affiliation=venture credibility, preferential access to contacts and resources; immersion; physical proximity increases interaction with contacts=AEs build their network; support staff=liaisons; AEs develop social & business skills; AEs build skills using social capital; cognitive proximity to business contacts</p>
<p>Salaran and Maritz (2013). The role of social ties in fostering innovation. <i>Journal of Enterprising Culture</i>, 21(02), 227-244.</p>	<p>3</p>	<p>Full-time academics N=271; University of Melbourne; online questionnaire;</p>	<p>Social Ties; Social Network;</p>	<p>Time spent with social ties=frequency of communication on innovativeness=presenting new ideas to business; increased social interaction increased innovativeness;</p>
<p>Fernández-Pérez et al. (2015). Professional and personal social networks: A bridge to entrepreneurship for academics? <i>European Management Journal</i>, 33, 37-47. doi:10.1016/j.emj.2014.07.003</p>	<p>3</p>	<p>Academic entrepreneurs at Spanish universities N=630</p>	<p>Professional and personal social networks</p>	<p>Social networks impact on academic entrepreneurs' intentions to innovate; moderated by entrepreneurial attitude & self-efficacy; social networks provide information and emotional support; mentors positively influence intentions more so than professional forums</p>

<p>Rasmussen et al. (2015). The transformation of network ties to develop entrepreneurial competencies for university spin-offs. <i>Entrepreneurship And Regional Development</i>, 27(7-8), 430-457. doi:10.1080/08985626.2015.1070536</p>	<p>3</p>	<p>Case study; university spinoffs N=4; Interview founders, team members, researchers, university managers, commercial support staff; N=54</p>	<p>Social networks</p>	<p>How do AEs form and develop social networks to construct entrepreneurial competencies need to establish spinoff? Initial startup-specific competency transforms over time; weak ties can become strong ties; 3 competencies opportunity refinement, resource acquisition, championing; leverage existing strong ties = increase resource acquisition and championing in early stage; later venture process=opportunity refinement relies on iteratively transforming weak ties with industry stronger ties</p>
<p>Lans et al. (2015). Show me your network and I'll tell you who you are: social competence and social capital of early-stage entrepreneurs. <i>Entrepreneurship & Regional Development</i>, 27(7-8), 458-473.</p>	<p>3</p>	<p>Academic spinoff entrepreneurs N=131; Netherlands university master's students enrolled in entrepreneurial skills course</p>	<p>Social skills; social competence</p>	<p>Personal capabilities=ability to develop social networks; self-promotion is key competence-directly influences structural aspects of social capital; Social competence increase with number of ties (strong or weak) and the range of occupations represented. Bonding vs. bridging social capital-managerial experience.</p>
<p>Hayter (2016). Constraining entrepreneurial development: A knowledge-based view of social networks among academic entrepreneurs. <i>Research Policy</i>, 45(2), 475-490.</p>	<p>3</p>	<p>Spinoff AEs N=79; social network surveys; interviews</p>	<p>Social network; business contacts</p>	<p>Contact, composition, contribution, and evolution of business networks of AEs; relationship of networks to entrepreneurial development; Network contribution relates to business stage; Advice, basic research, cofounder, establishment, academic/nonacademic + bridging; knowledge spinoff; services, seed fund; Dynamism</p>