UPFBE

Working Paper Series

2020/3

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Do specific entrepreneurial ecosystems favor high-level networking while others not? Lessons from the Hungarian IT sector

This publication was funded by the Higher Education Institutional Excellence Program of the Ministry of Innovation and Technology in Hungary, within the framework of the 4th thematic programme ”Enhancing the Role of Domestic Companies in the Reindustrialization of Hungary” of the University of Pécs. Grant Number: TUDFO / 47138/2019 – ITM.

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Do specific entrepreneurial ecosystems favor high-level networking while others not? Lessons from the Hungarian IT sector

This paper was published in Technological Forecasting and Social Change, available online 21 November 2021, at https://doi.org/10.1016/j.techfore.2021.121349

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Abstract

Each territorial unit is characterized by a specific entrepreneurial ecosystem (EE) consisting of interdependent actors and contextual factors that support or limit entrepreneurial innovation. Access to and mobilization of entrepreneurial resources is facilitated by social networks within the entrepreneurial ecosystem. However, the degree and quality of these networks are determined by various characteristics of the particular ecosystem itself. Using fuzzy-set Qualitative Comparative Analysis (fsQCA), we explored the configurations of micro, meso and macro conditions of the entrepreneurial ecosystem of ICT firms in a Hungarian city (Pécs), which result in high or very high-level networking performance. Our results show that certain ecosystems are capable of high-quality networking. In addition, we find that different ecosystem configurations are required for high informal, formal, or external networks.

Keywords

networking, entrepreneurship, entrepreneurial ecosystem, fuzzy QCA, regional development

Acknowledgement

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Tamás Sebestyén and *Ákos Tóth-Pajor* acknowledges support from the research project EFOP 3.6.2-16-2017-00017 "Sustainable, smart and inclusive regional and city models".

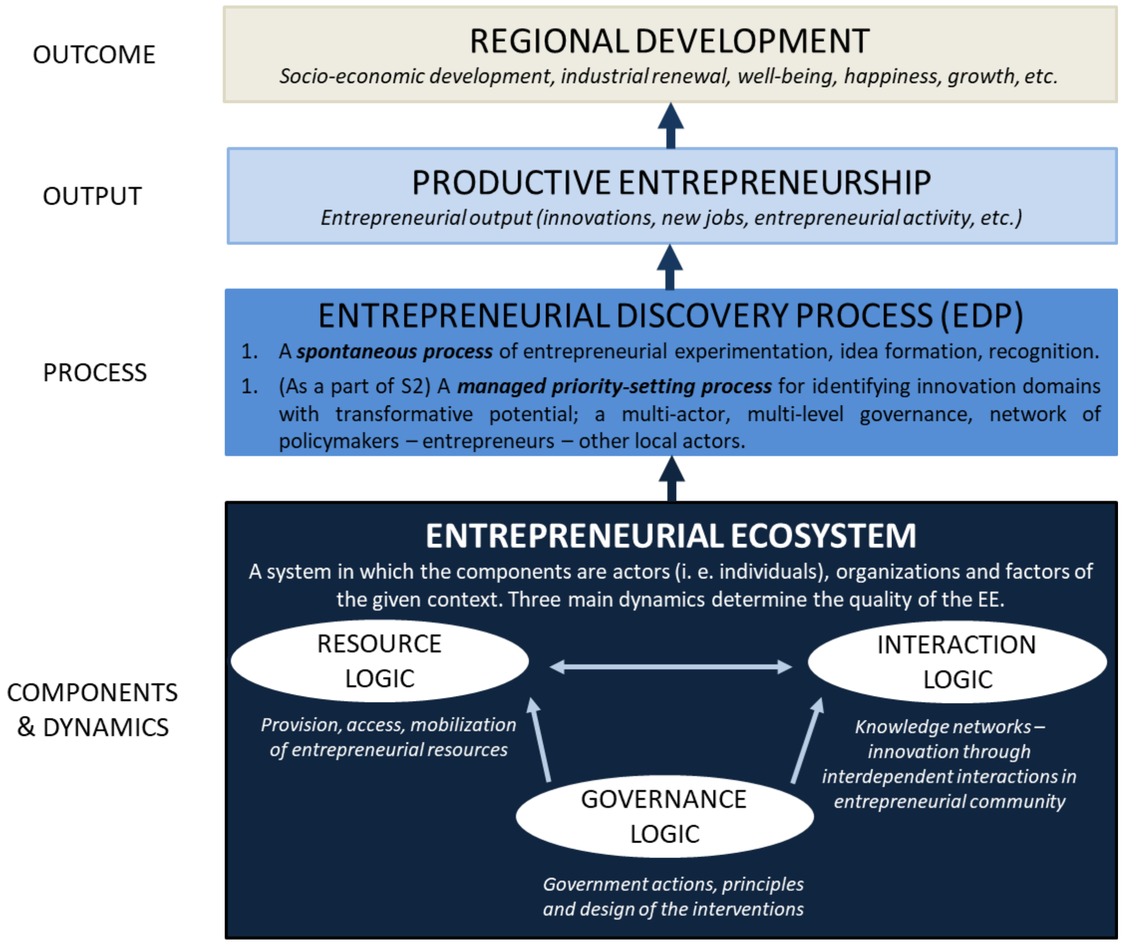
1. Introduction

The *smart specialization* (S2) approach is a pioneering regional policy concept for unlocking place-specific innovation potential (*OECD* 2013; *Pugh*, 2014; *Morgan*, 2017). Setting up *smart specialization strategies* (S3 or RIS3) in all European regions has become an important objective of EU cohesion policy[1]. The concept outlines an effective way to restructure the regional economic system: it builds on the region's ability to innovate by recognizing new opportunities and exploiting them through the concentration of resources and competences on a few new innovative domains of specific industries. New local innovations are created by using new resources (including new knowledge, new technologies or new competencies) and combining them with already existing resources in the region. These new resources may come from the local area or even from outside (*Foray*, 2014, 2019; *Antonelli and Cappiello*, 2016).

One of the central ideas of S2 is that *entrepreneurs* play a key role in the innovation process, indicating a clear message to decision-makers that traditional principal-agent (PA, or top-down) governance is ineffective in identifying new fields of innovation with transformative potential. As (tacit) knowledge is highly decentralized among local actors, policymakers do not possess obvious knowledge or information about the latter (*Foray*, 2017). Entrepreneurs being put in the focus, the *entrepreneurial discovery process* (EDP) is one of the main building blocks of the S2 approach, referring to the spontaneous process of forming new innovative business ideas and the occurrence of entrepreneurial experimentation. Recent literature suggests that the quality of the *entrepreneurial ecosystem* (EE) determines entrepreneurial opportunities and their discovery (*Acs et al.*, 2014; *Autio et al.*, 2019). High-quality EE can better support the process of entrepreneurial discovery, which ultimately results in a higher level of *productive entrepreneurship* (*Stam*, 2015, 2018). Although there is no consensus among researchers on the definitions of productive entrepreneurship, its important contribution to *(regional) economic development* is clear (*Wennekers and Thurik*, 1999; *Sternberg et al*., 2019). EE literature points out that the ecosystem, as the natural soil for spontaneous EDP, can be considered a *complex system*, i.e. configurations of many interdependent factors (*Roundy et al*., 2018). This means that ecosystem configurations can be very diverse, and their evolution is also influenced by path dependence (*Mack and Mayer*, 2016). *Figure 1* illustrates the logical relationships among the theoretical considerations mentioned above.

[1] As a fully-institutionalized strategic framework, RIS3 has become *ex-ante conditionality* for regions eligible for European Structural and Investment Funds (ESIF) in the 2014-2020 programming period (*EC, 2014*).

Figure 1 Relationship between concepts of smart specialization (S2), entrepreneurial discovery process (EDP), and entrepreneurial ecosystem (EE)



Source: own edition based on *Stam and van de Ven*, 2019, and *Cao and Shi*, 2020.

In recent years, critics of the S2 concept have revealed its potential pitfalls and have highlighted that the implementations of S3 policies appears to be less efficient in less developed regions (LDRs). While some experts suggest improving poorly functioning governance systems and local/regional leadership (*Martínez-López and Palazuelos-Martínez* 2019; *Fellnhofer* 2017), others emphasize that prior improvement of the institutional capacities is required for applying successful specialization policy (*Kroll*, 2015; *Rodríguez-Pose and Wilkie* 2017; *Magro and Wilson* 2019). Institutional capacity refers to the ability of regions to support the absorption of *new knowledge and ideas* that constantly challenge their existing institutional arrangement (*Capello and Kroll*, 2016). Many LDRs in Europe suffer from all kinds of capacity shortages or obstacles that hamper the innovation domain-seeking and priority-setting process of S3 (*Krammer*, 2017; *Hassink and Gong*, 2019). To avoid capacity-related traps and for the sake of a successful S3, *Foray* (2014, 2019) emphasizes that it makes no sense to search for best practices or “panacea”, but every region should evaluate its regional assets, namely its entrepreneurial ecosystem, to identify bottlenecks.

On the one hand, EDP, as a spontaneous process based on entrepreneurial trials and errors developed from the Kirznerian notion (*Kirzner*, 1979), is determined by the operation of EE in a particular region. In their recent article, *Szerb et al.* (2020) showed that if the essential elements of the entrepreneurial ecosystem are missing, and this is especially true for LDRs, then policies should focus first on their development rather than trying to specialize. In sum, the S3 does not work on a poorly performing EE foundation, and more importantly, the strategy itself cannot repair it, since that is not its goal or task. On the other hand, as the central element of S3, EDP has a different interpretation as well. In this sense, the EDP refers to a prioritization process which is based on an inclusive (multi-actor), embedded (place-based) and bottom-up process aimed at setting priorities for a region, taking into account the region’s resources and capacities that can create new market opportunities (*McCann and Ortega-Argilés*, 2015; *Foray*, 2019).

Although the entrepreneurial ecosystem is a very *„seductive”* concept today (*Stam*, 2015, p. 1764), and the growing literature on EE provides a number of theoretical frameworks, a deeper understanding, measurement, and modeling remains a major challenge. However, an important finding of EE research is that the identifying elements of an ecosystem alone are not sufficient to understand how it works and evolves. Beyond identification, revealing and analyzing the *interdependencies* between agents, organizations and institutions is equally important as the latter results in complex systems with different levels of efficiencies (e.g. adaptability) and consequently determines the quality of an ecosystem (*Alvedalen and Boschma*, 2017). In ecosystems networking works as a „connecting tissue” or “glue” between different elements. In their conceptual model, *Cao and Shi* (2020) identify three EE mechanisms based on *resource*, *interaction*, and *governance* logics. Their literature review confirmed that ecosystems can be perceived as *resource allocation systems* driven by entrepreneurs and regulated by institutional context. The resource logic refers to the provision, access and mobilization of entrepreneurship-related resources (e.g. finance, human and physical infrastructure). For productive resource allocation, entrepreneurs need to be able to gain access and mobilize them. However, not all entrepreneurs can do this as access to resources and their mobilization are not equally facilitated by their local social networks. Consequently, EEs are *interaction systems* of different actors as well whose knowledge acts as the key resource within the ecosystem, where innovation is generated through their interdependent interactions. Finally, the third identified mechanism is the *governance logic*: entrepreneurship is a highly context-related phenomenon, so government actions have a significant impact on entrepreneurial ecosystems.

The problem of lagging regions stems mainly from the lack of new resources (e.g. new knowledge, technology or competencies). However, improving local and interregional *networking* between actors can contribute to updating the malfunctioning ecosystem with new resources needed to promote entrepreneurial experimentation as part of the EDP. Consequently, in our article, we focus primarily on the *interaction mechanism that drives the EEs.*

To discover new business opportunities, a company either relies on its *inner resources* (knowledge, experience) or adopts *external knowledge*. In the latter case, the existence of appropriate (local/interregional inter-firm) *networks* is a precondition for acquiring the necessary new knowledge. This new knowledge will help discover new areas of innovation that can facilitate smart specialization within or across sectors. These networks are of particular importance for LDRs suffering from a lack of institutional capacities. In LDRs, if the size/quality of the internal entrepreneurial knowledge base does not reach the critical level that could be an internal source of EDP, then the impulses, motivation, information, knowledge, etc. must be acquired from outside the region. This requires appropriate networks that provide access to a wide variety of impulses and more abundant (EDP-supporting) resources in other areas. Findings of *Sebestyén and Varga* (2013) and *Varga and Sebetyén* (2017) for instance show that network connections with more developed regions have a significant impact on innovation activity in European resource-deficient LDRs, while in developed regions this effect is not observed.

Fitting in this line of research, our study seeks to address *how specific aspects of networks across firms are associated with different elements of the entrepreneurial ecosystem*. Once these associations are revealed, we can also determine ecosystem element(s) and their configurations that need to be developed to initiate S3-compliant innovation processes in lagging regions.

From a methodological perspective, this study is based on the results of semi-structured interviews between the CEOs of ICT companies operating in the center of the Southern Transdanubia region of Hungary, in the city of Pécs. Being mostly rural, with formerly well-functioning, but now abandoned heavy industrial basis, this region serves as a typical case for LDRs with scarce local innovative resources and a weak entrepreneurial ecosystem. The survey focuses on how the 29 ICT firms in the sample assess the individual (micro), organizational (meso) and environmental (macro) elements of their entrepreneurial ecosystem. The focus on the ICT sector is driven by the common perception that these companies belong to the high-tech sectors which are traditionally believed to be conducive to innovation. Thus, our case is able to shed light on the particular circumstances of such an industry in an LDR, by providing evidence on the relationship between the extent of their networking activity within and outside the region and the characteristics of the local entrepreneurial ecosystem.

The survey questions revealed an interesting relationship between the characteristics of the inter-firm network in the region and the elements of the local entrepreneurial ecosystem. Then, we employed fuzzy-set Qualitative Comparative Analysis (fsQCA) which is well suited for the analysis of cases where outcomes can result from several different combinations of conditions (*Ragin* 2008). With this method, we can identify the configurations of micro, meso, and macro elements in the local ecosystem that result in extensive inter-firm networks of the IT companies.

The structure of the paper is as follows. *Section 2* begins with a discussion of the theoretical framework from the entrepreneurial ecosystem perspective and introduces our theoretical model used for the investigation. Next, *Section 3* explains the data source and methodology. *Section 4* describes the results of the analyses. Finally, *Section 5* presents the discussion and conclusions of the study.

2. Theoretical background

2.1 Entrepreneurial ecosystem: measurement issues

The original concept of the entrepreneurial ecosystem was borrowed from ecology and later developed into a popular and influential stream of entrepreneurial research today (*Acs et al.*, 2017; *Volkmann et al.* 2019). According to *Spigel and Harrison* (2018), the ecosystem metaphor has simply become a *„buzzword”* (p. 151). Due to its growing popularity, several literature reviews have been published in recent years. The overall conclusion of these papers is that, despite its popularity, the concept is undertheorized (*Acs et al*., 2017; *Roundy et al*., 2017, 2018; *Malecki*, 2018; *Cavallo et al*., 2019; *Stam*, 2019) and still *„chaotic”* (*Spigel and Harrison* 2018, p. 152), and it yielded little systematic and consistent empirical results without a consensual definition and solid theoretical framework (*Stam* 2015, *Motoyama and Knowlton* 2017). An extensive systematic review of the literature by *Scaringella and Radziwonb* (2018) explored several ecosystem archetypes of the now popular ecosystem concept by revealing that these archetypes are rooted in well-established theories of the territorial approach. In sum, many questions known for decades have not been clarified yet, and hence the EE approach currently raises more questions than it answers. The EE approach offers, first of all, a conceptual framework that (1) emphasizes the multidimensional character of entrepreneurship; (2) underlines system-perspective (the interconnectedness of agents and institutions); (3) helps to measure the quality of entrepreneurial performance (*Ács et al.*, 2014; *Isenberg*, 2014; *Stam*, 2018).

However, still one of the most puzzling questions about the EE concept is *what research method would be best suited for its study*. A large fraction of the literature continues to focus on identifying the main factors of entrepreneurial ecosystems. Many researchers or institutions provide indicators, complex indices or theoretical frameworks for assessing, comparing and ranking the performance of national, regional or city entrepreneurial ecosystems (e.g. GEM[2], Scale Up® Ecosystem by Babson College[3], GEI[4] by The Global Entrepreneurship and Development Institute, EIP by OECD–Eurostat[5], Entrepreneurial Ecosystems by WEF[6], or Startup Genome[7]). As *Autio et al*. (2019) argue though, current entrepreneurship measurements are still *"a-theoretical and conceptually inadequate and methodological (measurement content) choices inadequately explained; none of the current operationalization capture characteristic structural elements of entrepreneurial ecosystems*" (p. 11). Furthermore, *Ragin* (2008) points out that such rankings based on composite indexes are entirely *relative*. Therefore, it would be more useful to explore the *complex relationships (interconnectedness)* between the identified factors: identifying causal relationships between them, determining the relative weight of each factor and understanding how each component contributes to ecosystem development. Nevertheless, the literature proposing and empirically testing new research methodologies for answering these issues is almost negligible.

Exploring the relationships between actors and components is currently a central issue in ecosystem research (*Zhang and Guan*, 2017). *Roundy et al.* (2017) argue that the nature of these relationships determines the quality of the ecosystem. Network analysis is increasingly being proposed as a feasible methodological solution for studying entrepreneurial ecosystems. Mapping micro-level relationships can help determine the size of the network needed to build a successful ecosystem. On the other hand, network characteristics (such as density, variability,

[2] *Global Entrepreneurship Monitor (GEM)*, https://www.gemconsortium.org
[3] *Scale Up® Ecosystem* http://scaleupecosystems.com/
[4] Formerly known as *GEDI*, the *Global Entrepreneurship Index (GEI)* https://thegedi.org
[5] The OECD-Eurostat *Entrepreneurship Indicators Programme (EIP)* http://www.oecd.org/sdd/business-stats/
[6] *Entrepreneurial Ecosystems Around the Globe and Early–Stage Company Growth Dynamics.* https://www.weforum.org/reports/entrepreneurial-ecosystems-around-globe-and-early-stage-company-growth-dynamics
[7] *Global Startup Report* by Startup Genome, https://startupgenome.com

connectivity, and diversity) affect ecosystem performance. Research to date has shown that if the distance between the actors is not optimal, it can negatively affect their entrepreneurial activity: too close relationships can result in an inward-looking entrepreneurial process that increases the risk of lock-ins while reducing the opportunity to recognize opportunities and recombine resources. On the other hand, a lack of proximity results in fragmented networks that hinder the proper functioning of the ecosystem (*Alvedalen and Boschma* 2017). Network analysis also allows for comparison of ecosystems (*Cooke* 2016), and it can help to determine whether dense networks, diversity of actors or external (non-local, interregional) relationships are more beneficial to ecosystems (*Auerswald* 2015). Applying network analysis, *Ter Wal et al.* (2016) demonstrate that the success of new firms depends to a large extent on the combination of relationships within the ecosystem, distinguishing *„open and specialized"* versus *„closed and diverse"* ecosystems. *De Hoyos-Ruperto et al.* (2013) demonstrated that the positive role of individual factors supporting entrepreneurial activity can be eliminated by inadequate social embeddedness, which negatively affects the success of firms. Exploring the start-up ecosystem of St. Louis, *Motoyama-Watkins* (2014) applied network analysis and found that specific individuals and activities are necessary as catalysts for the proper functioning of the ecosystem. Also, *Fuster et al. (2019)* examined the main actors of the Andalusian entrepreneurial university ecosystem and using a social network approach they identified *"an expansive wave effect which refers to the intensity of social networks links among participants located in different entrepreneurial university ecosystems through which knowledge spillover to other businesses occurs"* (p. 220).

Apart from studies directly focusing on entrepreneurial activity, there is significant literature which takes a network perspective and explores how different structural aspects of connections contribute to individual or organizational performance. While many studies establish a relationship between the centrality of nodes in a network and their performance along various dimensions (*Abbasi et al*., 2012; *Beadury and Clerk-Iamalice* 2010; *Hopp et al*. 2010), others focus on the *diversity of connections* (*Grannovetter* 1973; *Cohen et al.* 1997; *Cohen and Janicki-Deverts* 2009). *Perry-Smith* (2006) report higher creativity with more diverse connections, but evidence is also found with respect to financial status (*Pan et al.*, 2011), economic development (*Eagle et al*. 2010) or study performance (*Vaquero and Cebrian*, 2013; *Villapondo* 2002). *Burt et al*. (2000), *Burton et al*. (2010) and *Cross and Cummings* (2004) show a positive relationship between diversity as measured by managerial networks using internal evaluations and promotions as performance measures.

Ecosystems are unique, their components are interrelated, and therefore, due to multicollinearity and non-normality of data traditional statistical methods and assessment tools are unable to embrace such diversity and complexity, and consequently, are ill-suited for studying ecosystems (*Muñoz et al.* 2020). Qualitative Comparative Analysis (QCA) can also offer a feasible methodological solution for solving the challenge of complexity (*Roundy*, 2018). QCA as a set-theoretical analytical technique is appropriate for visualizing and analyzing the causal complexity of several social phenomena. It allows us to overcome the limitations of traditional linear methods (assuming a one-way causal relationship among conditions) by identifying configurations of causal conditions relevant to the given outcome.

The benefits of QCA have recently been confirmed by a number of different applications in different scientific fields, particularly in strategic management, innovation and entrepreneurship research (see the review of *Kraus et al.* 2018). In the field of entrepreneurship, a number of studies using the QCA method were published in the 2016 thematic issue of the Journal of Business Research (titled as *Set-theoretic research in business*). Most of these investigations are based on the Global Entrepreneurship Monitor database. With the same method, based on data from a sample of cities in the state of São Paulo, *Alves et al.* (2019) identified the constituent factors of different configurations that shape successful entrepreneurial ecosystems. *Abbate et al. (2019)* explored the different configurations of Business Model (BM) adopted by SMEs participate in an IoT platform aiming at developing smart cities. *Muñoz et al.* (2020) show how configurations of the local entrepreneurial ecosystem, as evaluated by local experts, promote or hinder the creation of new and innovative firms.

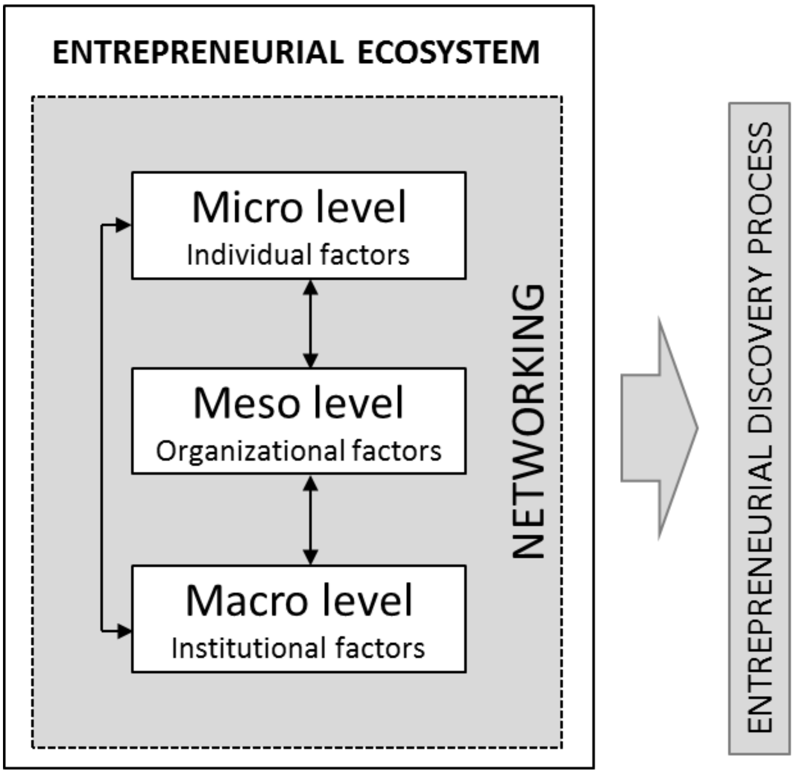
These studies mentioned above demonstrate that the use of QCA has increased in recent years and show that there are still promising opportunities for its application in entrepreneurial research.

2.2 Conceptual model

In the present study, we rely on the following EE definition *of Audretsch and Belitski* (2017), as it emphasizes the importance of networking and system-dynamics in the functioning of an ecosystem: EE works as *„a dynamic community of interdependent actors (entrepreneurs, supplies, buyer, government, etc.) and system-level institutional, informational and socioeconomic contexts… interact via information technologies and networks to create new ideas and more efficient policies"* (p. 4). As highlighted by the definition, business success is closely linked to the entrepreneur, i.e. to its psychological traits, personal characteristics, perceptions, attitudes, networks, (foreign) experience, learning and knowledge transmission abilities, etc. on the one hand. On the other hand, although entrepreneurial actions are ultimately undertaken by individuals, these individuals are always embedded in a given context. This context determines who will become an entrepreneur, what kind of entrepreneurial ambition they have, and also how successful their entrepreneurial actions will be (*Shane* 2003; *Baker and Welter*, 2018; *Welter* 2019).

Regarding the structure of ecosystems, the present study distinguishes micro, meso and macro levels: the *micro level* refers to the characteristics, attitudes etc. of actors that make up an ecosystem; the *meso level* refers to the different organizational characteristics of firms; while the *macro level* encompasses the broader institutional environment surrounding the micro and meso levels. It follows from the above definitions that the characteristics of the actors at the micro level are influenced by the meso and macro level contexts that surround them, but the actors can also affect their broader context. Networking, as the cohesive mechanism, is the "connecting tissue" between the actors and institutions at different levels. The quality of networks affects the access to resources and their mobilization, and hence it ultimately determines the quality of the EE. On the other hand, the different micro, meso, and macro-level elements of the EE determine what social capital can be created through networking. *Figure 2* summarizes our conceptual model, which illustrates the logical connection between the actors and institutions of the ecosystem on different levels, and networking as a mechanism that connects all the factors to create an ecosystem.

Figure 2 Conceptual model



Source: own edition.

2.2.1 Effect of networking on entrepreneurship

Recently proponents of the EE approach have pointed out that if we want to understand the mechanisms of ecosystems (why some promote EDP better than others) it is necessary to explore *the interrelationships* between the constituents. The purpose of networking is to exploit social capital, a resource hidden in social relationships depending on the quantity, quality, and structure of networks. Social capital can be seen as the network through which valuable resources for the start-up of a new firm can be attained like access to finance (*Kerr and Nanda*, 2009), to ideas and opportunities (*Shane and Venkataraman*, 2000) or to labor (*Dahl and Sorenson*, 2009). Social capital is created by knowing, appreciating and showing interest in each other, and consequently, trust emerges which facilitates networking. Trust between actors brings them together and later works as a "lubricant", rendering relationships smoother (*Anderson and Jack*, 2002). The positive correlation between networking and entrepreneurial performance/success both in the initial and later phases of a firm's life cycle is highly recognized (*Aldrich and Zimmer*, 1986; *Lee and Tsang*, 2001; *Wang and Lestari*, 2013; *Fayolle et al*., 2016; *Mitrega et al.*, 2017, *Mu et al*., 2017). *Moreno and Casillas* (2008) pointed out that firms stimulate processes such as entrepreneurial networking to enhance their innovativeness. Increasing the network density and/or diversity (*Bruderl and Preisendorfer*, 1998), is the key attribute of successful entrepreneurs which distinguish them from others (*Dubini and Aldrich*, 1991). Social capital facilitates the flow *of information* (*Adler and Kwon*, 2002; *Westlund and Bolton*, 2003) and reinforces *openness to the ideas of others* (*Malecki*, 2012).

2.2.2. Effect of actors on networks

Research on entrepreneurs' personal and behavioral characteristics seeks to answer the question of why and how an entrepreneur differs from a non-entrepreneur. The availability of large-scale administrative and specialized datasets (e.g. Facebook, LinkedIn) and the appearance of new multidimensional approaches (e.g. Big five model[8]) as well as new methodologies (e.g. big data) have led to flourishing research that explains what specific traits encourage people to become entrepreneurs (see the review of *Kerr et al.* 2018). At the same time, an increasing body of literature is addressing the identification of critical competencies that define networking and have found that successful networking is largely determined by personal behavior, attitudes, and skills (*Theingi et al*., 2008; Brescher, 2010; *Bratkovič Kregar and* Antončič, 2015). *Bratkovič Kregar et al.* (2019) found that if entrepreneurs do not have the capacity to exchange embedded resources, the network does not bring any value to them. Therefore, they argue that *networking self-efficacy* is crucial for success. The findings of *Wincent and Westerberg* (2005) indicate a positive relationship between the CEO's personality traits (i.e., tolerance for ambiguity and self-efficacy) and levels of inter-firm networking with other strategic SME participants. Several studies, using the Big Five personality traits model highlighted that some traits, namely Extroversion, Agreeableness and Openness to Experience, influence the networking capabilities of entrepreneurs (*Wolf and Kim*, 2012).

2.2.3 Effect of context on networks

At the same time, firms' local environment provides the means for efficient networks (*Littunen*, 2000) since the environmental and organizational context affect – support or limit – the relationships that can develop among actors. *Sawyerr et al.* (2003) studied the effects of perceived environmental uncertainty on personal networking activities and firm performance. Their findings confirmed that as the perceived environmental uncertainty increased, the frequency of internal networking increased as well, and this resulted in enhanced firm performance. *Torkelli et al.* (2012) surveyed 298 Finnish SMEs representing five different

[8] John, O., Srivastava, S. (1999): The Big Five trait taxonomy: History, measurement, and theoretical perspectives. Handbook of personality: Theory and research, 2 (510), 102–138. https://doi.org/citeulike-articleid:3488537

industry sectors. Their results indicate that both internal network competence and external environmental hostility play a role in SME internationalization propensity, but the influence of network competence is not moderated by environmental hostility. The empirical investigation of *Eisingerich et al*. (2010) shows that cluster performance is dependent on the ability of clustered firms to adapt their network structures to their environmental context. Their results suggest that high performing regional clusters are underpinned by (1) network strength and (2) network openness, but that the effects of these on the performance of a cluster as a whole are moderated by environmental uncertainty. *Kiss and Danis* (2008) investigated the role of social networks in the internationalization processes of new ventures. They found that both weak and strong social ties may have a strong positive effect on firm internationalization, but this effect depends on country-level institutional development.

As confirmed by the above literature review, several studies have shown that networking has a positive effect on a firm's performance by enhancing its innovativeness. Furthermore, it can be stated that personal traits, attitudes, and capabilities of micro-level actors determine the properties of networks, and thus ultimately affect the success of networking. On the other hand, the literature highlights that the meso and macro level contexts can also have significant modifying impacts on networking. We believe that our significant contribution to the literature lies in the fact that our research, in addition to examining how micro-, meso-, and macro-level factors affect networking, seeks to identify which ecosystems, i.e. what configurations of the ecosystem factors, result in high- or low-level networking.

3. Data and methodology

3.1 Data

We conducted semi-structured interviews in 2018 among Hungarian ICT entrepreneurs operating in Pécs. The city of Pécs is the administrative and economic center of Baranya County, which is part of the Southern Transdanubia statistical region. With 150,000 inhabitants, it is the 5th largest Hungarian city. At the same time, the city's population is steadily declining year by year.

According to Eurostat's 2017 business demography survey, the population of active enterprises, the birth of new enterprises and the number of fast-growing enterprises are about ten times lower in Baranya County than in Budapest, which is the most developed city in Hungary. The business population grew by 5.42%, but only 53.67% of startups survive the first

3 years. The share of fast-growing enterprises in terms of employment growth was only 11.39%, which is lower than the national average (12.66%). In addition, the institutional quality measured by the European Quality of Government Index (EQI) is rather low in this region[9]. The EQI score was 28.0 in the Southern Transdanubian region, with this score the region ranked 159th (out of 202 regions) in 2017. These data highlight that the Pécs region is a typical case of the LDRs with weak entrepreneurial activity and low institutional quality, which makes it difficult to implement smart specialization strategies in the region.

Before conducting the interviews, we collected information about the ICT sector in Pécs from the Opten database, which provides a wide range of information about Hungarian companies. Then we selected the ICT firms that were founded in Pécs. Based on this search, we identified 37 ICT companies and we managed to reach out to 31 of them with our interview. Finally, 29 companies agreed to undertake the interview, so the rejection rate was only 6.45%, and our *sample covers 78.38% of the companies in the ICT sector in Pécs*. We conducted all interviews within two weeks, and prior to that we conducted test interviews with two other entrepreneurs to make sure our questions are clear, understandable, and that the questions measured the qualities we intend to measure with them. Our sample consists of 29 entrepreneurs who are chief executives of the ICT firms located in Pécs. As part of our study, we surveyed the corporate networks of all 29 companies to map the entrepreneurial ecosystem of the local-regional ICT sector. The 29 companies named a total of 449 partner companies.

We developed an interview structure similar to *Neumeyer and Santos* (2018) who examined the influence of individual and organizational level factors on the social network connectivity of ventures with sustainable and conventional business models in two municipal entrepreneurial ecosystems in the United States. Our interview differed in that we did not address the role of different business models (in networking), while in addition to examining individual and organizational factors of the firms, entrepreneurs were also asked to comment on business framework and systemic conditions of the entrepreneurial ecosystem in which they operate. A 5-point Likert scale was applied to all questions in our questionnaire. Finally, when needed, we calculated aggregate indices using core indicators.

The interview consists of 8 blocks. *Figure 3* shows the structure of the interview classifying each block of the interview according to whether it examines factors belonging to

[9] According to the EQI's definition, institutional quality refers to "a multidimensional concept consisting of high impartiality and quality of public service delivery, along with low corruption" (EQI 2017, https://ec.europa.eu/regional_policy/en/information/maps/quality_of_governance/)

micro, meso or macro levels[10]. As micro level factors, we measured the demographic characteristics of the entrepreneurs, entrepreneurial identity and attitudes. Regarding the meso level factors, we collected information about the enterprise itself, which provides a framework for the entrepreneurial activity. We also assessed the opinion of entrepreneurs about the systemic and framework conditions of their entrepreneurial ecosystem, which are classified as macro level factors.

Figure 3 The structure of the interview

<table>
<tr><th colspan="3">Blocks of the semi-structured interview</th></tr>
<tr><th>Micro level</th><th>Meso level</th><th>Macro level</th></tr>
<tr><td rowspan="2">Block 1. Demographic data</td><td>Block 4. Idea generation</td><td rowspan="4">Block 8. Entrepreneurial environment, systemic and framework conditions</td></tr>
<tr><td>Block 5. Venture typology</td></tr>
<tr><td>Block 2. Entrepreneurial identity</td><td>Block 6. Innovation capacity</td></tr>
<tr><td>Block 3. Entrepreneurial attitude</td><td>Block 7. Personal network</td></tr>
</table>

Source: own edition.

3.1.1 Micro level: individual factors

In the first block of the interview, we asked the entrepreneurs about their demographic situation. We gathered information about the entrepreneurs as individuals and the organizations they established. All interviews were conducted with entrepreneurs who were CEOs of their companies. Individual attributes include sex, birth date, education, number of firms established, number of years spent as entrepreneurs. The firms' leaders in our sample have been working as entrepreneurs for an average of 16 years, and several of them have founded more than one company. In 2019, the average sales revenue of the investigated ICT firms was 183,325,000 Hungarian Forints (Min: 357,000 HUF, Max: 1 135,486,000 HUF). The number of employees for each company was below 250. Thus, we can say that we interviewed experienced

[10] The online version of the interview is available at the following link: Entrepreneurial ecosystem survey

entrepreneurs who run small and medium-sized enterprises in Pécs. The 29 executives in the sample were all men. We were curious about the entrepreneur's previous entrepreneurial experience as well, therefore, we asked the following two questions regarding entrepreneurial experience: (1) "*How long have you been an entrepreneur?*" and (2) "*How many businesses have you founded so far?*".

In the second block of questions, the interviewed entrepreneurs were characterized according to their *entrepreneurial identities/motivations*. Using categories posited by *Cardon et al.* (2013), we distinguished three types of identities: inventor, founder, and developer. An *inventor* is motivated by the discovery of new market opportunities, the development of new products and services, and the development of new prototypes (MVPs). The *founder* type of entrepreneur is motivated by the creation of the social, human and financial resources needed to start a new business, while a *developer* is primarily motivated by growth after founding. A 5-point Likert scale was used for each question, and the scores for each question were summed separately according to the three types of entrepreneurial identities, and finally, the scores for the different identity types were summed. For this measure, a higher score means a stronger entrepreneurial identity. According to the three categories, *there is no company with a dominant motivation among the examined 29 IT firms*. The companies in the sample primarily have inventor *and* developer motivations, while they are hardly characterized by founder motivation. The only exception is the answer "*running my own business gives me energy*" as this typical founding motivation was an answer for nearly 70% of the chief executives (in the case of 20 firms). In a nutshell, all companies in the sample are characterized by "mixed motivations": on average, 87.1% of leaders agreed with certain categories of the developer type, while 69.7% agreed with certain categories of the inventor type, and 33.6% agreed with some categories of the founder type.

To find out whether the entrepreneurial mindset is characteristic of Hungarian IT entrepreneurs, their *entrepreneurial attitudes* were surveyed. Based on the suggestions of *Bolton and Lane* (2012), here we measured to what extent can entrepreneurs be characterized by entrepreneurial thinking in terms of *risk-taking*, *innovation*, and *proactivity*. By summing the scores of the three types of attitudes, each entrepreneur can be characterized by an aggregate entrepreneurial attitude value that expresses the degree to which he or she has an entrepreneurial spirit. If the calculated aggregate score is high, it indicates a high level of entrepreneurial attitude. The maximum value of the score is 50 points and the potential minimum is 0. The 29 companies in the sample achieved an average of 36 points, and only 44.8% of them exceeded this average. Thus, based on this aggregate score, it can be seen that the IT companies in the sample are characterized by a *restrained entrepreneurial mindset.* Interestingly, the interviewed entrepreneurs are characterized by both a high level of risk aversion and proactive behavior: on average, only 29.9% of leaders agreed with at least one of the categories of risk-taking, viz. showing a risk-taking entrepreneurial mindset; on average, slightly more than half (58.6%) of the leaders agreed with at least one of the categories that characterize innovation activity, viz. having an innovative entrepreneurial mindset; while on average 88.5% of the interviewed leaders agreed with at least one of the categories that measure proactivity, viz. exhibiting proactive entrepreneurial behavior. Consequently, *the restrained entrepreneurial mindset can be explained primarily by the risk-averse behavior of the entrepreneurs.*

3.1.2 Meso level: organizational factors

After measuring the individual factors, we talked with the entrepreneurs about their business ideas and models. We applied the business idea evaluation questionnaire developed by the *Interregional Innovation System (IRIS)* project to identify how established the business ideas of the firms are[11]. This measure includes several questions about the innovativeness of the business idea, the market, the financial needs, and the key resources. A firm can achieve a maximum of 40 points for its idea development activity depending on the degree to which the idea is developed.

Next, we examined the firms' innovation capacities as organizational factors. A corporate environment conducive to innovation is essential to realize an innovative entrepreneurial idea. In this case, the respondents had to assess different problems that may influence their firm's innovation capacity. For this, we used the validated scale of *Hansen and Birkinshaw* (2007). This scale includes questions about the internal and external idea generation process and the selection, development and diffusion of innovative ideas. It consists of 13 questions which are measured on a 5-point Likert scale. All of these questions relate to various problems regarding innovation within the organization. By summing the scores of the different types of capacities, the innovation capacity of each IT company in the sample can be characterized by an overall score. If the calculated aggregate score is high, that indicates a low level of innovation capacity at the given firm, in other words, a corporate environment with a restrained innovation capacity. The maximum value of this aggregated score is 65 points and the potential minimum is 0. *The*

[11] IRIS Innovative Business Idea Evaluation Method („Interregional innovation system IRIS 100049" project wp2 – Interregional SME development) VI. Innotech Conference, 5th October 2011, https://www.interreg-athu.eu/en/projects-2007-2013/priority-1/

higher the score is, the more detrimental the corporate environment for innovation in a particular firm. In general, the answers support the general impression that the executives of the surveyed IT companies perceive that *their corporate environment favors innovation*.

In the seventh block of the interview, we applied an ego-network method based on the work of *McCallister and Fishcer* (1978), and *Marsden* (1990) to map the personal networks of the investigated firms. The executives had to name their strategic partners, who they could rely on in a variety of situations. They should name a maximum of five partners like other entrepreneurs, representatives of government institutions, higher education institutions, accelerators, incubators, banks, support service providers, innovation role models, investors, suppliers, buyers, and employees. We tried to identify as many actors of the entrepreneurial ecosystem as possible. We also gathered information about the nature of these relationships, therefore we distinguished formal/informal, intra- and interregional, regional/foreign partners.

3.1.3 Macro level: environment

The last block of the interview includes questions about the systemic and framework conditions of the entrepreneurial ecosystem based on the entrepreneurial ecosystem model of *Stam* (2015). We asked the executives about how satisfied they were with the different conditions of their entrepreneurial environment. In the case of systemic conditions, we posed this question concerning networks, role models, finances, talent, knowledge, support services. Regarding the framework conditions, we asked their opinions regarding formal institutions, culture, demand and physical infrastructure. Entrepreneurs expressed their opinions on a 5-item Likert scale. In general, interviewed entrepreneurs *perceive their environment unfavorably both in terms of systemic and framework conditions*. Regarding the systemic conditions, networking, the availability of talented and committed workforce, and the relationship with higher education institutions are perceived as problematic. At the same time, interviewed entrepreneurs of the Hungarian IT sector consider general support services satisfactory. In the case of framework conditions, culture is considered the most problematic because the interviewed entrepreneurs think that society has a poor overall image of entrepreneurs. Secondly, they consider the lack of demand (for their product) and the formal regulatory environment as problematic.

3.2 fsQCA

The interview data described above provides a set of different characteristics on the sample firms. The question we would like to answer is how specific configurations of these characteristics contribute to the extent of firm level networking. A particularly useful analytical tool to handle this question is fuzzy set Qualitative Comparative Analysis (fsQCA).

According to *Ragin* (2000), the fundamental premise of QCA is configurational thinking. Social reality is characterized by causal complexity, in which several combinations of causal conditions can result in a particular outcome. A major advantage of QCA as a set-theoretical approach is that it is appropriate for studying cases as configurations of different causal conditions. QCA is based on set theory, the language of Boolean algebra, and logical minimization to capture complex complementarities between causal conditions and to analyze set-subset relationships (*Ragin* 2008). The method is suitable for identifying *"multiple conjunctural causations"* across cases of particular research phenomena. Here "multiple" implies the number of different paths resulting in the same outcome (equifinality), while the world "conjunctural" refers to the notion that each path is a combination of causal conditions (*Rihoux and Ragin*, 2009, p. 8.).

Set-theoretic relationships are essentially asymmetrical. This asymmetric thinking is one of the major attributes of QCA that distinguishes it from mainstream statistical methods, which are typically symmetrical by design[12] as they divide the explained variation of a dependent variable among independent variables and offer only one causal model that best fits the data. Furthermore, these traditional methods average out or simply ignore outliers, which are equally part of the context. By contrast, the QCA method is more case-sensitive, which means if a configuration explains only one case, it is not less valuable than other more empirically confirmed configurations (*Ragin* 2008, *Woodside* 2013). Using the QCA method, we can identify the *necessary* and/or *sufficient* conditions for producing an outcome. As for necessity, a condition is considered necessary if the outcome is a subset of it. As for sufficiency, a causal condition is regarded as sufficient (but not necessary) to an outcome if the condition contributes to a particular outcome (i.e. it is its subset) but the given outcome may occur under other conditions as well (*Ragin*, 2008).

The fuzzy-set QCA (fsQCA) is the extended version of the prior crisp-set (csQCA) and multi-variable (mvQCA) methods. In a crisp-set a case is either in or out any given set, i.e. either present or absent, while in fuzzy sets a case is fully in or fully out a set, but it can also be partially in. The fuzzy membership scores show the extent to which different configurations belong to a set. Due to fsQCA, we can calibrate partial membership in a set based on values in the interval between [0] (non-membership) and [1] (full membership) (*Ragin* 2008, p. 29).

[12] See for the detailed explanation in *Woodside*, 2013, p. 464.

Consequently, fsQCA has a mixed-method design as it combines the qualitative and quantitative assessment of cases: 0 and 1 anchor qualitative states (case is fully in or fully out), but values between them indicate continuous variables (*Stejskal and Hajek* 2019).

In our case, fsQCA is a useful way to identify the causal complexity between the various micro, meso and macro conditions of an entrepreneurial ecosystem leading to high/low-level firm networking. Its application is also supported by the fact that our sample is small, and an important advantage of fsQCA is that it is suitable for testing small samples.

4. Results

4.1 Important EE factors in networking

In this subsection, we examine *the relationship between the individual (micro), organizational (meso), and contextual (macro) factors of entrepreneurial ecosystems and the size (degree) of a firms' network.* The analysis is based upon the results from the survey discussed in the previous section. First, we calculated Pearson correlation coefficients between the different factors measured in the survey and the networking activity of the sample firms measured by the number of partners.

4.1.1 Individual factors and networking

As a first step, we focused on understanding the relationship between firms' demographic characteristics and the size of their networks. In this respect, we can use the answers referring to entrepreneurial experiences (Block 1, question 4d and 5e). *Table 1* shows that there is *no significant connection between the entrepreneurs' earlier experience and the size of their networks.*

By summing the scores of the three motivation types (inventor, founder, developer), which reflect the answers to the questions in Block 2 of the survey, each entrepreneur can be characterized by a specific motivation level. *Table 1* shows no significant correlation between the motivation level and the network of the entrepreneurs. However, examining each motivation type separately, we can find a significant, positive and *moderate correlation between the developer type of entrepreneur and the size of their network.* This means that those entrepreneurs have larger networks which have a more pronounced developer-type motivation. For the other two motivation types, no significant relationship is found.

On the individual level, we finally examined whether entrepreneurial attitudes are related to networking. Questions in Block 3 of the survey reflect these attitudes (risk taking, innovativeness and proactivity). *Table 1* shows that there is *a positive correlation between the proactivity of entrepreneurs and their network*, but there is no correlation between other attitudes or the aggregated overall attitude score and the degree of the network.

4.1.2 Organizational factors

Along with individual EE factors, the interview also allows for the analysis of organizational context. As a first step, we examined whether there is a correlation between the age of firms and the size of their networks. As seen in *Table 1*, the Pearson's correlation coefficient does not show a significant relationship (Block 1, question 2b). The survey also includes a typology of firms according to the types of entrepreneurship (Block 5). The results of the ANOVA test in *Table 2* show that the two types present in our sample (managed growth and lifestyle types) significantly differ from each other with respect to their network sizes.

Finally, the innovation capacity of the companies is related to the size of their networks. The survey measures innovation capacity along six dimensions (see questions in Block 6), which can be aggregated to comprehensively measure how well a company's organizational features are conducive to innovation. The higher this aggregate score, the less favorable the corporate environment is for innovation. *Table 1* shows that there is a correlation between this measure and the degree of the networks of firms in the sample: companies with less favorable conditions (i.e. higher score) tend to have smaller networks. The analysis was also performed on the level of each innovation capacity dimension. The results in *Table 1* show that the size of the network increases through greater openness to external ideas, higher risk-taking behavior, simplification of new product development, and reduced sales difficulties.

4.1.3 Environmental factors

As part of the survey, we also asked questions regarding the perceived environmental conditions of the firms (questions in Block 8). To measure the context, we used the different dimensions suggested by *Stam* (2015). The results in *Table 1* show that there is *no significant correlation between any of these environmental factors and network size*. However, certain elements of the environment have an impact: there is a positive, moderate relationship between the existence of a positive role model, positive social perception, the level of development of the infrastructure and the size of business networks.

Table 1 Pearson's R between different EE factors and network size (degree)

Individual (micro level)	Network degree
Demographic characteristics (Block 1)	
how long (question 4d)	,230
how many firms (question 5e)	,101
Entrepreneurial identity (Block 2)	
inventor	,177
founder	-,022
developer	,462*
Ent_identity	,310
Entrepreneurial attitude (Block 3)	
risk	,215
inventor	,188
proactivity	,482**
Entr_attitude	,307
Organisational (meso level)	
Venture tenure (Block 1)	
venture tenure (question 2b)	,246
Capacity for innovation (Block 6)	
in-house brainstorming	-,152
co-ordination between business areas	-,323
ideas from an external source	,585**
selection	-,415*
development (product)	-,404*
diffusion	-,532**
Innovative capacity	-,422*
Entrepreneurial environment (macro level)	
Entrepreneurial environment (Block 8)	
networks	-,345
role models	,408*
financing	,339
talents	,002
knowledge	-,114
support services	,169
formal institutions	-,077
culture	,447*
demand	-,220
physical infrastructure	,437*
Systemic conditions	,139
Framework conditions	,079
Entr_environment	,120

Source: own calculation

Table 2 Anova table

			Sum of Squares	df	Mean Square	F	Sig.
network degree * typology	Between Groups	(Combined)	74,570	1	74,570	6,183	**,019**
	Within Groups		325,637	27	12,061		
	Total		400,207	28			

Measures of Association		
	Eta	Eta Squared
network degree *	**,432**	,186

Source: own calculation

4.2 Network diversity and performance

As exposed in the Introduction, this study focuses on network diversity. As opposed to the previous results which looked at the correlation between different EE factors and the simple size (degree) of the network of entrepreneurs, this section establishes some measurements with respect to network diversity and analyze the correspondence between this diversity and EE factors.

4.2.1 Measuring diversity in networks

There are several approaches in the literature to measure the diversity of a whole network (see e.g. *Johnson et al.*, 2013), but most studies analyze the diversity in the connections of a single node. *Madan et al*. (2010) reflect the diversity of social connections with the number of partners, while *Cohen et al.* (1997) and *Cohen and Janicki-Deverts* (2009) use the different types of relationships which a node has. In a similar manner, *Putnam* (2007) measures diversity by the number of different types of partners. While these measures use information only on the ego-network of nodes, if data is available on the whole network, more sophisticated measures can be used such as betweenness centrality (*Abbasi et al.*, 2012; *Beadury and Clerk-Iamalice*, 2010; *Cross and Cummings*, 2004) or network constraint (*Burt et al.*, 2000). When the nodes in the network typically have many connections and/or relative tie strengths are accounted for with all other nodes in the network, measuring diversity can go beyond simple counts and some statistics of the distribution of the partner/connection types can be employed (*Leydersdorff et al.*, 2018).

In this paper the coverage of the network survey limits the possible measures of network diversity. As respondents reported only their ego networks, we can rely on simple count measures of diversity within these ego networks. *Table 3* below summarizes the different diversity measures used in this study.

Table 3 Measures of network diversity

Diversity	The number of different partner types (like seller, buyer, politician, etc.).
Relative diversity	The number of different partner types relative to the possible (all) partner types. For example, if a node has 10 partners, but only 3 different types, while there are 20 types in the survey, the relative diversity is 3/20=0.015.
Concentration	The share of the most important partner type. This measures how concentrated a node's connections are into one specific partner type. For example, if a node has 10 partners but all of them belong to the same type, then this concentration is 1. If it had 10 different types, concentration would be 0.1.
Weighted concentration	It is similar to the previous measure, but connection weights are used: more important connections weigh more.

Herfindahl index	A standard measure of concentration.
Weighted Herfindahl index	The same as the previous measure, but weighted connections are used.
External orientation	The share of connections reaching out of the region.
Weighted external orientation	The same as the previous measure, but weighted connections are used.
International orientation	The share of connections reaching out of the country.
Weighted international orientation	The same as the previous measure, but weighted connections are used.
External diversity	The number of partner-types with which the node has at least one external connection. For example if a mode has 10 connections, 5 of which is out of the region, but all these 5 are of the same type, then external diversity is 1. If the 5 external connections would cover 3 different types, external diversity would be 3.
International diversity	The same as the previous measure, but international connections are counted.

Source: own edition.

4.2.2 Results with diversity

In order to test the effect of EE components on network diversity, we took the following output measures from the survey:

- Entrepreneurial identity of the respondent and its 3 subcategories: discoverer, founder, developer.
- The attitude of the entrepreneur and its 3 subcategories: risk, innovation and proactivity.
- Innovation capacity of the entrepreneur.

The choice of these factors was driven by the results in *Table 1* where we found a direct correlation between them and the network size of entrepreneurs. As directly correlating network diversity and entrepreneurial characteristics did not yield meaningful results, we elaborated on the way this correlation is measured, using a block-correlation method as specified below.

First, using the original values for diversity and entrepreneurial characteristics, we calculated relative measures by normalizing with the average. Second, using these normalized values, we set up four categories with respect to all diversity-characteristics pairs: (1) below average in both diversity and characteristic, (2) below average in diversity and above average in characteristic, (3) above average in diversity and below average in characteristic, (4) above average in both diversity and characteristic. All observations are assigned to one of these groups. Third, we added the number of observations in groups (1) and (4) as reflecting positive correlation (P) and added the number of observations in groups (2) and (3) as reflections of negative correlation (N). Then, the $R = 1 - 2(P/N + 1)$ measure translates the observation counts onto the interval between -1 and 1, where -1 means perfect negative correlation and 1 means perfect positive correlation. Correlation in this sense reflects the extent to which observations group into opposite quadrants of an imaginary scatter plot divided by the average values along the entrepreneurial characteristic and network diversity axes. Fourth, a reference distribution is simulated with an equal probability of the observations showing up in all four groups and the distribution of the R values under this uniform null hypothesis is calculated. Fifth, the observed R values were evaluated against the null hypothesis above as being significantly different from zero. The table below contains all diversity-characteristic pairs and the resulting R values. Black and grey marking shows negative and positive significant (at 5%) correlations respectively.

Table 4 shows the results of these block-correlation calculations. All cells refer to one pair of an entrepreneurial characteristic and a network diversity measure and show the calculated block-correlation (R value) for the given pair. Shaded cells refer to significant correlation with the black ones marking negative and the grey ones marking positive movement. The results are far from conclusive; however there are some systematic results. It seems that the simplest measure of diversity, the number of different partner types negatively correlate with both entrepreneurial identity and attitude. On the other hand, those diversity measures the extent to which entrepreneurs have connections over the border (Foreign orientation, weighted foreign orientation and foreign diversity) negatively correlate with a discoverer identity and the proactive attitude: those entrepreneurs seem to have more diverse networks with respect to foreign links which are less characterized by these features.

Apart from external orientation, which positively correlates with the founder identity, positive correlation is typically found with concentration-type measures, reflecting the extent to which the network of entrepreneurs are concentrated to one type of partners: *entrepreneurs with higher entrepreneurial identity and attitude tend to have more concentrated networks.*

Table 4 Block-correlation of entrepreneurial characteristics and network diversity

	Entrepreneurial identity				Entrepreneurial attitude				Innovation capacity
	discoverer	*founder*	*developer*	Entrepreneurial identity*	*risk*	*innovation*	*proactivity*	Entrepreneurial attitude**	capacity***
Diversity	-0,0805	0,0345	-0,0575	-0,1494	-0,0588	-0,0805	-0,0805	-0,1059	0,0345
Relative Diversity	-0,0805	0,0345	-0,0575	-0,1494	-0,0588	-0,0805	-0,0805	-0,1059	0,0345
Concentration	-0,0345	-0,0575	0,1264	0,0345	0,1529	0,0575	0,0575	0,1294	-0,0575
Weighted Concentration	0,0805	0,0575	0,1034	0,1494	0,0353	0,0805	0,0805	0,0824	-0,0345
HHI	0,0805	-0,0345	0,0575	0,1494	0,0588	0,0805	0,0805	0,1059	-0,0345
HHI Weighted	0,1034	-0,0575	0,0805	0,1724	0,0824	0,1034	0,1034	0,1294	-0,0575
External Orientation	-0,0575	0,1034	-0,0345	-0,0345	0,0588	0,0345	-0,0115	-0,0118	0,0115
Foreign Orientation	-0,1494	-0,0345	0,0115	-0,0805	0,0588	-0,0115	-0,1034	-0,0353	0,0575
Weighted External Orientation	-0,0575	0,1034	-0,0345	-0,0345	0,0588	0,0345	-0,0115	-0,0118	0,0115
Weighted Foreign Orientation	-0,1494	-0,0345	0,0115	-0,0805	0,0588	-0,0115	-0,1034	-0,0353	0,0575
External Diversity	-0,0115	0,0575	-0,0345	-0,0345	0,0588	0,0805	-0,0115	-0,0118	-0,0345
Foreign Diversity	-0,1494	-0,0345	0,0115	-0,0805	0,0588	-0,0115	-0,1034	-0,0353	0,0575

Note:
* *Entrepreneurial identity*: the sum of the values of the discoverer, founder and developer.
** *Entrepreneurial attitude*: the sum of the values of risk, innovation and proactivity.

*** *Capacity*: the sum of the values of the different indicators measuring a firm's innovation capacity.
Source: own calculation.

4.3 Configurations of EE factors in networking: a fuzzy-set QCA approach

In the previous sections, we focused on how different characteristics and conditions of the entrepreneurial ecosystem correlate with the networking capacity of the surveyed entrepreneurs. In this section, we drive attention to causal relationships between these factors. As discussed in the introduction, fsQCA is used to reveal those configurations – sets of different causal conditions – of the individual (micro), organizational (meso) and environmental (macro) characteristics of the entrepreneurial ecosystem that result in a high-level firm networking. Also, relying on the asymmetric thinking of fsQCA, we explore possible combinations that may lead to low-level networking. The data described in *Section 3* are used to perform the fsQCA, along with the various network diversity measures applied in *Section 4.2*.

4.3.1 The calibration of the variables

After selecting the input and output variables, the next step for fsQCA is the calibration of the variables. Using the direct method, we convert the scores of our variables into fuzzy membership scores between 0.0 to 1.0 according to the thresholds of the three qualitative anchors: full membership (1.0), full non-membership (0.0), and the crossover point (0.5). Between the two edges the cases appear as different degrees of membership[13]. The crossover point is a qualitatively anchored midpoint referring to "*the point of maximum ambiguity (fuzziness) in the assessment of whether a case is more "in" or "out" of a set*" (*Rihoux and Ragin* 2009, p. 90). In this current version of the software, calibration is automated and easy to perform once the thresholds are decided.

Our outcome variable is *networking* (based on questions in Block 7) measuring the size of the respondent's network. High degree refers to the respondents' rich connectedness while a low number indicates their relative isolation. Besides this core indicator of networking, other diversity indicators were used as dependent variable listed in *Table 3*. A total of six different dependent variables were used in our fsQCA calculation:

— *Networks* (N): the number of all partners.

[13] For a detailed description of the calibration procedure see *Ragin* (2008: 86-94)

- *External networks* (EN): number of interregional connections (with partners located outside the city)
- *Informal networks* (IN): the number of all informal partners (within and out of the city)
- *Formal networks* (FN): the number of all formal partners (within and out of the city).
- *Weighted Herfindahl index* (HHIw): the extent to which connections are concentrated to a single partner type (weighted connection scores are used).
- *Weighted external orientation* (EOw): number of interregional connections with partners located outside the city (weighted connections are used).

Based on the consideration of *Khedhaouria and Thurik* (2017), we created two fuzzy set measures of above-average networking outcomes: (1) a permissive *"high networking outcome"* version and (2) a strict *"very high networking outcome"* version. The two versions were developed using different thresholds to transform the selected outcome variables into fuzzy sets:

- *Permissive version*: membership in the set of firms with a "*high networking (HN) outcome*" was coded as 0 if a firm showed average or below-average, i.e. low networking activity (about the 50th percentile), and as 1 if the firm showed above-average, i.e. high networking activity (about the 75th percentile or higher). As the crossover point, we chose the halfway of the 50th and 75th percentiles.
- *Strict version*: membership in the set of firms with "*very high networking (VHN) outcome*" was coded as 0 for high networking activity (about the 75th percentile), and 1 if the firm showed extraordinary, above-average, i.e. very high networking activity (about the 95th percentile or higher). As the crossover point, we chose the halfway mark of the 75th and 95th percentiles.

In the current study, the number of casual conditions (input variables) is seven, which is within the suggested limit of eight (*Ragin* 2008). These conditions are related to the individual (micro) level such as (1) demographic characteristics of the entrepreneur, (2) entrepreneurial identity and (3) entrepreneurial attitude; to the organizational (meso) level such as (4) venture tenure, (5) idea development, and (6) innovation capacity; and finally to the (7) entrepreneurial environment (macro-level). A detailed description of these variables can be found in *Section 3*.

The calibrated scores of the input variables (causal conditions) are also tied to different thresholds of the three qualitative anchors: full membership (fuzzy score = 0.95), the crossover point (fuzzy score = 0.50), and full non-membership (fuzzy score = 0.05). By specifying breakpoints, we followed the suggestions of *Condurasa et al.* (2016), *Khedhaouria and Thurik* (2017), and *Wu et al.* (2019) and used the 25th, 50th, and 75th percentile values for full non-membership, crossover point, and full membership, respectively. Drawing on three breakpoint values, we created a measure of membership in the set of Hungarian IT firms with "very high networking outcome", and with "high networking outcome", coding membership as fully out of the set if a firm showed input values of the 25th percentile or below and fully in the set if a firm showed input values of the 75th percentile or higher. The crossover point was set at the medium (the 50th percentile). *Table T1 in the Appendix* shows both the non-calibrated data and the data after the applied calibration criteria. The calibrated fuzzy membership scores of the input and output variables can be found in the *Appendix* (T2 and T3).

4.3.2 Results

Using fuzzy-set QCA, we aim at exploring configurations of micro, meso and macro conditions of the entrepreneurial ecosystem that result in high or very high networking outcomes. As we pointed out in the methodology part, compared to symmetrical correlational connections, a key feature of set-theoretic arguments is that they are essentially asymmetric[14]. Therefore, we also examine the combinations that can explain *below-average*, i.e. *"low"* or *"very low" networking outcomes* of the IT firms.

After calibrating the raw scores into fuzzy membership, two steps remain to identify relevant configurations. First, our empirical analysis begins with the examination of conditions deemed *necessary* for a strong or very strong ecosystem, and then continues with the analysis of *sufficiency* conditions and configurations.

Necessary conditions

After calibrating both input and output variables into fuzzy set scores, the next step is to determine those *necessary conditions* which are required for the outcome. By convention, a condition is called "always necessary" or "almost always necessary" if the consistency score exceeds the threshold of 0.90 or 0.80 (*Ragin* 2008, *Schneider et al.*, 2010). The QCA software produces the consistency and coverage scores for individual conditions. In this context, consistency (with necessary measures) refers to *"the degree to which the causal condition is a superset of the outcome, while coverage indicates the empirical relevance of a consistent superset"* (*Ragin*, 2017, p. 20). *Table 6* presents the results of the necessary analysis for very high or high networking and its absence (very low or low networking).

[14] For detailed explanation see *Ragin*, 2008, p. 15. or *Rihoux and Ragin*, 2009, p. 89–94.

As the table shows, *entrepreneurial identity* (IV2) and *idea development* (IV5) achieved consistency scores higher than 0.80 so they can be considered almost always necessary for very high firm networking when we apply strict thresholds (VHN). The same two conditions are necessary conditions for very high informal networking (VHIN) with strict thresholds. Besides, *entrepreneurial attitude* (IV3) and *idea development* (IV5) are also conditions necessary for very high external networking applying strict thresholds (VHEN). Entrepreneurial *demographic characteristic (age)* (IV1) is a necessary prerequisite for very high formal networking (VHFN/HFN) using either permissive or strict thresholds. Examining the effect of weighted external orientation (VHEOw) of firms on networking, we found that *idea development* (IV5) is a necessary condition.

From these results, it can be concluded that different factors are necessary for informal, external or formal networking. Interestingly, the absence of *innovation capacity* (~IV6) is a necessary condition for very high informal networking (VHIN) under strict thresholds. Using permissive thresholds, other conditions for high/low networking cannot be considered necessary. In sum, achieving a very high outcome (degree of network) requires fulfilling certain necessary criteria, while achieving a smaller network does not require any necessary criteria.

Table 6 Summary table of necessary conditions

Strict version

Conditions	Very High Network (VHN)		~ VHN		Very High External Network (VHEN)		~ VHEN		Very High Informal Network (VHIN)		~ VHIN		Very High Formal Network (VHFN)		~ VHFN		Very High Weighted HHI (VHHHIw)		~ VHHHIw		Very High Weighted External Orientation (VHEOw)		~ VHEOw	
	Consistency	Coverage	Consistency	Coverage	Consistency	Coverage	Consistency	Coverage	Consistency	Coverage	Consistency	Coverage	Consistency	Coverage	Consistency	Coverage	Consistency	Coverage	Consistency	Coverage	Consistency	Coverage	Consistency	Coverage
Demography(fsIV1)	0.56	0.22	0.51	0.79	0.64	0.13	0.51	0.88	0.54	0.22	0.52	0.80	**0.98**	0.31	0.43	0.70	0.52	0.20	0.54	0.84	0.66	0.14	0.50	0.87
Entr. Identity (fsIV2)	**0.82**	0.32	0.45	0.69	0.71	0.14	0.49	0.86	**0.84**	0.35	0.46	0.70	0.25	0.08	0.57	0.92	0.38	0.15	0.57	0.88	0.40	0.08	0.53	0.92
Entr. Attitude (fsIV3)	0.69	0.29	0.45	0.73	**0.88**	0.18	0.46	0.84	0.73	0.32	0.44	0.70	0.41	0.14	0.53	0.90	0.33	0.13	0.55	0.90	0.69	0.15	0.48	0.86
Venture tenure (fsIV4)	0.61	0.24	0.49	0.76	0.42	0.08	0.53	0.93	0.63	0.26	0.48	0.74	0.64	0.21	0.49	0.79	0.43	0.17	0.56	0.87	0.26	0.05	0.54	0.94
Idea development (fsIV5)	**0.80**	0.31	0.46	0.70	**0.86**	0.17	0.49	0.85	**0.81**	0.33	0.46	0.69	0.60	0.19	0.51	0.82	0.61	0.23	0.51	0.78	**0.84**	0.18	0.49	0.83
Innov. Capacity (fsIV6)	0.24	0.09	0.61	0.91	0.34	0.06	0.56	0.94	0.22	0.09	0.63	0.93	0.47	0.14	0.55	0.86	0.54	0.20	0.54	0.81	0.46	0.09	0.54	0.91
Entr. Environment (fsIV7)	0.53	0.23	0.47	0.79	0.34	0.07	0.49	0.93	0.55	0.25	0.49	0.80	0.66	0.23	0.45	0.79	0.56	0.24	0.47	0.78	0.47	0.11	0.49	0.92
~fsIV1	0.48	0.20	0.49	0.81	0.44	0.09	0.49	0.92	0.52	0.23	0.49	0.79	0.08	0.02	0.57	0.99	0.59	0.25	0.48	0.79	0.42	0.09	0.50	0.92
~fsIV2	0.23	0.10	0.56	0.92	0.34	0.07	0.50	0.93	0.29	0.13	0.57	0.93	0.77	0.26	0.43	0.74	0.71	0.29	0.45	0.74	0.65	0.15	0.47	0.86
~fsIV3	0.35	0.14	0.56	0.87	0.28	0.05	0.55	0.97	0.33	0.14	0.57	0.88	0.71	0.23	0.49	0.80	0.76	0.30	0.46	0.73	0.43	0.09	0.53	0.93
~fsIV4	0.40	0.17	0.51	0.83	0.67	0.14	0.47	0.87	0.39	0.17	0.51	0.83	0.37	0.12	0.51	0.87	0.69	0.29	0.46	0.76	0.76	0.17	0.45	0.82
~fsIV5	0.25	0.11	0.55	0.91	0.25	0.05	0.51	0.96	0.26	0.12	0.55	0.91	0.44	0.15	0.49	0.86	0.44	0.19	0.50	0.83	0.24	0.05	0.51	0.96
~fsIV6	0.78	0.34	0.39	0.66	0.71	0.15	0.44	0.85	**0.83**	0.38	0.38	0.64	0.55	0.19	0.45	0.81	0.50	0.22	0.47	0.80	0.57	0.14	0.45	0.87
~fsIV7	0.51	0.20	0.53	0.81	0.69	0.13	0.50	0.86	0.57	0.23	0.54	0.81	0.41	0.13	0.56	0.89	0.50	0.19	0.54	0.83	0.67	0.14	0.52	0.88

Permissive version

Conditions	High Network (HN)		~ HN		High External Network (HEN)		~ HEN		High Informal Network (HIN)		~ HIN		High Formal Network (HFN)		~ HFN		High Weighted HHI (HHHIw)		~ HHHIw		High Weighted External Orientation (HEOw)		~ HEOw	
	Consistency	Coverage	Consistency	Coverage	Consistency	Coverage	Consistency	Coverage	Consistency	Coverage	Consistency	Coverage	Consistency	Coverage	Consistency	Coverage	Consistency	Coverage	Consistency	Coverage	Consistency	Coverage	Consistency	Coverage
Demography(fsIV1)	0.66	0.48	0.44	0.53	0.71	0.53	0.44	0.53	0.58	0.43	0.49	0.59	**0.80**	0.49	0.40	0.53	0.45	0.35	0.57	0.66	0.70	0.52	0.44	0.53
Entr. Identity (fsIV2)	0.54	0.39	0.50	0.61	0.49	0.37	0.55	0.65	0.66	0.50	0.43	0.51	0.43	0.26	0.56	0.74	0.28	0.21	0.68	0.80	0.49	0.37	0.54	0.64
Entr. Attitude (fsIV3)	0.61	0.47	0.43	0.54	0.56	0.44	0.46	0.58	0.68	0.54	0.41	0.52	0.45	0.29	0.51	0.72	0.28	0.23	0.64	0.78	0.57	0.45	0.45	0.57
Venture tenure (fsIV4)	0.70	0.51	0.44	0.53	0.67	0.50	0.45	0.54	0.67	0.50	0.43	0.51	0.67	0.41	0.45	0.60	0.34	0.26	0.65	0.76	0.65	0.49	0.45	0.54
Idea development (fsIV5)	0.67	0.48	0.45	0.54	0.68	0.51	0.45	0.53	0.69	0.51	0.44	0.52	0.67	0.40	0.46	0.60	0.48	0.36	0.56	0.65	0.69	0.51	0.44	0.52
Innov. Capacity (fsIV6)	0.36	0.25	0.64	0.75	0.53	0.38	0.56	0.65	0.37	0.26	0.65	0.75	0.50	0.30	0.55	0.71	0.67	0.50	0.45	0.51	0.52	0.38	0.58	0.66
Entr. Environment (fsIV7)	0.56	0.44	0.43	0.57	0.60	0.49	0.42	0.54	0.48	0.39	0.49	0.63	0.66	0.44	0.39	0.57	0.44	0.37	0.50	0.64	0.59	0.47	0.43	0.56
~fsIV1	0.36	0.28	0.57	0.73	0.37	0.30	0.60	0.76	0.45	0.36	0.52	0.66	0.23	0.15	0.61	0.87	0.56	0.46	0.44	0.55	0.37	0.30	0.60	0.76
~fsIV2	0.47	0.36	0.50	0.64	0.54	0.43	0.47	0.59	0.35	0.28	0.58	0.73	0.59	0.38	0.45	0.63	0.74	0.60	0.33	0.41	0.53	0.42	0.47	0.59
~fsIV3	0.41	0.30	0.58	0.71	0.46	0.35	0.55	0.67	0.39	0.29	0.63	0.76	0.57	0.35	0.49	0.66	0.73	0.57	0.37	0.44	0.45	0.34	0.56	0.67
~fsIV4	0.36	0.28	0.60	0.77	0.39	0.31	0.58	0.74	0.35	0.28	0.58	0.74	0.36	0.23	0.56	0.78	0.69	0.56	0.37	0.46	0.39	0.31	0.57	0.72
~fsIV5	0.37	0.29	0.56	0.74	0.36	0.29	0.58	0.74	0.35	0.28	0.58	0.75	0.35	0.23	0.54	0.78	0.54	0.45	0.45	0.56	0.35	0.28	0.58	0.75
~fsIV6	0.65	0.52	0.36	0.48	0.52	0.43	0.46	0.61	0.66	0.54	0.36	0.48	0.52	0.35	0.45	0.66	0.35	0.29	0.56	0.72	0.54	0.44	0.46	0.60
~fsIV7	0.45	0.33	0.57	0.68	0.44	0.32	0.60	0.70	0.54	0.40	0.52	0.62	0.35	0.21	0.61	0.79	0.56	0.43	0.50	0.57	0.45	0.34	0.59	0.69

Note:

"~" indicates the absence of the condition (low or very low), e.g. ~VHN = very low networking, ~VHEN = very low external networking, ~HEN = low external networking, etc. Bold entries to emphasize that these values are greater than 0.9 or 0.8 (namely the minimum thresholds for identifying the "necessary" and "almost always necessary" conditions)

Source: own calculation.

Sufficient conditions

After the analysis of necessary conditions, we performed a fuzzy set analysis to identify those sufficient conditions from the micro, meso and macro EE factors which lead to very high/high or very low/low networking outcome. The results are shown in *Table 7*.

For identifying sufficient conditions, the first step is the construction of the truth table applying the fsQCA software. The truth table algorithm helps "*the assessment of the distribution of cases across different logically possible combinations of conditions*", and contributes to *"the assessment of the consistency of the evidence for each combination with the argument that the cases with this combination of conditions constitute a subset of the cases with the outcome*" (*Ragin*, 2017, p. 38). The truth table lists and sorts (according to the frequency and along with the cumulative percentage of cases) all the possible combinations of conditions and the empirical outcome associated with each configuration. The matrix contains 2^k rows, where k refers to the number of input variables. With the seven causal conditions, there are 128 (i.e. 2^7) corners to the vector space. These 128 corners match to 128 logically feasible arguments that can be composed using seven dichotomous causal conditions. Each of the 29 cases (firms) has some degree of membership in all 128 causal combinations and is unevenly distributed in the 7-dimensional vector space. There are good instances (i.e. firms with greater than 0.5 membership) of the 128 logically possible combinations of conditions. The other instances are so-called logical remainders while there are no solid empirical instances of any of them and therefore are handled as counterfactual cases for additional simplification. The next task is to establish a *number-of-cases threshold* to decide which combinations of causal conditions are empirically relevant. The general rule when selecting a frequency cutoff is that the larger the total N, the higher the frequency threshold. In this situation, a plausible threshold is a minimum of 1 case with greater than 0.5 membership in a combination. It means that those combinations that are valid for at least one case, have been selected and all other combinations with no cases are deleted.

As a next step, the combinations are listed according to their consistency scores. The value of this score shows the proportion of cases in the combination that displays the outcome in question. It is impossible to designate each case to just one combination (as in csQCA) because each case has some degree of membership in each configuration. However, due to the truth table, it is possible to report which configurations have strong cases, as the last column in this table indicates the degree of set-theoretic consistency of causal combinations as subsets of very high/high or very low/low networking outcomes. Consistency (with sufficiency) measures the truth value of each possible combination, showing that membership in a combination is a subset of membership in the outcome. While coverage shows how much of the outcome is covered (or explained) by each solution term and by the solution as a whole (*Ragin*, 2017, p. 60). To select the combinations, a threshold value for consistency should be determined. In this case, the consistency value was set on 0.8 as *Khedhaouria and Thurik* (2017) used[15]. It means that combinations with a consistency score equal to or above 0.8 are labelled 1, otherwise 0.

In fuzzy-set QCA logical reminders are crucial. Based on their role in the analysis, the fsQCA offers three different solutions applying the Boolean minimization process: (1) a "complex" solution, (2) a "parsimonious" solution and (3) an "intermediate" solution. The first solution does not contain the so-called logical remainders[16], while the second and third ones do. However, the parsimonious solution involves all of them and the intermediate solution contains only those which are plausible for the analysis. Here, following the recommendation of Ragin (2008), we present the intermediate solutions, because this solution does not allow the removal of all necessary conditions, therefore it is superior to the other solutions (*Rihoux and Ragin*, 2009).

In *Table 7* we show only those combinations with sizable empirical weights according to their values of unique coverage (see *Wu et al.* 2019). Unique coverage means *"the proportion of memberships in the outcome explained solely by each individual solution term (memberships that are not covered by other solution terms)"* (*Ragin*, 2017, p. 61). The table shows the casual paths for a very high or high (configuration C1–C5) and a very low or low firm networking (configuration C6–C18). *Woodside* (2013) suggests that a model (solution) can be considered informative when overall solution consistency is above 0.74 and coverage is between 0.25 and 0.65.[17] This means that the causal conditions present in these configurations are highly consistent subsets of the solution. The overall solution coverage indicates that these causal conditions account for at least 25% of the membership in the solution.

— *Configuration C1* sufficiently accounts for *very high networking (VHN)* by 70% of the total cases and covers 28% of them, i.e. using strict thresholds high firm demography (entrepreneurial experience and past) in combination with high entrepreneurial identity,

[15] *Ragin and Rihoux* (2009) recommended that it should be avoid to set this value below 0.75, since it represents substantial inconsistency.

[16] Logical remainders are the not observed combinations which were excluded through the Boolean minimization process (*Rihoux and Ragin*, 2009).

17 Solution Consistency is *"the degree to which membership in the solution (the set of solution terms) is a subset of membership in the outcome"*, while solution coverage refers to "*the proportion of memberships in the outcome that is explained by the complete solution"*. (see calculation in *Ragin*, 2017, p. 61).

attitude, venture tenure (age), idea development with low innovation capacity and low entrepreneurial environment lead to very high firm networking.

- *Configuration C2* sufficiently accounts for *very high informal networking (VHIN)* by 72% of the total cases and covers 27% of them. The configuration covers the same causal conditions as C1.
- *Configuration C3* sufficiently accounts for *high informal networking (HIN)* by 85% of the total cases and covers 21% of them, i.e. using permissive thresholds high firm demography (entrepreneurial experience and past) in combination with high entrepreneurial identity, attitude, tenure (age) with low innovation capacity and low entrepreneurial environment lead to high informal networking between firms. In this combination, high informal networking can be achieved regardless of whether idea development is supportive, as indicated by the blank space that signals a “don't care” situation.
- *Configurations C4* and *C5* together exhibit *high formal networking (HFN)* by 78% of the total cases and covers 41% of them. According to C4, using permissive thresholds high firm demography in combination with low identity, attitude and low idea development with a high tenure, innovation capacity and high entrepreneurial environment lead to high formal networking. While, according to C5 a very high firm demography, high innovation capacity and high entrepreneurial environment with moderate identity, attitude, tenure and idea development can lead to high formal networking.

At the same time, the asymmetric thinking of fsQCA helps us to explore the alternative combination for achieving very low/low firm networking, which is also key for our research:

- *Configurations C6* and *C7* sufficiently account for *very low firm networking* (~VHN) by 90% of the total cases and cover 60% of them. According to C6, using strict thresholds moderate firm demography in combination with a low level of identity and attitude and a very low level of idea development, and with a high tenure and very high innovation capacity can lead to very low firm networking. In this combination, very low networking can be achieved regardless of the entrepreneurial environment being supportive or not. On the other hand, low demography, identity, attitude, entrepreneurial environment and a very low tenure and idea development in combination with a very high innovation capacity lead to very low firm networking between firms.

— *Configuration C8* sufficiently accounts for *low firm networking* (~HN) by 91% of the total cases and covers 39% of them. This configuration is very similar to C7 (but in this case using permissive thresholds).

— *Configurations C9* and *C10* together sufficiently account for *very low firm external networking (~VHEN)* by 93% of total cases and cover 44% of them. According to C9 very low demography, a low altitude and low innovation capacity in combination with a moderate-high identity, idea development and entrepreneurial environment lead to a very low firm external networking. In this combination, very low external networking can be achieved regardless of whether the venture tenure is supportive or not, as indicated by the blank space that signals a “don't care” situation. According to C10, using strict thresholds very low demography, idea development and entrepreneurial environment in combination with a low identity, attitude and venture tenure with a moderate-high innovation capacity lead to very low external networking.

— *Configuration C11* sufficiently accounts for *low firm external networking (~HEN)* by 95% of total cases and covers 39% of them. This configuration is very similar to C7 (but in this case using permissive thresholds).

— *Configuration C12* and *C13* together sufficiently account for a *very low firm informal networking* (~VHIN) by 94% of total cases and cover 57% of them. According to C12 a very low idea development with a low identity and attitude in combination with moderate-high venture tenure with a high demography and high innovation capacity lead to very low informal networking. In this combination, very low informal networking capability can be achieved regardless of whether the entrepreneurial environment is supportive or not, as indicated by the blank space that signals a “don't care” situation. On the other hand, according to C13, using strict threshold a very low venture tenure and idea development with low demography, identity, attitude and low entrepreneurial environment in combination with a high innovation capacity can lead to very low informal networking.

— *Configuration C14* and *C15* together sufficiently account for a *low firm informal networking* (~HIN) by 89% of total cases and cover 53% of them. In these combinations we use permissive thresholds, the combinations show very similar results to C12 and C13.

— *Configuration C16 and C17* sufficiently account for *very low firm formal networking* (~VHFN) by 99% of total cases and cover 49% of them. According to the C17 combination, using strict thresholds very low demography, with very low venture tenure and idea development with low identity and attitude in combination with high innovation capacity lead to very low formal networking.

— C18 represents the combination using permissive thresholds. This combination sufficiently accounts for a *low firm formal network* (~HFN) by 98% of total cases and covers 40% of them. The combination is very similar to C17.

We use the symbols for configuration solutions that have been widely used in the QCA literature. A black circle (●) indicates the presence of a condition, while the circle with a cross (⊗) means its absence. This indicates a "do not care" solution in which the causal condition can be either present or absent sufficiently leading to a particular outcome. Blank spaces refer to a “not important” condition. To distinguish core conditions from peripheral ones, we have large circles to indicate the core, and small circles to indicate peripheral conditions. Note that core conditions are derived from parsimonious solutions and that peripheral conditions are from intermediate solutions. Also note that intermediate solutions constitute subsets of the most parsimonious (or simplest) solution.

Table 7 Sufficiency conditions for very high/high and very low/low networking outcome

Conditions	Configurations																	
	VHN	VHIN	HIN	HFN		~VHN	~HN		~VHEN		~HEN	~VHIN		~HIN		~VHFN		~HFN
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18
	1	1	1	1	2	1	2	1	1	2	1	1	2	1	2	1	2	1
Demography (IV1)	●	●	●	●	●	●	⊗	⊗	⊗	⊗	⊗	●	⊗	●	⊗	⊗	⊗	⊗
Identity (IV2)	●	●	●	⊗	●	⊗	⊗	⊗	●	⊗	⊗	⊗	⊗	⊗	⊗	●	⊗	⊗
Attitude (IV3)	●	●	●	⊗	●	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
Tenure (IV4)	●	●	●	●	●	●	⊗	⊗		⊗	⊗	●	⊗	●	⊗		⊗	⊗
Idea (IV5)	●	●		⊗	●	⊗	⊗	⊗	●	⊗	⊗	⊗	⊗	⊗	⊗	●	⊗	
Capacity (IV6)	⊗	⊗	⊗	●	●	●	●	●	⊗	●	●	●	●	●	⊗	⊗	●	●
Environment (IV7)	⊗	⊗	⊗	●	●		⊗	⊗	●	⊗	⊗		⊗		⊗	●	⊗	⊗
Raw coverage	0.277311	0.27186	0.211607	0.273913	0.145652	0.187651	0.162566	0.182825	0.130374	0.154877	0.187289	0.191105	0.148393	0.213483	0.185393	0.131732	0.139602	).169192
Unique coverage	0.277311	0.27186	0.211607	0.265217	0.136956	0.136517	0.119633	0.137396	0.107258	0.113731	0.138358	0.144430	0.109203	0.162921	0.139326	0.085749	0.102734	).124242
Consistency	0.702128	0.72766	0.849462	0.726225	0.740332	0.896313	1.000000	0.979228	0.875776	0.994065	0.988131	1.000000	1.000000	0.875576	0.979228	0.987578	1.000000	).994065
Overall solution coverage	**0.277311**	**0.27186**	**0.211607**	**0.410870**		**0.599614**		**0.390028**	**0.444753**		**0.392013**	**0.572875**		**0.530899**		**0.491715**		**0.40202**
Overall solution consistency	**0.702128**	**0.727660**	**0.849462**	**0.784232**		**0.902032**		**0.910737**	**0.933075**		**0.952186**	**0.944122**		**0.891509**		**0.992475**		**0.983931**

Note: "~" indicates the absence of the condition (low or very low), e.g. ~VHN = very low networking, ~VHEN = very low external networking, ~HEN = low external networking, etc. Black circles (●) indicate the presence of a condition and the circle with a cross (⊗) indicates its absence.

Source: own calculation.

5. Discussion and conclusions

The network of actors and institutions holds the whole entrepreneurial ecosystem together. In essence, without networking, without this "connective tissue", there would be no ecosystem. Although recent theoretical framework models highlight the importance of networking, at the same time, we still find only a negligible body of literature that offers a methodological solution for examining the networks of ecosystem actors. With our study, we want to ease this shortcoming, so we incorporated networking as the cohesive force of the ecosystem into our EE theoretical framework. Based on the literature, we started from the premise that the networking abilities of entrepreneurs are primarily determined by their personal (psychological) traits, behavior, thinking, aspirations, etc., and by the main characteristics of their organizations. At the same time, both the individual's abilities, thinking, attitudes, and the created organizations are affected by the contexts in which they are embedded.

The results presented in Section 4.1 and 4.2 support our hypothesis that the number of relationships among actors (here firms), their network degree (quantity) and diversity (quality), are influenced by their individual and organizational characteristics and contexts. According to Pearson's correlation coefficient, there is no significant relationship between the previous business experience of the CEOs of the ICT firms and the size of their network. Furthermore, we conclude that although the leaders of the sampled ICT companies do not have a dominant entrepreneurial identity, but the majority of them consider themselves as a developer and/or explorer rather than a founder type of entrepreneur. The correlation showed that there is a significant, moderately positive relationship between the developer type of entrepreneur and the size of his/her network. That is, the more developer type a leader is, the larger his network. We also examined the characteristics of the firms themselves. We found that there is no relationship between the age of the ICT firms and the size of these firms' networks. At the same time, it was found that companies with different leadership styles are characterized by different sized networks. According to company executives, companies' willingness to innovate is most hindered by strict financial and investment regulations required to develop new ideas, risk-averse attitudes towards product development, inefficient corporate management and prolonged successful market launch. Overall, the study confirmed that an organizational environment that is less supportive of innovation harms the size of the networks. The interviewed executives generally had a negative assessment of the environmental context in which they currently operate. The analysis showed that the existence of a good "role model", the right "social perceptions", the advanced physical infrastructure and the right business network can have a positive impact on networking activity.

To understand the combined role of individual, organizational, and environmental factors in the networking activity of the leaders of Hungarian ICT firms in Pécs, we had to find a research method that can address these factors in a systemic approach rather than in isolation. Therefore, we chose the fuzzy QCA method, which can identify the configurations of individual, organizational, and environmental factors required for high (or low) networking activity. Furthermore, the method can be used effectively for a small sample. The stricter the thresholds that we consider to be a high or very high network, the more likely it is that there are some necessary factors without which a very high network cannot be achieved. The study shows that a proper entrepreneurial identity and sufficient idea development activities are essential to building a *very high network*. Similarly, this is required for a *high informal network*. At the same time, our results confirmed that informal networking is constrained by an organizational environment that inhibits innovation. Besides the activity of idea development, a *high external network* (outside the region or abroad) requires a more appropriate entrepreneurial attitude: i.e. proactivity, innovation and high risk-taking. In contrast to the case above, *very high or high formal networking* requires a long entrepreneurial past and experience.

Sufficient conditions for high and very high networking were also examined. It can be concluded that there is only one possible configuration that allows one to develop high or very high networks in the ICT industry: for both general and informal networking, company leaders need to have the right entrepreneurial characteristics, while neither the organizational environment nor general context matter. However, there are two ways to achieve a high or very high formal network: whether or not leaders have important entrepreneurial qualities (entrepreneurial identity, attitude and capability of idea development), it is the entrepreneur's past and the organization's steady market presence (age), the favorable organizational and general context are the ecosystem factors that matter here. Several configurations can result in low or very low networking, but in general, it is typical that while the organizational context is appropriate, at the same time the characteristics of the entrepreneur and the general context are responsible for low networking. These findings provide a series of implications on academic, as well as policy levels.

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Appendix

T1. Non-calibrated and calibrated data statistics (thresholds)

Variables	Statistics															
	Min		25th percentiles		50th percentiles		Halfway 2		75th percentiles		Halfway 1		95th percentiles		Max	
	Un-calib.dat	*Calib. Data*	*Un-calib.dat*	*Calib. Data*	*Un-calib.dat*	*Calib. Data*	*Un-calib.dat*	*Calib. Data*	*Un-calib.dat*	*Calib. Data*	*Un-calib.dat*	*Calib. Data*	*Un-calib.dat*	*Calib. Data*	*Un-calib.dat*	*Calib. Data*
Conditional variables																
Demography (IV1)	9	0	12	0.05	17	0.5			22	0.95					32	1.0
Entr. Identity (IV2)	38	0	48	0.05	50	0.5			53	0.95					56	1.0
Entr. Attitude (IV3)	25	0	34	0.05	36	0.5			39	0.95					46	1.0
Venture tenure (IV4)	4	0	8	0.05	13	0.5			15	0.95					29	1.0
Idea development (IV5)	19	0	29	0.05	31	0.5			34	0.95					37	1.0
Innovation Capacity (IV6)	23	0	26	0.05	34	0.5			36	0.95					41	1.0
Entr. Environment (IV7)	25	0	31	0.05	34	0.5			35.8	0.95					41	1.0
Outcome variables																
Strict version - *"very high networking"*																
Very high network (VHN)	12	0							18	0.05	19	0.5	20	0.95	30	1.0
Very high external network (VHEN)	0	0							6	0.05	7.9	0.5	9.8	0.95	12	1.0
Very high informal network (VHIN)	6	0							12	0.05	14	0.5	16	0.95	21	1.0
Very high formal network (VHFN)	3	0							6	0.05	6.8	0.5	7.6	0.95	9	1.0
Very high Weighted HHI (VHHHIw)	0.65	0							1.9	0.05	1.14	0.5	1.2	0.95	1.38	1.0
Very high weighted external orientation (VHEOw)	0	0							1.57	0.05	1.84	0.5	2.11	0.95	2.78	1.0
Strict version - *"high networking"*																
High network (HN)	12	0			16	0.05	17	0.5	18	0.95					30	1.0
High external network (HEN)	0	0			3	0.05	4.5	0.5	6	0.95					12	1.0
High informal network (HIN)	6	0			10	0.05	11	0.5	12	0.95					21	1.0
High formal network (HFN)	3	0			5	0.05	5.5	0.5	6	0.95					9	1.0
High weighted HHI (VHHHIw)	0.65	0			0.99	0.05	1.04	0.5	1.2	0.95					1.38	1.0
High weighted external orientation (VHEOw)	0	0			0.76	0.05	1.17	0.5	1.57	0.95					2.78	1.0

Source: own calculation.

T2. Calibrated independent variables

Firm ID	fsIV1	fsIV2	fsIV3	fsIV4	fsIV5	fsIV6	fsIV7
1	0.35	0.88	0.18	0.99	0.98	0.25	1.00
2	0.50	0.00	0.00	0.95	0.00	0.95	0.97
3	0.95	0.05	0.18	0.01	1.00	0.05	0.50
4	0.95	0.00	0.50	0.99	0.05	1.00	1.00
5	0.95	1.00	1.00	0.57	0.99	0.02	0.05
6	0.92	0.50	0.98	1.00	0.88	0.02	0.50
7	0.97	0.50	0.98	1.00	0.88	0.02	0.50
8	0.03	0.00	0.00	0.03	0.00	1.00	0.00
9	0.05	0.95	0.18	0.01	0.17	0.99	0.50
10	0.95	0.00	0.00	1.00	0.05	1.00	1.00
11	0.95	1.00	1.00	0.57	0.17	0.02	0.05
12	0.01	0.95	0.73	0.01	0.72	0.02	0.50
13	0.05	0.88	1.00	0.05	0.98	0.05	0.05
14	0.03	0.18	0.05	0.03	0.05	0.95	0.12
15	0.95	0.05	0.18	0.38	1.00	0.05	0.50
16	0.95	1.00	0.95	1.00	0.95	1.00	1.00
17	0.35	0.88	1.00	0.25	0.99	0.05	0.00
18	0.01	0.50	0.98	1.00	0.88	0.02	0.50
19	0.97	0.88	0.50	0.84	0.01	0.95	0.84
20	0.77	0.00	0.00	0.57	0.00	1.00	0.00
21	0.50	0.73	0.18	0.25	0.88	0.18	0.99
22	1.00	0.00	0.00	1.00	0.05	1.00	1.00
23	0.03	0.18	0.05	0.01	0.05	0.95	0.12
24	0.08	0.95	0.05	0.25	0.95	0.13	1.00
25	0.50	0.18	0.73	0.57	0.17	0.95	0.05
26	0.08	0.73	0.95	0.38	0.46	0.95	0.12
27	1.00	0.01	0.88	0.25	0.95	0.95	0.00
28	0.08	0.95	0.05	0.95	0.72	0.50	0.50
29	0.03	0.98	0.95	0.00	0.17	0.41	0.50

T3. Calibrated outcome variables

Firm ID	fs VHN	fs VHEN	fs VHIN	fs VHFN	fs HN	fs HEN	fs HIN	fs HFN	fs VHHHIw	fs HHHIw	fs VHEOw	fs HEOw
1	0.95	0.05	0.82	0.05	1.00	0.95	1.00	0.95	0,00	0,00	0,00	0,76
2	0.00	0.00	0.00	0.00	0.00	0.01	0.05	0.00	0,96	1,00	0,00	0,02
3	0.00	0.05	0.00	0.68	0.00	0.95	0.00	1.00	1,00	1,00	0,67	1,00
4	0.05	0.19	0.01	0.68	0.95	0.99	0.50	1.00	0,00	0,02	0,16	0,98
5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0,00	0,00	0,04	0,95
6	0.95	0.00	0.95	0.00	1.00	0.01	1.00	0.00	0,00	0,00	0,00	0,00
7	0.95	0.00	0.95	0.00	1.00	0.01	1.00	0.00	0,00	0,00	0,00	0,00
8	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.05	0,09	0,98	0,00	0,02
9	0.95	0.00	0.95	0.00	1.00	0.01	1.00	0.00	0,00	0,03	0,00	0,00
10	0.00	0.05	0.00	0.68	0.05	0.95	0.00	1.00	0,01	0,67	0,12	0,98
11	0.00	0.00	0.05	0.00	0.50	0.05	0.95	0.05	0,00	0,00	0,00	0,05
12	0.95	0.99	0.95	0.00	1.00	1.00	1.00	0.00	0,00	0,00	1,00	1,00
13	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.95	0,00	0,06	0,00	0,00
14	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0,45	1,00	0,00	0,00
15	0.05	0.00	0.00	0.99	0.95	0.05	0.05	1.00	0,87	1,00	0,00	0,06
16	0.00	0.05	0.00	0.05	0.05	0.95	0.05	0.95	0,00	0,00	0,12	0,98
17	0.00	0.01	0.00	0.00	0.00	0.73	0.00	0.05	0,00	0,03	0,05	0,95
18	0.05	0.05	0.50	0.00	0.95	0.95	1.00	0.00	0,00	0,00	0,11	0,97
19	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.05	0,00	0,05	0,00	0,00
20	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.05	0,00	0,00	0,00	0,23
21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0,05	0,95	0,00	0,00
22	0.05	0.05	0.01	0.68	0.95	0.95	0.50	1.00	0,00	0,00	0,01	0,89
23	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0,05	0,95	0,00	0,00
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0,98	1,00	0,00	0,00
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0,43	1,00	0,00	0,00
26	0.00	0.00	0.00	0.00	0.00	0.01	0.05	0.05	1,00	1,00	0,00	0,02
27	0.00	0.54	0.05	0.00	0.50	1.00	0.95	0.05	0,01	0,78	1,00	1,00
28	0.00	0.00	0.05	0.00	0.05	0.27	0.95	0.00	0,00	0,00	0,00	0,34
29	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.00	0,00	0,00	0,00	0,01