

Cantner, Uwe; Wolf, Tina

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The selective nature of innovator networks: From the nascent to the early growth phase of the organizational life cycle

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by

**Uwe Cantner
Tina Wolf**

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The selective nature of innovator networks: from the nascent to the early growth phase of the organizational life cycle

Uwe Cantner^{1,2}

Tina Wolf¹

¹Friedrich Schiller University Jena
School of Economics and Business Administration
DFG Graduate School "Economics of Innovative Change" (DFG-GRK 1411)
Carl-Zeiss-Str. 3
07743 Jena, Germany

²University of Southern Denmark
Department of Marketing and Management
I2M Group
Campusvej 55
DK-5230 Odense M

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Abstract

Earlier studies have shown that entrepreneurs play a key role in shaping regional development. Innovator networks where these entrepreneurs are members of have been identified as one among many critical factors for their firms' success. This paper intends to go one step further and analyses in how far differing characteristics of these networks lead to different firm performances along the early stages of the organizational life cycle (nascent stage, emergent stage, early growth stage). A sample of 149 patenting (innovative) firms in Thuringia is analysed, using data from the commercial register and the German patent office. The results show that there is an inverted u-shaped relationship between the chances of a firm to survive and the connectivity of the network the firms are connected to but only in the later stage of the early organizational

life cycle; while the structure of the ego-network never plays a role. A quite central position in the network shows-up to be unfavourable.

1. Introduction

Over the 1990s, scholars have come to the consensus that networks play an important role for the emergence and survival of new ventures (Aldrich and Reese 1993, Larson and Starr 1993, Stuart et al. 1999). However, with regards to the evolutionary process behind firm growth and survival at different stages of the organizational life cycle (Hite and Hesterly 2001), recent interest has been devoted to the variable ‘location’ as a critical factor, shaping firm performance.

We elaborate the approach of regional innovator networks (RIN) which can be defined as networks that are built up by actors who cooperatively engage in the creation of new ideas and then economize the results (Cantner and Graf 2007), where the economization can be realized within an existing firm or by the formation of a new venture. In a previous study (Cantner and Wolf 2016) we found that for a new venture being simply connected to the innovator network increases the survival probability. The further step in this paper is to look at the “quality” of the network and of how a new venture is connected to the network (position in the network, relation to other actors, bridging functions). Examining the relationship between network position of the founder and survival of firms can provide both, an estimation of the role of different elements of network structure in firms’ success and an empirical indicator for the effectiveness of knowledge flows through networks.

According to the propositions by Hite and Hesterly (2001), an analysis of the relationship between the selectivity of the innovator network and start-ups’ survival cannot be conducted independently of the organizational life cycle status of the individual firm. Therefore, we consider three early stages in the life cycle, namely, the nascent stage, the founding stage and the post founding stage, and ask the following research question: *What role does the structure of the innovator network, the position of the founder(s) in the network and the structure of the founder’s ego-network play for the survival of firms in the early stages of the organizational life cycle?*

To address this overarching research question, we have constructed a biographical firm dataset, based upon data on incorporations of enterprises in

Thuringia as well as on patent data comprising all German patents applied for at the German Patent Office.

The reminder of the research paper goes as follows: Section 2 introduces the early stages of the organizational life cycle. Section 3 explains how knowledge diffuses in regional innovator networks. Section 4 combines the arguments of sections 2 and 3 and explains how the stages of the organizational life cycle and the regional innovator network do coevolve. Section 5 describes the database, section 6 the variables and methodology used. In section 7, we present the empirical results while we conclude in section 8.

2. Organizational life cycle

In strategy and entrepreneurship research, organizational life cycles are used to explain how firms evolve through the following (mostly five) progressive stages: emergence, early growth, later growth, maturity and death (Churchill and Levis 1983, Gartner et al. 1992). These studies expect that the emergence stage of the firm, and with this it's life, begins when the organization is legally created (Gartner et al. 1992). However, as Reynolds (2000) argues, there is also an important phase before the legal founding which is the conception or nascent stage of the firm life.

In this paper, we will concentrate on the phases between nascent entrepreneurship and early growth of the firm. Throughout all the phases of a firm's life, the strategic goals, natural resource needs and acquisition challenges are changing several times (Hite and Hesterly 2001).

A nascent entrepreneur can be defined as 'someone who initiates serious activities that are intended to culminate in a viable business startup' (Aldrich 1999, p. 77). This means that in this phase, the nascent entrepreneur is experimenting with different business ideas, starts to take care of the first stages in the founding process (like writing a business plan) and starts to collect resources along with applying for financial funds. Depending on the industry/technology the start-up will be active in, the founder(s) might also start to produce first prototypes. In this phase there seems to be no real strategic orientation but the four factors entrepreneurial personality, environment, resources, and founding process comprehensively influence founding success (Kessler and Frank 2009, Cantner and Stuetzner 2013).

After the legal founding of the firm, the emergence stage begins (Gartner et al. 1992). In the emergence stage, the firm starts to act on the real market such that one could say that after the legal founding the start-up enters in to the selective process of competition. In this phase the only strategic goal of the firm is not to die, thus to survive the selection process (Hite and Hesterly 2001). With respect to resources, these newborn firms usually lack internal resources and capabilities to reach this goal (Baum 1996). Additionally the operations of emerging firms are characterized by a high degree of uncertainty and equivocality (Gartner et al. 1992) as well as by a lower degree of legitimacy and reputation (Hite and Hesterly 2001).

If the firm enters the early growth stage, it has survived already the toughest part of the competition process, usually due to a competitive advantage. Now the firm is settled in the market and might be for the first time able to set its own conditions. Thus, when the firm enters the early growth stage it starts to make real strategic decisions and therefore requires a broader scope of resources but, however, could already gain legitimacy and reputation which reduces uncertainty (Hite and Hesterly 2001).

Organizational life cycle theory does not describe the exact time span or duration for the single phases of the life cycle. This is not surprising since the development of a firm is an individual process which differs from firm to firm. The nascent stage is usually considered to take around three years (Kessler and Frank 2009). After the legal firm founding, it is well known that survival rates are very low in the beginning due to the liabilities of newness and smallness (Parker 2009). After an initial honeymoon phase (which is the emergence stage according to the organizational life cycle theory), many small and young firms suffer from these liabilities and exit while others enter the early growth stage. Studies on the distribution of survival rates see the length of the emergence stage somewhere between five and seven years (Phillips and Kirchhoff 1989, Bartelsman et al. 2005).

Of course along with the changes in needs for the young firms, the influence of the social (scientific) network around the founders changes. Before elaborating this, we start by describing the role of innovative networks per se.

3. Knowledge diffusion in RINs

We define the RIN as a network that is built up by actors, living in a certain region, which cooperatively engage in the creation of new ideas and then economize on the results in the market - either within an existing firm or by the formation of a new venture (Cantner and Graf 2007, Balconi et al. 2004). Innovative actors building the RIN are employees of firms, of research institutes or of universities, students or self-employed persons who actively engage in research (Cantner and Wolf 2016).

After we have defined the innovator network, the following question arises: How can the connection of single actors to the RIN contribute to firms' innovation? As mentioned in the definition, the RIN inherits connections among actors that are engaged in research, no matter if it is basic or applied (Cantner and Graf 2007, Balconi et al. 2004). These actors usually are experienced experts and they have current knowledge in their field. Since knowledge can be codified or tacit, acquiring new knowledge pieces may require personal contacts to other actors which possess this new knowledge (Howells 2002). Breschi and Lissoni (2006) argue that pure knowledge spillovers can only take place by trade-unrelated personal communication or through reverse engineering. However, when tacitness of knowledge plays a role, knowledge spillovers are not possible anymore without active participation of the inventor. Thus, actors that are connected to the social network of innovators will receive more new knowledge pieces than an isolated actor and they will therefore have a higher probability to find new combinations.

As pointed out: Knowledge, which is possessed by actors and transferred via the RIN, is an important prerequisite for the generation of innovations within a firm. By definition, actors connected to the RIN intend to economize their research's results (Cantner and Graf 2007). This can happen within an existing firm or by founding a new one. Thus, a firm whose employees or founders are connected to the innovator network will be more likely to be innovative than firms whose employees or founders are isolated from this network (Cantner and Wolf 2016). With respect to the creation of a new firm, the interpretation of the contribution of an entrepreneur's network to the firms' scientific knowledge base is similar to the notion by Murray (2004) but we adapt it to entrepreneurship theory. Murray (2004) investigates in how far academic

scientists contribute to the firm's own scientific network by providing their scientific social capital. Our notion of the regional innovator network points to the importance of the whole research community within a region. Furthermore, we expect an entrepreneur who is connected to this regional research community (from now on, we call him networked-founder), not an academic inventor as Murray (2004) does, to bring his scientific social capital to the firm and to also intent to translate it to the firms' scientific network. This so called scientific social capital of the firm is even increased if there is more than one networked-founder (team founding). Thus, the scientific human capital of the founder(s) leads a firm to become embedded within the scientific community of the region. Scholars have argued that linkages and the resulting networks are key vehicles through which firms obtain access to external knowledge (Powell et al. 1996). The connection to such a network delivers information and it is a vehicle for the rapid communication of news about opportunities and obstacles. Thus, the generation of innovation and the recognition of new market opportunities are eased, which both are drivers of growth and survival (Audretsch 1995).

4. Early stages in the organizational life cycle and the evolution of firm networks

As argued above, the needs of a firm change along its life cycle and consequently the exigence to the innovator network changes over time. At the same time, the network itself evolves and changes. This is due to the process of dynamic network evolution where firms strategically adapt and align their networks to serve their needs (Golden and Dollinger 1993, Ostgaard and Birley 1994, Balland et al. 2015). This means that the individual firm changes its ego-network but, if all firms do this, naturally the whole network changes. Therefore, in contrast to Hite and Hesterly (2001) who specifically focus on the egocentric network of the firm, we will additionally consider the structure of the whole regional innovator network as influential factor on firm success.

4.1 Structural issues on the diffusion of knowledge in RINs

It has been pointed out in chapter 3 that the connection to a regional innovator network can influence firm's innovative success and in line with this, firms' growth and survival. If we consider start-ups, connected to the RIN, specific

effects of network structures on the organizational performance may play a role. These specific effects also depend on the stage in the organizational life cycle and the related strategic needs of the firms.

Considering the nascent stage of the firm's live, Cantner and Stuetzer (2013) show that factors like start-up capital, the functional background and entrepreneurial experience of the founders seem to overweight the importance of social capital for the success of the new venture. The founders are too busy in writing the business plan, getting funds and find a niche to put their business idea in that the scientific social capital plays a less relevant role in this stage of the organizational life cycle. Therefore, we expect that the structural form of the innovator network does not influence the firm in this very early stage:

Hypothesis 1-a:

*The connectivity of the innovator network in the **nascent stage** of the organizational life cycle does not influence the firms' chances to survive.*

In the emergent stage, the firm already entered into the market and started to compete with other actors in this market. In this phase, the founders need to know everything that is going on in the technological field. In highly connected networks where one finds connections between many of the actors, knowledge can flow quite fluently from one actor to the other. Gilsing et al. (2008) additionally argue that highly connected networks help to understand new knowledge adequately since partners may complement actors' absorptive capacities and they help building up trust by reputation. For example Fershtman and Gandal (2011) find for open source software projects that the success of the projects there is a positive connection to the closeness centrality of the project network. Also Meagher and Rogers (2004) prove formally that there exists a feedback between spillovers and innovation and that those industries with a greater network density have a higher proportion of innovators. Cohesive networks are characterized by high density, high mutuality among ties and a relative high frequency of ties among group members, while in sparsely connected networks, where fragmentation is quite high, only a small number of knowledge spillovers may occur (Wasserman and Faust 1994). During the emergence stage, young firms profit from better access to resources and a mutual understanding which is driven by a high degree of

trust and expected future reciprocity (Hite and Hesterly 2001). Therefore, we hypothesize that:

Hypothesis 1-b:

*Firms have higher chances to survive if the connectivity of the net their founder is connected to is high in the **emergent stage**.*

When the firm develops and enters into the early growth stage, the advantages of a very cohesive network may turn into disadvantages. First, the costs associated with maintaining contacts to many actors are quite high (Burt 1992). Second, if there are many direct and indirect ties in the net, every actor knows what the other actors know and therefore it is less likely to gain new knowledge inflows from the net (Gilsing et al. 2008). Third, there is the risk of undesired knowledge spillovers in a way that the partners of actor A's partners may receive parts of A's knowledge although A doesn't want it (Gilsing and Nooteboom 2005). Therefore, in the early growth stage, the fragmented network becomes more appropriate (Hite and Hesterly 2001). Thus, we hypothesize the following:

Hypothesis 1-c:

*Firms have higher chances to survive if the connectivity of the net their founder is connected to is low in the **early growth stage** of the organizational life cycle.*

4.2 Entrepreneurs position in the RIN and knowledge flows to the firm

After we have defined in chapter 4.1 how the net as a whole should look like to positively contribute to the survival of the nascent and young firm, we now have a look at the founder's position in the net. Which position of a single node (networked-founder) is favourable to profit as much as possible from knowledge flows in the net? And how does this depend on the stage in the organizational life cycle?

If we look at the entrepreneurs' position in the network, we basically look at how important he is. In graph theory, centrality is a measure of how well connected or active an actor is in the overall network. Thus centrality helps measuring how prominent or important single actors are in the net (Wasserman

and Faust 1994). The actor with the highest centrality, is the one “where the action is” as he is the most visible actor in the network (Gilsing et al. 2008).

As argued above, in the nascent stage, factors like start-up capital, the functional background and entrepreneurial experience of the founders are the main factors, influencing firm survival (Cantner and Stuetzer 2013). Therefore, we again expect that the entrepreneurs’ position in the network does not influence the chances of his chances to survive. Therefore, hypothesis 2a goes as follows:

Hypothesis 2a:

*A central position of the networked-founder’ in the RIN in the **nascent stage** of the organizational life cycle does not influence firm survival.*

After the firm entered the market, it needs to know everything that is going on in the technological field. A networked-founder, with a high degree centrality is in direct contact or adjacent to many other actors (networked-founders or inventors) such that this founder should be recognized by others as a major channel of information. This makes it more likely for him to receive knowledge spillovers, thus information about opportunities or obstacles. Consequently, we hypothesize:

Hypothesis 2b:

*The more central the position of the networked-founder’ in the RIN in the **emergent stage** of the organizational life cycle the higher are the firms’ chances to survive.*

We argued above that the firms’ need for a cohesive network decreases over the life cycle, due to a better control of the resource and knowledge flows between the other actors (Hite and Hesterly 2001). If we now consider the position of the founder in the network, we might expect that central actors may be comparably able to control knowledge flows and even use this position for his own purposes (Burt 1992). This then makes it more likely for the networked founder to receive and control knowledge spillovers. Therefore, we hypothesize for the early growth stage that:

Hypothesis 2c:

*The more central the position of the networked-founder' in the RIN in the **early growth stage** of the organizational life cycle the higher are the firms' chances to survive.*

4.3. Entrepreneurs' ego-network and knowledge flows to the firm

In social networks theory, a debate has arisen over the form of egocentric network structures that can appropriately be regarded as beneficial for connected firms (Walker et al. 1997). Coleman (1988) sees the optimal social structure of an ego network in dense and interconnected networks, while Burt (1992) sees a network consisting of disconnected alters as optimal. Also the number of direct and indirect ties may play a role for the advantageousness of a network structure (Ahuja 2000). As Hite and Hesterly (2011), we consider the optimal structure of the ego-network to change over the firm's life.

Again, the nascent stage is characterized by factors like start-up capital, the functional background and entrepreneurial experience rather than the social networks (Cantner and Stuetzer 2013). Therefore, we expect no connection between the shapes of the ego-networks within the innovator network and the success of the new ventures:

Hypothesis 3a:

*The shape of the egocentric networks within the innovator network does not influence survival of the firm in the **nascent stage**.*

In the emergent stage, the firm needs to be informed about everything that is going on in the technology and the related market. Therefore, an ego-network that is allowing for the highest possible amount of knowledge inflow is favourable (Hite and Hesterly 2011). According to Coleman, densely embedded networks (closed networks) with many connections and thus no or less structural holes is associated with a higher innovative output. Ahuja (2000), among other factors, investigates the relationship between the number of structural holes in the ego network of a firm and innovative outputs and finds that having many structural holes is associated with reduced innovation. Since this kind of ego-network structure is exactly what a start-up in the emergent stage needs, we hypothesize:

Hypothesis 3b:

*The more closed the ego-network of a networked-founder is, the higher is the survival probability of this founder's firm in the **emergence stage**.*

However, if the firm moves to the early growth stage, it rather needs an ego-network that allows a strategical use of the own position (Hite and Hesterly 2011). One characteristic of the ego-network is brokerage/structural holes (Burt 1992). Networks usually consist of one or more components. Burt defines a 'hole' / non connection between those components as structural hole. As we see nodes as actors, one could say that "people on either side of a structural hole circulate in different flows of information. Structural holes are thus an opportunity to broker the flow of information between people, and control the projects that bring together people from opposite sides of the hole." (Burt 1992). One could also say that structural holes guarantee that partners on both sides of the whole have access to different information flows (Hargadon and Sutton 1997) and the information coming from this connection is non-redundant (Gilsing et al. 2008). However, not every firm or actor has the same chance to be in a bridging position. Central firms tend to become better informed about the things happening in the network what increases their ability to form new and valuable ties (Gnyawali and Madhavan 2001, Gilsing et al. 2008). Thus, we hypothesize that:

Hypothesis 3c:

*The more structural holes the ego-network of the founder has, the higher are the chances to survive when the firm moves to the **early growth stage**.*

5. Compounding the database

To address the hypotheses introduced above, we have constructed a biographical firm dataset, based upon two data bases. First, we use data on incorporations of enterprises in Thuringia which is based on the commercial register. Second, we rely on patent data comprising all German patents applied for at the German Patent Office in the time period between 1993 and 2004.

Incorporations

Information on new ventures was collected by the Thuringian Founder Study¹. The data base was drawn from the commercial register for commercial and private companies in Thuringia and contains information on the founders (date of birth, name, surname, academic title, address, gender) and on the firms (date of founding, date of closing, trade name, location, legal form, spin-off or not, industry). The survey population consists of 12,505 founders whose 7,016 companies were founded between 1990 and 2006 and are either active or have failed meanwhile. After we have cleaned the data (exclusion of firms founded before 1993 since the German reunification came with a phase of many management buyouts of former state combines; exclusion of firms where the founding date was missing; extraction of only those firms that are active in innovative industries following the classification of Grupp et al. (2000) which is classifying innovative industries by means of R&D-intensity) a population of 4,566 companies was left.

Innovator Network

As mentioned in the introduction, we use patent data in order to measure the innovator network. Per definition, this network comprises persons who cooperatively engage in the creation of new ideas and then economize the results (Cantner and Graf 2007). How these two aspects of creating and economizing new ideas can be combined into the innovator network and what this means for new ventures has been elaborated in more detail by the authors' earlier paper Cantner and Wolf (2016) and shall not be repeated here. To summarize the arguments of the paper mentioned one can say that patent data, which basically just contains information on inventions, is a sufficient measure of innovator networks since the aim of commercialization can be expected behind the legal protection of the invention.

We used data from the German Patent Office where we have in Thuringia 6,969 inventors (name, surname, address) and 5,381 patent applications (IPC-Code, name and address of the applicant, application date and year), resulting after checking raw data for misspelling of personal names².

¹ Note that this data base was just the starting point for the Thuringian Founder Study Questionnaire. It is therefore not identical to the questionnaire data collected by the Thuringian Founder Study.

² For consistency, we used a routine which was applied to all data sets.

It has been found that regions differ with respect to firms' success due to different infrastructural conditions (Heckmann and Schnabel 2005, Storey 1994). Additionally, the conditions for bringing competencies into innovator networks may differ between functional regions since an innovator may find the competencies he needs easier in large and dense networks compared to smaller ones (Ejermo and Karlsson 2006). This holds especially true for large regions with a university and several research institutes. Not just that universities and research institutes are responsible for knowledge spillovers which have a positive influence on innovations (Audretsch and Lehmann 2005), it can also be expected that actors in these networks are better connected and thus better informed than those in regions without research facilities and with less dense networks (Ejermo and Karlsson 2006). On the basis of these considerations, we have created 12 one-mode-affiliation networks of innovators (RINs) according to the Thuringian travel-to-work areas³ (ttwa) as defined by Granato and Farhauer (2007) who applied factor analysis for commuter streams.

Combination of both

The combination of the information from the regional innovator network with our firm database was done by matching names of firm founders with names of inventors in our innovator network. It must be pointed out that this approach does not come without bias. However, we tried to check for addresses and birth dates in order to make the matches more accurate. If one or more founders of a firm are listed as inventor on a patent, then in a first step, we counted this firm to be innovative. Sure, we here assume what we cannot observe, namely that the founder intends to economically exploit his invention within his own firm rather than selling licences or leaving the exploitation to the applicant. However, since a patent application protects the knowledge from usage by other actors, it signals an intention to further use it for example to generate an innovation, which per definition is the economization of new ideas. Furthermore, every granted patent inherits a test with respect to the commercial

³ Figure 1 in the appendix shows a card of Thuringia and its ttwas. Sonneberg, Saale-Orla-Kreis, Altenburger Land and Eichsfeld are connected to regions outside Thuringia by means of commuter streams. For the creation of the regional innovator networks, we also included patents and inventors from these regions.

usability of the invention. By combining both databases, we were able to identify networked-founders in the RINs and relate their network positions, properties to their firms. They are connected to the regional innovator network of the ttwa their firm is located at. As patenting is a quite rare event, we come up with a database of 149 innovative firms out of the sample population we have from the commercial register, which was 4,566 founded firms in Thuringia.

6. Variables and methodology

The next section is dedicated to present the variables used and the methodology applied. Table 1 gives a detailed overview on all variables used in the estimations; table 2 presents the correlations between these variables.

Table 1 Description of variables used in order to investigate the selective nature of innovator networks

	Variable	Description	Obs	Mean	Std. Dev.	Min	Max
Structure of the network (H1a-c)	$Net_{.3}$	Variable describing the density of the network three years before the firm founding.	149	0.007	1.000	-1.063	3.308
	$Net_{.3}SQ$	$Net_{.3}$ Squared	149	0.992	2.035	0.000	10.942
	Net_0	Variable describing the density of the network in the year of founding.	149	0.001	1.003	-0.821	2.915
	Net_0SQ	Net_0 Squared	149	1.000	2.334	0.001	8.495
	Net_{+5}	Variable describing the density of the network five years after firm founding.	149	0.000	1.003	-1.043	1.622
	$Net_{+5}SQ$	Net_{+5} Squared	149	1.000	0.931	0.000	2.631
Position of the founder (H2a-c)	$EV_{.3}$	Founders' eigenvector centrality three years before the firm founding.	37	-0.777	17.315	-86.497	57.735
	EV_0	Founders' eigenvector centrality in the year of founding.	149	0.000	0.001	0.000	0.009
	EV_{+5}	Founders' eigenvector centrality five years after firm founding.	149	0.019	3.276	-29.564	26.400
	$MC_{.3}$	Binary variable, indicating whether the firm has been connected to the main component three years before the firm founding.	149	0.007	0.082	0.000	1.000
	MC_0	Binary variable, indicating whether the firm has been connected to the main component in the year of its founding.	149	0.040	0.197	0.000	1.000
	MC_{+5}	Binary variable, indicating whether the firm has been connected to the main component five years after its founding.	149	0.188	0.392	0.000	1.000

Table 1 continued

	Variable	Description	Obs	Mean	Std. Dev.	Min	Max
Ego-Net (H3a-c)	<i>Constr₋₃</i>	Constraint of the ego-network three years before the firm founding.	149	0.223	0.396	0.000	1.125
	<i>Constr₀</i>	Constraint of the ego-network in the year of its founding.	149	0.445	0.454	0.000	1.125
	<i>Constr₊₅</i>	Constraint of the ego-network five years after firm founding.	149	0.677	0.381	0.000	1.125
Controls	<i>PatExperience</i>	Number of patents the firm founders applied for before the firm has been founded.	149	1.309	2.205	0.000	11.000
	<i>#Patents</i>	Number of patents the firm applied for from the year of founding on.	149	2.268	4.132	0.000	28.000
	<i>#Founders</i>	Number of founders in the team.	149	1.638	0.816	1.000	6.000
	<i>Spinoff</i>	Binary variable, indicating whether the firm is an academic spin-off or not.	149	0.195	0.397	0.000	1.000
	<i>CapComp</i>	Binary variable, indicating whether the firm has the legal form of a capital company (1) or a private company (0).	149	0.960	0.197	0.000	1.000
	<i>Acad</i>	Variable counting the number of founders in the team heaving an academic title.	149	0.383	0.643	0.000	4.000
	<i>OutsideConn</i>	Binary variable, indicating whether the respective company has also connections to other networks than the one it is located in.	149	0.295	0.458	0.000	1.000
	<i>Meanturb</i>	Mean of industry turbulence in the time span of three years before the firm has been founded and the three years afterwards.	149	3.235	6.466	-0.394	23.241

Table 1 continued

	Variable	Description	Obs	Mean	Std. Dev.	Min	Max
Net _{.3}	<i>Innovators_{.3}</i>	Size of the innovator network the founders are connected to three years before the firm has been founded.	149	301.691	258.600	11.000	868.000
	<i>Aggregation_{.3}</i>	Level of aggregation of the network the founders are connected to three years before the firm founding.	149	0.054	0.055	0.013	0.273
	<i>LC_{.3}</i>	Size of the largest component of the network the founders are connected to three years before the firm founding.	149	0.117	0.076	0.045	0.364
Net ₀	<i>Innovators₀</i>	Size of the innovator network the firm is connected to in the year of founding.	149	780.134	560.084	32.000	1836.000
	<i>Aggregation₀</i>	Level of aggregation of the network the firm is connected in the year firm founding.	149	0.055	0.066	0.011	0.246
	<i>LC₀</i>	Size of the largest component of the network the firm is connected to in the year of firm founding.	149	0.142	0.129	0.043	0.493
Net ₊₅	<i>Innovators₊₅</i>	Size of the innovator network the firm is connected to five years after the firm has been founded.	149	1531.617	991.999	75.000	2875.000
	<i>Aggregation₊₅</i>	Level of aggregation of the network the firm is connected to five years after the firm founding.	149	0.149	0.170	0.012	0.428
	<i>LC₊₅</i>	Size of the largest component of the network the firm is connected to five years after the firm founding.	149	0.286	0.243	0.032	0.654

Table 2 Correlations of the variables used in order to assess the influence of the selective nature of the innovator network

	1	2	3	4	5	6	7	8	9	10	11
1 <i>Net₋₃</i>	1										
2 <i>Net₋₃SQ</i>	0.6745*	1									
3 <i>Net₀</i>	-0.3059*	0.0296	1								
4 <i>Net₀SQ</i>	-0.3157*	0.0016	0.8817*	1							
5 <i>Net₊₅</i>	-0.4452*	-0.1395	0.7009*	0.4648*	1						
6 <i>Net₊₅SQ</i>	-0.2098*	0.0133	0.5609*	0.5455*	0.7212*	1					
7 <i>EV₋₃</i>	-0.3759*	-0.5851*	0.0283	0.0161	0.0537	-0.0208	1				
8 <i>EV₀</i>	-0.0854	0.0033	0.2395*	0.2649*	0.1329	0.1431	0.0076	1			
9 <i>EV₊₅</i>	0.0475	0.0065	0.0586	-0.0095	0.0422	-0.0516	0.0111	0.0259	1		
10 <i>MC₋₃</i>	0.2724*	0.4032*	-0.0509	-0.0218	-0.0858	0.0079	-0.8365*	-0.0068	-0.0005	1	
11 <i>MC₀</i>	0.0955	0.3298*	0.2229*	0.1793*	0.1522	0.2403*	-0.4250*	0.4013*	0.0098	0.4013*	1
12 <i>MC₊₅</i>	-0.2021*	-0.0479	0.2680*	0.0815	0.4747*	0.2932*	0.0296	0.1709*	0.1678*	-0.0395	0.2510*
13 <i>Constr₋₃</i>	-0.0084	0.0512	0.0536	0.0099	-0.0471	-0.0346	0.0751	0.0885	0.0057	0.0808	0.1661*
14 <i>Constr₀</i>	-0.0875	0.0227	0.1167	0.1329	0.0499	0.121	0.1641	-0.0381	-0.0021	-0.0173	0.0862
15 <i>Constr₊₅</i>	0.0629	0.0023	-0.1083	-0.0477	-0.007	0.1129	0.1516	-0.1171	-0.0557	-0.0789	-0.0678
16 <i>#Patents</i>	-0.1708*	0.0554	0.0835	0.0061	0.078	-0.0457	-0.1137	0.2502*	0.0046	0.1007	0.1266
17 <i>PatExperience</i>	-0.1258	0.0225	-0.0487	-0.1093	0.0437	-0.1257	-0.0827	-0.0054	0.1034	0.0545	0.0281
18 <i>#Founders</i>	-0.1939*	-0.0675	0.0017	0.009	0.0191	-0.0797	-0.1158	0.1378	-0.0541	0.0367	0.0073
19 <i>Spinoff</i>	-0.3358*	-0.0649	0.3469*	0.3149*	0.3528*	0.2482*	0.022	0.1672*	0.0029	-0.0404	0.0718
20 <i>CapComp</i>	-0.0672	-0.1276	-0.1712*	-0.1779*	-0.0255	-0.0353	-0.0076	0.0168	0.0012	0.0168	0.042
21 <i>Acad</i>	-0.2506*	-0.0517	0.1121	0.0949	0.1685*	0.0292	0.0244	0.0792	0.0846	-0.0491	-0.069
22 <i>OutsideConn</i>	-0.0997	0.0155	-0.0789	-0.0506	-0.0083	-0.0661	-0.2532	0.127	0.12	0.127	0.1668*
23 <i>Meanturb</i>	-0.0588	-0.1453	-0.1335	-0.1072	-0.1148	-0.1339	0.2242	-0.0369	-0.0019	-0.0248	-0.089

*p<=.05

Table 2 continued

	12	13	14	15	16	17	18	19	20	21	22	23
12 <i>MC</i> ₊₅	1											
13 <i>Constr</i> _{.3}	0.1089	1										
14 <i>Constr</i> ₀	0.0038	0.4045*	1									
15 <i>Constr</i> ₊₅	-0.0981	-0.001	0.3861*	1								
16 <i>#Patents</i>	0.2764*	0.3987*	0.2121*	-0.2157*	1							
17 <i>PatExperience</i>	0.1605	0.1245	0.0419	-0.2320*	0.4394*	1						
18 <i>#Founders</i>	0.0243	0.1345	0.0286	-0.1307	0.2655*	0.2095*	1					
19 <i>Spinoff</i>	0.1541	0.003	0.2514*	0.0695	0.0852	0.1079	0.1149	1				
20 <i>CapComp</i>	0.0985	0.0293	0.0413	0.0912	0.0754	0.0714	0.0767	0.0145	1			
21 <i>Acad</i>	0.0345	0.0589	0.0971	-0.0981	0.2544*	0.5281*	0.3177*	0.1827*	-0.0375	1		
22 <i>OutsideConn</i>	0.2159*	0.051	0.0274	-0.1107	0.2906*	0.4151*	0.1800*	0.2020*	0.1326	0.3712*	1	
23 <i>Meanturb</i>	-0.1551	0.0528	0.0174	0.1965*	-0.1285	-0.139	-0.03	-0.0603	0.0766	-0.1476	-0.1154	1

*p<=.05

6.1 Estimation framework

Since success is measured in terms of survival, we apply Cox's proportional hazards model (1972) which gives a valid estimate of the survival rate for data sets including right-censored and left truncated cases. In survival analysis typically the relationship of the survival distribution to several covariates is examined. In our model, the firms' hazard to die in the next period is dependent on covariates as the networks' structure, the founder's position in the network and the structure of his ego-network.

Since a (scientific) social network is not a static but a dynamic construct which is developing gradually (Gay and Dusset 2005), we have to take time dependent effects into account. The connectedness of the innovator network and also the founders' position in the net are changing over the organizational life cycle and it is also path dependent (Hite and Hesterly 2001). This would mean that the structure of the network and the position of the founder in this network is dependent on the past structure and position respectively. To cover the early three stages in the organizational life cycle, we decided to measure our dependent variables at three points in time: first three years before they found the firm ($t=-3$) is representing the nascent stage, exactly in the year of firm founding ($t=0$) is representing the beginning of the emergent stage and five years afterwards ($t=+5$) is representing the beginning of the early growth stage. This allows us to control for gradual effects with respect to the development of the networks' structure and to observe the coevolution of the network structure and the organizational life.

6.2 Variables

6.2.1 Measuring the structure of the regional innovator network

In order to measure the structure of the RIN, we use several graph-theoretic concepts. Regarding size, the straightforward way to measure is to count the number of nodes, which is the total number of inventors in the travel-to-work area (Lobo and Strumsky 2008). The variable *Innovators_t* thus measures the total number of inventors based in a respective TTWA in the certain stage of the organizational life cycle.

We use two variables to capture the structural features of a regional innovator

network. The first one is a concept we adopt from Lobo and Strumsky (2008) which is basically a Herfindahl index based on the distribution of component sizes. This variable $Aggregation_t$ measures the proportion of inventors in a RIN who are grouped into larger components⁴ and variable ranges between zero and one, whereupon a value close to one indicates that most inventors in the TTWA are grouped into few components. In order to measure the extent to which inventors in a TTWA are intensely linked to one another we use as second variable the *size of the largest component* (LC_t), which captures the share of inventors within the TTWA that had a collaborative relationship within the largest component.

Having a look at the correlation table for variables describing the regional network structure (Table 3), it is conspicuous that the three variables describing the structure of the network ($Innovators_t$, $Aggregation_t$ and LC_t) are highly and significantly correlated. Hence, we decided to apply factor analysis and to concentrate those variables to one factor “ Net_t ”. Table 4 shows the results of this analysis for the three points in time nascent stage, emergence stage and early growth stage. The higher the value of this variable the larger, more cohesive and more connected is the network of the respective ttwa.

Table 3 Correlation table for variables describing the network structure

Variable	1	2	3	4	5	6	7	8	9
1 $Innovators_{-3}$	1								
2 $Aggregation_{-3}$	-0.5482*	1							
3 LC_{-3}	-0.4579*	0.9178*	1						
4 $Innovators_0$	0.9518*	-0.5870*	-0.4813*	1					
5 $Aggregation_0$	0.5725*	0.0463	0.1928*	0.4457*	1				
6 LC_0	0.5993*	-0.0202	0.1792*	0.4873*	0.9734*	1			
7 $Innovators_{+5}$	0.8106*	-0.5923*	-0.4853*	0.9477*	0.2551*	0.3049*	1		
8 $Aggregation_{+5}$	0.6004*	-0.2265*	-0.0093	0.7018*	0.5638*	0.6370*	0.6901*	1	
9 LC_{+5}	0.6208*	-0.2393*	0.0033	0.7103*	0.5554*	0.6568*	0.6873*	0.9805*	1

⁴ For details see Lobo and Strumsky (2008), p.876.

Table 4 Factor Analysis Network Structure

Variable	Net_t	Uniqueness
<i>Innovators</i> _{.3}	-0.7271	0.4713
<i>Aggregation</i> _{.3}	0.9573	0.0836
<i>LC</i> _{.3}	0.9278	0.1393
<i>Innovators</i> ₀	0.6847	0.5312
<i>Aggregation</i> ₀	0.9523	0.093
<i>LC</i> ₀	0.9648	0.0691
<i>Innovators</i> ₊₅	0.8427	0.2898
<i>Aggregation</i> ₊₅	0.9675	0.0639
<i>LC</i> ₊₅	0.9666	0.0657

In order to test hypotheses 1a-c and to find out more on the relationship between the structure of the regional innovator network and the success (survival probability) of the firm, we regress the variable Net_t together with different firm-specific control variables on the hazard ratio of the firm (this is the basic principle of the Cox regression model).

When we assess the relationship between the founders position in the net and the structure of the ego-net on the survival probability of the firm (Hypotheses 2a-c and 3a-c), we use Net_t as regional control variable. We have argued above that the characteristics and structure of innovator networks differs regionally. The networks, we have constructed for the analysis performed here, have been created for 12 ttwas in Thuringia such that the variable Net_t basically reflects the regional endowment with respect to the innovator network.

The variable Net_t measures the overall structure of the network the firm is connected to, irrespectively of the number of founders and the question of how many founders are connected to the network. In the next two steps of analysis, we distinguish between the position of the founder in the whole network and the structure of the ego-network. This is of cause estimated for single nodes. There is a small number of cases, where more than one founder is connected to the network. In these cases, we assumed a multiplicative effect and summed up the values for the nodes.

6.2.2 Measuring entrepreneur's position in the network

When analysing the founders' position in the network, we basically want to know how central he is in the network as such. In order to assess this, we use two concepts. First, centrality is measured here by means of eigenvector-centrality and reveals how well connected an actor is in the overall network (EV_t)⁵. The eigenvector approach identifies the most central actors in terms of the "global" or "overall" structure of the network (Hanneman and Riddle 2005). Thus, by taking into account direct as well as indirect ties of single actors it assumes that a node is central to the extent that the node is connected to others who are central (Bonacich 1972). Higher scores indicate that actors are "more central" to the main pattern of distances among all of the actors, lower values indicate that actors are more peripheral. For the case that more than one founder is connected to the network, we summed up their individual values for EV_t .

The second concept we use is the membership in the main component. The main component of the network is the maximal connected sub graph. This measure thus captures the degree of fragmentation in a RIN's structure. If the network has more than one component, different information flows pass each component. Since the main component connects the largest number of nodes, being connected to this component may induce most knowledge flows (Powell et al. 1996). With respect to the RIN, this means that a networked-founder which is a member of the main component is more central to the network and thus his firm profits comparably more from network's knowledge flows. MC_t takes a value of one if (one of) the entrepreneur(s) of the firm is connected to the main component and is zero otherwise.

6.2.3 Measuring the ego-network of the entrepreneur

In order to assess the influence of the closeness of the networked-founder's ego-network, we use the variable $Constr_t$ which is a structural hole measure

⁵ We measured centrality by means of Eigenvector centrality (Bonacich 1972). There exist different measures for centrality like betweenness centrality (Anthonisse 1971, Freeman 1977), closeness centrality (Beauchamp 1965) or hub centrality (Kleinberg 1999). We decided for the Eigenvector centrality since it is a feedback centrality which is showing whether the actor is connected to the top connected other actors in the net which might be especially useful for young and small companies who are in need of good contacts.

introduced by Burt (1992). This is a summary measure that taps the extent to which ego's connections are to others who are connected to one another (Hanneman and Riddle 2005). A high value of this variable indicates that the entrepreneur occupies a position in the net which is less constrained and where he can broker more extensively. In other words, the higher this measure, the less structural holes the ego-network has and the more closed it is. For the case that more than one founder is connected to the network, we summed up their individual values for *Constr_i*.

6.2.4 Control Variables

In order to compare and contrast the effects of network structure as well as founders' position in the net and firms' characteristics on survival we, additionally to the dependent variables introduced in the above chapter, used a set of control variables which may influence firms' survival.

#Patents. This variable counts the number of patents the founders of the firm applied for after the firm has been founded. Founders with more patents might be more connected to the network such that in order to make statements on the main variables of interest in this paper, we need to control for the quantity of patent applications.

PatExperience. This is a variable counting the number of patents the founders of the respective firms have applied for before the firm has been founded. Cantner and Wolf (2016) found that experience in patenting is a main driver of patenting in the future such that this influences the founders future network which we want to analyze.

#Founders. This variable indicates the number of persons that has founded the respective firm. It has been argued earlier in this text that more founders may bring a broader range of scientific capital to the firm and thus also influence firms' success.

Spinoff. This dummy variable measures whether the firm is an academic spin-off or not. Academic spin-offs are usually founded on the basis of innovative

products and additionally have the ‘mothers’ support, which makes them more successful (Utterback 1974).

CapComp. This variable indicates whether a firm has the legal form of a capital company ($Capcomp=1$) or of a private company ($Capcomp=0$). It has been found that private companies may have higher chances to be successful, thus to survive, since the founders adhere with their private capital (Harhoff et al. 1998).

Acad. This variable counts the number of founders with an academic title. It has been found that academics usually have a larger network of scientific contacts (Breschi and Catalani 2010) and may therefore add more to the scientific network of the firm.

OutsideConn. Being connected to more than on RIN may enlarge the scientific network of the firm. Thus, with this variable, we measure whether the firm has connections to more than the RIN where it is located at.

Meanturb. The firms in the sample are active in different industrial sectors and of course the sector plays an important role to for the survivability of a firm. Since this paper is analyzing young firms, it is not only controlled for sectors but to also for the economic environment/stage of the sector they are active in. For this purpose, data from the IAB (Institut für Arbeitsmarkt- und Berufsforschung) has been used, which contains the number of firm founding and closing for each industry (Nace 2-digit level) for the years 1976 to 2010. Based on this data, the variable named *Meanturb* has been constructed, which is measuring the turbulence in the sector the firm is active in for a time span of six years, three years before the firm has been founded and three years afterwards. The turbulence is measured as number of firm founding in a certain sector in the specific years minus the number of firm close downs in the same sector in the same years. From this value, the mean over the six years around the firm founding is estimated and used for analysis.

7. Empirical results

Hypothesis 1a states that there is no connection between the structure of the network and the chances for a firm to survive in the nascent stage of the organizational life cycle, while hypothesis 1b and 1c suggest a decreasing importance of the connectedness of the network and firm survival. In order to measure how dense the whole network is, we applied factor analysis and created the variable Net_t which is the combination of three variables describing the network as such (size of the network, aggregation level of the network and size of the largest component). The larger the variable Net_t , the more connected the network in the sense that there are more actors which are highly aggregated and which's largest component is relatively big. Table 5, model 1 provides the results for all three stages in the early organizational life cycle. We do not find a significant relationship between the survival of the firm and the network structure in the nascent stage and year of firm founding/beginning of the emergent stage and thus have to accept hypothesis 1a and to reject hypothesis 1b. However, we find a significant relationship between the hazard ratio and the network structure five years after firm founding (Net_{+5}), when the early growth stage develops. The coefficient of Net_{+5} is larger than one, which means that the risk to die in the next period is increased when the connectedness of the network is increased. This supports hypothesis 1c. The squared term of Net_{+5} ($Net_{+5}SQ$) however is smaller than one which indicates that from a certain network size on, the hazard starts to become smaller again. This inverted u-shape relationship between network size and the survival of the firm indicates that there are two favorable situations for the firms. Either they are connected to a network which is quite fragmented or to a network which is extremely connected. This finding might be due to the fact that Hite and Hesterly (2001) are right in their assumption that the cohesiveness of the network decreases while the bridging of structural holes increases over time. Since we could not observe the exact date of movement between the two stages in the organizational life cycle but only narrowed this date by assuming that this might happen after roughly five years (Phillips and Kirchhoff 1989) it might just be that after five years some firms are still in the emergence firms (cohesiveness is important) and others already went to the early growth stage (structural holes are important).

Hypotheses 2a-c relate to the overall centrality of the position of the founder in the network. While hypothesis 1a suggests no relationship between the survival in the nascent stage and a central position of the founder, hypothesis 2b and 2c suggest a positive influence of a central position on the chances to survive, but for different reasons. In order to measure this relationship, we use Eigenvector centrality, as well as the membership in the main component.

Model 2 in Table 5 analyzes the variables EV_{-3} , EV_0 and EV_{+5} as representatives of the actors Eigenvector centrality. We find that only the coefficient for EV_{-3} becomes significant, a result that interestingly stands against our hypothesis 2a stating no connection between survival and centrality in the nascent stage. Rather a central position seems to hinder survival. Looking at the membership in the main component, we find a significant result for the early growth stage. However, in contrast to hypothesis 2c, we find a negative relation. If we reinterpret this result in the light of Hite and Herstely's (2001) proposition that in the later stages, firms do not need a very dense network anymore, we might say that also the connection to the main component becomes unfavourable at a certain point in the life cycle. Therefore, the power argument of being in a position to control knowledge might not be that strong for our database.

Finally, although we find significant relationships, we have to reject hypotheses 2a-c.

Hypothesis 3a states that closed ego networks of a networked-founder in the nascent stage have no influence on its survival. In model 4 of table 5, we use the variable $Constr_{-3}$ to measure this relationship and find no significant relationship such that we cannot accept hypothesis 3a. Hypothesis 3b and 3c, taken together, state that from the emergent to the early growth stage in the organizational life cycle, the favourable network moves from a closed one to a quite fragmented one. In table 5 we find no significant effects.

Over all models in table 5, the variable measuring the connectivity of the whole network shows up to be significant at the beginning of the early growth stage. But this relation takes an inverted u-relationship.

Table 5 Influence of the network structure and the ego-network on the hazard ratio

Dep. Var.	Cox regression – Breslow Method for ties survival			
	model 1	model 2	model 3	model 4
	H1a-c	H2 a-c	H2 a-c	H3 a-c
EV ₋₃		1.034 *		
		(1.721)		
EV ₀		0.000		
		(-0.000)		
EV ₊₅		1.010		
		(0.168)		
MC ₋₃			6.010	
			(0.000)	
MC ₀			0.000	
			(-0.000)	
MC ₊₅			4.567 ***	
			(2.811)	
Constr ₋₃				0.791
				(-0.428)
Constr ₀				1.332
				(0.573)
Constr ₊₅				2.124
				(1.376)
Net ₋₃	1.214	1.192	0.938	1.172
	(0.640)	(0.579)	(-0.211)	(0.523)
Net ₋₃ SQ	0.928	0.947	0.990	0.921
	(-0.521)	(-0.379)	(-0.068)	(-0.550)
Net ₀	0.715	0.701	0.731	0.810
	(-0.577)	(-0.599)	(-0.551)	(-0.348)
Net ₀ SQ	1.134	1.142	1.158	1.091
	(0.523)	(0.542)	(0.607)	(0.350)
Netplus ₊₅	2.355 **	2.512 **	1.539	2.426 **
	(1.982)	(2.086)	(0.974)	(2.011)
Netplus ₊₅ SQ	0.509 *	0.484 *	0.575	0.444 **
	(-1.842)	(-1.940)	(-1.535)	(-2.140)

z-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.10

Table 5 continued

Method Dep. Var.	Cox regression – Breslow Method for ties survival							
	model 1 H1 a-c		model 2 H2 a-c		model 3 H2 a-c		model 4 H3 a-c	
Patthvor2	0.918 (-0.794)		0.915 (-0.819)		0.879 (-1.165)		0.918 (-0.714)	
Patth2	0.950 (-0.941)		0.950 (-0.934)		0.968 (-0.561)		0.963 (-0.660)	
Grnder	1.442 (1.985)	**	1.473 (2.100)	**	1.408 (1.917)	*	1.532 (2.223)	**
Spinoff	0.170 (-2.291)	**	0.172 (-2.283)	**	0.169 (-2.234)	**	0.122 (-2.565)	**
Capcomp	0.435 (-1.234)		0.421 (-1.281)		0.386 (-1.390)		0.339 (-1.538)	
Acad	1.501 (1.249)		1.464 (1.168)		1.612 (1.375)		1.391 (0.994)	
Outsideconnection	0.558 (-1.158)		0.569 (-1.098)		0.360* (-1.825)	*	0.605 (-0.995)	
Meanturb	1.022 (0.916)		1.016 (0.644)		1.025 (1.031)		1.012 (0.455)	
Observations	149		149		149		149	
No. Of Failures	38		38		38		38	
Prob>Chi2	0.0185		0.0318		0.0042		0.0230	

z-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.10

8. Conclusion

Over all analyses, we find that there is no influence of the networks' structure in the nascent stage of the organizational life cycle. This supports the findings by Cantner and Stuetzer (2013) who show that factors like start-up capital, the functional background and entrepreneurial experience of the founders seem to overweight the importance of social (scientific) capital for the success of the new venture. However, for Eigenvector centrality, we find a small negative effect indicating that a central position in the innovator network is not too favourable in the nascent stage of the firm' life. A reason might be the high inflow and redundancy of information, reaching a node in a central position. A person which has to concentrate on getting start-up capital and writing a

business plan might easily be overstrained by this. For sure, this point leaves open space for further research.

Having a look at the structure of the ‘home’ network of the firm, we find an inverted u-shaped relationship between the survival of firms and the connectivity of the network. Thus, very loose networks and very dense networks seem to be favorable for the survival of firms but nothing in between. Additionally, we find that it becomes unfavorable to be connected to the main component when the firm enters the early growth stage. In the theoretical part of this paper, we argued that Burt (1992) and Coleman (1988) have two opposite views on the interdependency between the structure of the ego-network and the related benefits for the actor (Gilsing et al. 2008, Gilsing and Nooteboom 2005). While Burt says that a loose network is favorable since it brings possibilities to broker and control knowledge flows, Coleman says that dense networks are favorable since they allow for more knowledge spillovers. Hite and Hesterly (2001) translate these considerations to the organizational life cycle and argue that firms need a “Coleman-network” in the emergent stage but a “Burt-network” when they enter the early growth stage. The inverted u-shape we find might be due to the individuality of each firm’s history. Some firms might change to the early growth stage already after two years, while others need six. What the results show is that Burt and Coleman both have their eligibility. Additionally, Hite and Hesterly seem to be on the right track with their idea of changing requirements on the network over the organizational life cycle. In a future research, it would be recommendable to have survey data and identify the moment when a firm leaves one stage and enters the other individually.

With respect to the influence of the founder’s position in the network on firms’ success, we looked at his centrality and on his membership to the main component. We find that being a member of the network’s main component has a negative influence on the survivability of firms in the early growth stage. Thus, we disproved our theoretical argumentation, stating that the main component inherits most knowledge spillovers and thus increases the number of opportunities for innovation. However, also here, the arguments raised above may hold. In the largest component, the actors may all work in the same

technology such that there is less variety of technologies which may be unfavorable for new combinations and thus firms' performance, especially in the later stage of the early firm development.

With respect to control variables we find that firms have better chances to survive if they are a spin-off and if they have connections also to other networks than only to the one in the region where they have their headquarters. This positive effect of a mother institution for highly innovative firms has already been described and empirically analyzed by Cantner and Goethner (2011). However, the influence of various connections to different networks seems to be an interesting issue. Is it important to which ones of the regional networks the firms are connected to? Is it possible for firms to be overconnected? Is there an optimal rate of outside connection? These and other questions are still open for future research.

Having a look at the mere number of founders, we find a negative effect on survival. Thus too many founders reduce a firm's chances to survive. In the theoretical part of this paper, we argued that the number of founders may have a positive influence since they may all add to the scientific network of the firm. However, Cantner, Goethner and Stuetzer (2010) found that the composition of the team plays an important role for the success of a firm. Their findings may explain our results since they showed that it is not quantity but quality of the founding team that counts and our results also go into this direction.

Additionally, Lobo and Strumsky (2008) argued that the variable network aggregation also indicates whether actors in the region have worked in the same technology. Interpreting our results from that angle our results point to the interpretation that variety of technologies in a network is favorable for firms' success. Since this interpretation is very vague it leaves space for future research.

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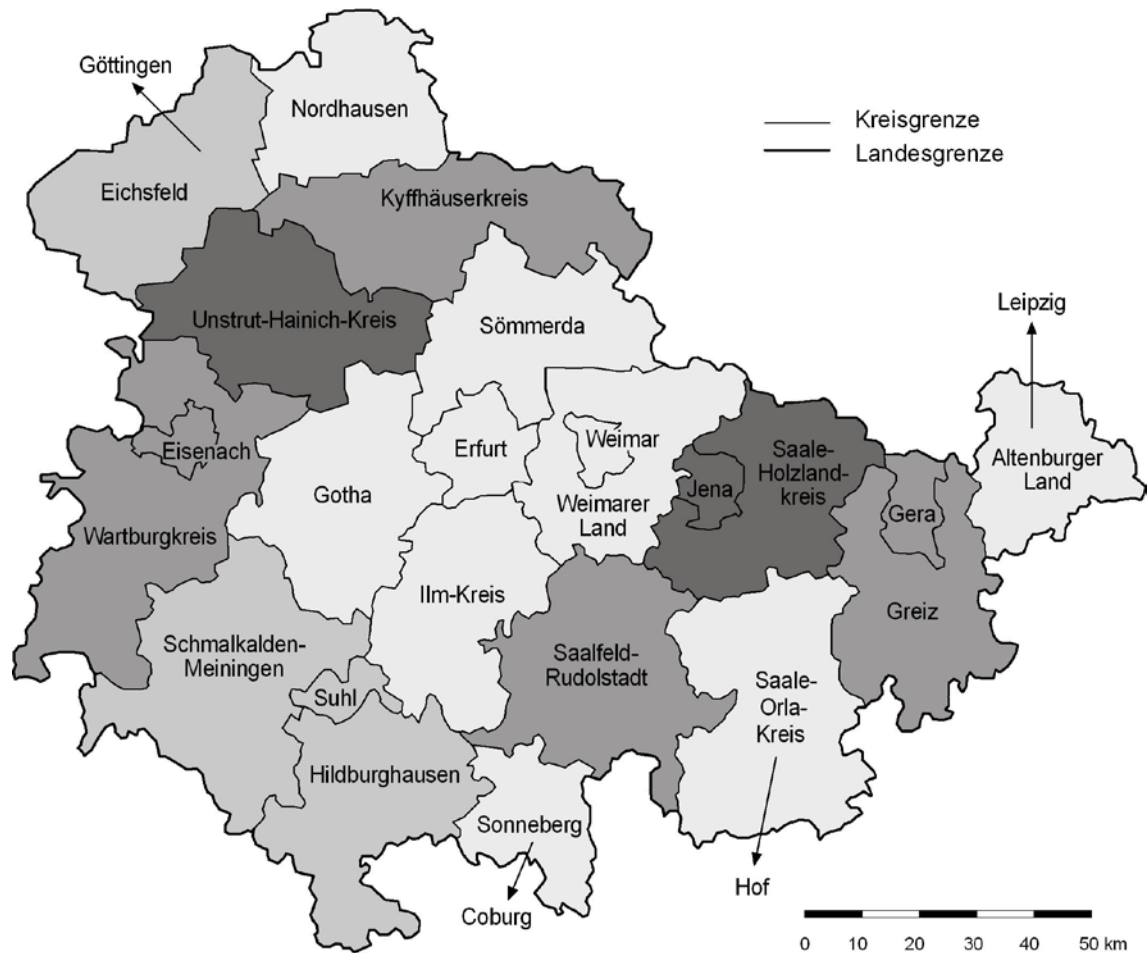
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Appendix

Figure 1 Thuringia and its travel-to-work areas



Thuringian travel to work areas according to the estimations of Granato and Farhauer (2007)