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Innovative Companies' Survival and The Region - Isn't it just being there?

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**Innovative Companies' Survival and the Region
Isn't it just being there?**

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1. Introduction

At least since Schumpeter published his work 'The Theory of Economic Development' (1912), a wide body of literature has focused on the evolutionary process behind firm growth and survival. Recently a growing interest is devoted to the variable 'location' as a critical factor, shaping firm performance. However, less attention has been paid to the region-specific characteristics that may play a relevant role in determining the growth and survival of a firm. Some works see university-based knowledge spillovers as one such factor (Audretsch and Lehmann 2005, Cassia et al. 2009). We extend this approach to the regional innovator network (RIN), promoting region-specific knowledge spillovers. RINs can be defined as networks that are built up by actors which cooperatively engage in the creation of new ideas and then economize the results (Cantner and Graf 2007). This economization can be realized within an existing firm or by the formation of a new venture. We focus in this paper on new ventures and investigate the influence a RIN has on their performance. If a new venture is connected to a well functioning RIN, knowledge spillovers may result in new ideas, promoting firm's survival. Moreover, it is not irrelevant to which network a firm is connected since RINs may have different network characteristics.

Two data bases are used. First, patent data delivers RINs for all Thuringian travel-to-work areas. The second data base we use contains information on innovative ventures founded in the period between 1990 and 2006, drawn from the register for commercial and private companies in Thuringia. Both data sources were merged by the names of inventors and founders. In a first step, we conduct survival analysis in order to investigate the influence of a connection to the RIN Jena on the hazard rate of the firm population.

2. Innovation, Firms and the Regional Innovator Network

Innovation and survival

Innovation is defined as "a process that begins with an idea, proceeds with the development of an invention, and results in the introduction of a new product, process or service to the marketplace" (Edwards and Gordon 1984, p.1). Both, (i) the founding of a new firm and (ii) the survival of existing firms are dependent on the successful mastering of this process. As to (i), innovation is considered to be one of three important characteristics

entailed by entrepreneurship (OECD 1998). This view stems from Schumpeter's (1912) suggestion that innovation is a creative *modus operandi* of an entrepreneur (Nijkamp 2009). Audretsch and Lehmann (2005, p. 1192) formulate the relationship as follows: "...entrepreneurship is an endogenous response to the potential for commercializing knowledge that has not been adequately commercialized by the incumbent firms". Thus, entrepreneurs discover an opportunity to exploit a new technology (Shane 2000) and implement this by founding a firm. As to (ii) by creating new variations, new innovative firms compete with incumbent firms, which force the latter to improve or change their production processes or product portfolios. Under these conditions, incumbent firms must be innovative if they are to survive (Brown and Eisenhardt 1997). Non-innovators will fall behind, while first movers respectively firms with an entrepreneurial orientation secure a position of competitive advantage (Lumpkin and Dess 1996).

Summarizing the discussion, we may formulate a hypothesis about survival and performance of innovative firms. Comparing innovative and non-innovative firms, the former ones are supposed to have a higher lifespan which may increase with the number of innovations. This consideration is summarized in hypothesis 1:

H 1: Innovative firms survive longer than non innovative ones and this effect grows with the number of innovations.

Innovation and the innovator network

Before World War II, and thus also in Schumpeter's theory, the linear model of innovation was the generally accepted one (Kline and Rosenberg 1986). In this model, events flow smoothly in a one-way street. First, one engages in research, after that development is pursued which is followed by production and by marketing. Looking more closely on how new ideas are created and innovations come up, according to the definition of Edwards and Gordon (1984), a more complex process as compared to the linear model is going on. Kline and Rosenberg (1986) visualize this complex process and propose the 'chain-linked model' which entails five different paths of activity and considers feedbacks between the different stages of innovation. This model, however, does not recover where feedbacks and information flows are coming from. In this respect, over the last decades the concept of collective invention and innovation, brought up by Allen (1983) and von Hippel (1987), has

been developed. This concept has been said to form the basis for the systemic view of innovative activities and the innovation process (Cantner 2000). At its bottom-line, innovations are considered as new combinations (Schumpeter 1912). Consequently, they require recombining different pieces of existing knowledge (Cantner and Meder 2007). The pieces of knowledge, required to successfully innovate, may not be in the immediate reach of an actor or firm but may rather lie outside (Cowan et al. 2006). Thus, access to external knowledge is considered an important prerequisite for innovative success. At this point, collectivity comes into play. No single individual or firm can solve all problems (Ejeremo and Karlsson 2006) since it does not hold all knowledge available in the world. Especially invention processes are based on the combination of various pieces of knowledge which are possessed by various economic actors. With this perspective in mind, we can argue that invention and innovation activities rely on processes of collective or social learning and exchange of knowledge between actors (Lundvall 1992, Doloreux and Parto 2005), whereas learning is a process by which existing knowledge is selected and combined based upon a new perspective (Ejeremo and Karlsson 2006). Consequently the creation of innovation requires knowledge spillover-producing interaction. These knowledge spillovers can happen deliberately, for example in the context of research collaborations, or involuntary and unintended.

Cassia et al. (2009), as well as Audretsch and Lehmann (2005), see university-based knowledge spillovers as the most important form of knowledge spillovers. They argue that knowledge from universities flows in the economic system and affects firms' propensity to create new market opportunities and introduce new ideas in the market. Cassia et al. (2009) as well as Audretsch and Lehmann (2005) have shown that a university's knowledge spillovers have a positive influence on firms growth. Besides university-based knowledge spillovers, also spillovers, originated from firm-researchers and employees of research institutes may play an important role since this knowledge may be more applied and ready for the market.

As stated above, knowledge spillovers are an important device for the generation of innovations and they are mainly transferred via personal contacts. Breschi and Lissoni (2006) comprehensively elaborated this process. They argue that pure spillovers can only take place by trade-unrelated personal communication or through reverse engineering (Breschi and

Lissoni 2006). However, when tacitness of knowledge plays a role, knowledge spillovers are not possible anymore without active participation of the inventor. As to the question why inventors should accept to pass information deliberately, Breschi and Lissoni (2006) find the answer in 'social obligations'. University researchers for example obey to the principles of open science and dedicate themselves to the production of public goods. Also corporate researchers may be willing to provide their colleagues with free advice as long as it is reciprocated. Since tacitness plays an important role with respect to new generated knowledge, one could think of knowledge as a club good. Outsiders, defined as actors that are not connected to the social network of innovators, can be excluded from consuming the knowledge while insiders, defined as actors that are connected to the social network of innovators, benefit from non-rivalry in the consumption of the shared knowledge.

Such a social network can be defined as innovator network (IN) that is built up by actors 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 IN are employees of firms, of research institutes or of universities, students or self-employed persons who actively conduct research. These research oriented relationships may be formal and informal, they indicate intended as well as unintended knowledge transfers and exchanges (respectively knowledge spillovers), and they form the basis for new ideas facilitated by the combination of existing knowledge (Edwards and Gordon 1984). Moreover, there are various types of relationships. They may be based on formal research cooperations between several actors or firms. Additionally, they may be based on researcher, inventor or innovator mobility. It can also not be excluded that quite informal contacts such as knowing each other from playing tennis in the same sports club, eating in the same restaurant or from bringing their little ones to the same nursery contribute to knowledge exchange and transfer.

For a firm, the connection to the IN promotes the expansion of its knowledge base and its potential to innovate. Consequently, being integrated to an IN can provide an important prerequisite for the generation of innovations and therefore it may serve as an important facilitating device for long term firm survival of a firm (Thornhill 2006).

Summarizing the discussion, we may formulate further hypotheses. Hypothesis one states that innovative firms have a higher potential to survive, compared to less innovative ones.

As discussed above, knowledge spillovers reaching a firms' via the connection to a network of innovators may positively influence a firms' potential to innovate. Thus, we hypothesize that within the group of innovative firms, connected ones are supposed to create more innovations than isolated firms since they receive more knowledge spillovers.

H 2: Firms that are connected to the innovator network are more innovative than non-connected ones.

Bringing together the considerations concerning the effect of innovations on survival and of the IN on innovation, may allow the conclusion that the connection to the innovator network positively influences the chances to survive for firms because it raises innovativeness. This leads us to hypothesis 3:

H 3: Innovative firms survive longer than non-innovative firms and this effect is driven by the connection to the innovator network.

IN structures and performances

With respect to firm's survival and success, location (and here the region) has been identified as one among many critical factors (Heckmann and Schnabel 2005, Storey 1994). Locations differ with respect to their organizations like universities, research institutes, firms or public agencies, as well as with respect to institutional factors like norms and regulations, a qualified labour force or business taxes. Besides these, but related, an important locational factor is the regional innovation system as defined by Cooke et al. (1997). The network of innovators (IN) can be seen as a core element of such a regional innovation system.

In this context, various research has shown that, first, innovative activities are spatially not evenly spread but a rather regionally bounded phenomenon (Asheim and Isaksen 2002). Thus, innovative performance differs among different regional innovation systems (e.g. Porter 1990, Jaffe et al. 1993). Second, regions differ with respect to the success of their respective firms or with respect to founding rates (e.g. Storey 1994). Related to our hypotheses about the relationship between the IN and the success of incumbent firms we now enhance the analysis by the regional dimension and talk about regional innovator networks (RIN). We presume that various characteristics of the respective regional innovator

networks are affecting firm performance and survival. Among those characteristics the network properties like a high degree of connectedness, a high centrality of single actors or the existence of structural holes are of importance. Additionally, we expect effects related to the very characteristics of the knowledge flowing in the network. Some regions are highly specialized, thus concentrated on a small number of industries. In these regions, the knowledge flowing through the RIN will also be very specialized and therefore the knowledge bases of the network-actors will have a high degree of overlap. Other regions are more diverse with respect to the knowledge applied (due to the composition by industries). Consequently, the knowledge flowing through the network is rather diverse and the actors' knowledge bases show a low degree of overlap.

After testing the influence of the (non-spatial representation of the) innovator network for whole Thuringia on the survivability of firms, we proceed by testing for regional differences in this effect. These differences may be the result of differences in the quality of the RIN. Thus, we analyze the different travel-to-work areas and hypothesize the following:

H 4: *The effect of the IN on the survivability of firms differs regionally.*

3. 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

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.

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) a population of 4,566 companies has been used in our investigation.

Innovator Network

Per definition, the innovator network comprises persons who cooperatively engage in the creation of new ideas and then economize the results (Cantner and Graf 2007).² In order to picture the innovator network, at least in the form of linkages that arise from the participation in a common team of inventors, we use patent data. According to Breschi and Lissoni (2006), we assume that inventors who worked together on the same patent know each other well enough to be willing to exchange information and to tolerate that this information may be passed on to somebody else than the receiver. Since those networks include members of various companies, circulation of knowledge across companies can be expected. Hence, what we look at is an inventor network which is not the same as an innovator network. The issue of commercialization of the new idea distinguishes the latter from the former.

Second, there is the aspect of economization. This aspect restricts the network to those persons who develop new products or processes for their own firm or for their employer. They may be researchers, technologists or engineers whose aim is to create marketable ideas respectively innovations. Of course, if we measure patent networks, we do not know

² Both aspects have to be elaborated further. First, to be cooperatively engaged in the creation of new ideas does not necessarily mean being involved in active research cooperation. Rather it means that people may also be in the same sports club, meet each other in the same bars or restaurants, are former colleagues, have met on a conference/trade fair or take their little ones to the same nursery. The pivotal role in this respect comes to the fact that people are in contact. Also in a bar or in a sports club people talk about their jobs. Besides private information, they exchange information on what they are working on, what some colleagues of them are doing, what they have read about or what projects they are working on. This information must not be specifically related to innovative activities but at least these contacts lead to know-who respectively knowledge of who may be able to help you solving a certain problem. The underlying assumption of our approach is that a firm which is founded by one or more persons has access to the social capital of exactly these contacts they bring with. If it's not new influences for innovative activities, then this social capital at least helps to find an appropriate contact person for solving (also technical) problems. Of course, it would also be possible to find appropriate contact persons at the internet but face-to-face contacts and personal acquaintances are an important feature since members of social networks who personally know each other tend to exchange more information, help or advice (Breschi and Lissoni 2006). Measuring these kinds of relationships of course is impossible.

whether these patents will end in a new product or process and there is no information available about how the invention has been pursued. However, since a patent application protects the knowledge from usage by other actors, it signals an intention to further use it for example in order to generate an innovation which per definition is the economization new ideas. Consequently, what we analyze is a network of potential innovators. Further, we call this network innovator network.

On the basis of these considerations, we constructed the innovator network of Thuringia³ by including all patent applications to the German Patent Office between 1993 and 2004 on which at least one Thuringian inventor (the assignment was made by postal codes of inventors' address) was listed. The resulting data base contains information on 6,969 inventors (name, surname, address) and 5,381 patent applications (IPC-Code, name and address of the applicant, application date and year). The number of inventors results after checking raw data for misspelling of personal names. Using this data set, we have constructed the one-mode affiliation network of innovators, where the connection is based upon co-inventions. The information resulting from an analysis of the network of innovators can be effectively combined with other sources of information (Balconi et al. 2004) - in our case with the firm database.

Regional Innovator Network

By analyzing the innovator network (IN) XX Thuringia at all, we intend to identify the basic effect of the innovator network on firms' survival. However, 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 (Ejeremo 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

³ From now on, as a matter of simplification, we call this network 'innovator network' in contrast to the regional innovator networks which belong to different Thuringian travel-to-work areas.

research facilities and with less dense networks (Ejeremo and Karlsson 2006). Following these considerations, we expect the effect of the innovator network to differ between regions. In order to analyse this expectation, we have created 12 regional innovator networks according to the Thuringian travel-to-work⁴ areas as defined by Granato and Farhauer (2007).

Combination of both

The combination of the information from the innovator network with our firm database was done by matching names of firm founders with the names of the 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 with an application date later than the date of firm founding, 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.

If a founder is identified as being innovative in the sense of having patents, he need not necessarily be connected to the (regional) innovator network. In a second step, we therefore created an attribute dataset, identifying inventors (separately for our 12 travel-to-work areas and one for Thuringia) which at the same time have incorporated a firm. We then applied network analysis in order to distinguish between connected and isolated inventor-founders. Of course, if a firm was founded by more than one inventor-founder it is counted to be connected if at least one founder is not isolated.

The information we received from the analysis of the innovator network entered our company data base as dummy for being innovative (*innovativeThur*), in a connected (*connThur*) or isolated (*isoThur*) stage, as well as as the sum of patents the founders of a firm applied for (*#patentsThur*).

The information we received from the analysis of the 12 regional innovator networks entered our company data base as dummy for being innovative (*innovativeTTWA_i* (*i*=1, ...,12)), in a connected (*connTTWA_i* (*i*=1, ...,12)) or isolated (*isoTTWA_i* (*i*=1, ...,12)) stage, as well as as the sum of patents the founders of a firm applied for (*#patentsTTWA_i* (*i*=1, ...,12)).

⁴ Figure 1 in the appendix shows a card of Thuringia and its travel-to-work areas.

Table 1 and 2 report some descriptive statistics for the data base we've created.

(Table 1 and 2 about here.)

4. Method and Hypotheses

The methodology we apply in order to meet the goals identified in the introduction to this article is driven by the specifics of our data base at hand as well as by the definition of our variables. We first have to be aware of the fact that there is no theoretical or logical rationale for a direct effect of the connection to an innovator network on firms' survival. Rather, we only expect that the connection to the innovator network has a positive influence on the innovativeness, measured as number of patents, within the group of innovative firms. Additionally, we measure innovation in terms of patent applications. Being connected to the innovator network is by this study's definition only possible for firms which are innovative, thus have patents. Innovative firms however should have better chances to survive compared to non-innovative firms. Consequently, we have to consider several groups of firms. First, we have to distinguish innovative from non-innovative firms, measured by patents created by the founders. Second, within the group of innovative firms, we have to distinguish firms that are connected to the innovator network via their founders' co-inventions from isolated ones. The connection to the innovator network should have a direct and positive influence on innovativeness in the group of innovative firms. Innovativeness however should have a positive effect on survival within the whole population of Thuringian firms. If this holds true, we should also find evidence for an indirect effect of a connection to the innovator network on survival via innovations.

Our point of departure is innovation. Innovation has been found in several studies to have a positive influence on the success of firms. According to this, we formulated hypothesis 1. Since in this study success is measured in terms of survival, we apply Cox's proportional hazards since they give a valid estimate of the survival rate for data sets including right-censored and left truncated cases.⁵

⁵ It has been widely recognized that survival as an outcome variable does not come without bias. The problem arises due to non-complete measurements on all 'members' or entities of a random sample (Kaplan and Meier 1958). For example in medical follow-up studies, contact to some of the individuals will be lost before their

The second step of analysis relates to hypothesis 2. We want to test whether firms that are connected to the innovator network are more innovative than non-connected ones. With our data at hand, we measure innovativeness as the number of patents applied for by the founders in the year of founding or afterwards. This variable has a negative binomial distribution such that we apply negative binomial regression methods.

Testing hypothesis 3 again requires Cox's proportional hazards model (1972) since the outcome variable is survival.

In a fourth step, we proceed by testing for regional differences in this effect.

5. Empirical Results

Innovator Network

Table 3 shows the results concerning hypotheses 1 to 3 which aim at analyzing the influence of the innovator network on firms' survival.

(Table 3 about here.)

Model 1 tests hypothesis 1, stating that innovative firms survive longer than non-innovative firms and that this effect grows with the number of innovations. Applying Cox's proportional hazards model, we regress the number of patents (*#patents*), invented by a firms' founder(s) on the survival rates of firms. Since we cannot expect that survival is only driven by innovations, we also include the variables *SpinOff*, *CapComp*, *Acad* and *#Founders* as regressors. The number of patents a firm's founder applied for has a significant and positive influence on the survivability of firms. Thus, model 1 confirms hypothesis 1:

death and others will die due to other reasons. Similarly the observation of the lifetime may be ended at a certain point in time, due to the need to get out a report within a reasonable time. In many applications, and this holds also for our investigation, survival may be a subject to right censoring and left truncation (Tsai et al. 1987). Right-censored cases are study objects whose failure event is not observed. The term "right-censored" implies that the event of interest is to the right of our data point (Kaplan and Meier 1958). In other words, if the units were to keep on operating, the failure would occur at some time after our data point. Truncation is a source of bias in survival analysis, in which certain objects are ignored and not sampled (Tsai et al. 1987). Left-truncation occurs when some subjects are registered at a delayed time. Our database contains firms founded at several points in time. Thus, we have a problem with left-truncation. We also cannot observe the event of interest (closure) for some of our observations, thus we also have right-censored data.

innovative firms survive longer than non innovative ones and this effect is driven by the number of innovations (patents). Additionally, we can find significant effects of *SpinOff*, *CapComp* and *#Founders*. If the firm is a spin-off from a university or a research institute, it has a hazard rate which is only 15% of a non-spin-off hazard rate. Also a larger number of founders makes longer survival more probable. If the firm has the legal form of a capital company, as compared to a private company, its hazard ratio is increased to 114%.

Model 2 tests hypothesis 2. Since we try to find out, whether the connection to the innovator network, as compared to an isolated situation, has a positive influence on the innovativeness of a firm, we analyze only the group of innovative firms and regress the dummy for being connected (*ConnThur*) on the number of patents (*#patents*). We find a significant positive effect, which leads us to the conclusion that we cannot reject hypothesis 2: firms that are connected to the innovator network are more innovative than isolated ones. In addition to the variable of interest, we included control variables. Capital companies have significantly more patents than the private companies. In other words, capital companies are more innovative. The number of academics in the team has also a significant and positive influence on the number of patents. This may be explained by the findings of Balconi et al. (2004) that academics exchange more information with more people and across more organizations than non-academics.

Since we have found that innovations positively influence survival and that the connection to the IN positively influences innovations, we have to find out whether the first effect is driven by the second one. We therefore in model 3 splitted the variable *#patents* into two variables – *InnoConn* and *InnoIso*. *InnoConn* represents patents of connected actors, while *InnoIso* represents patents of isolated ones. We then regressed these two variables and our controls on survival. As one can see from table 3, we find that the effect of innovations on survival is only driven by connected actors. The controls show the same values as in the first model. Thus, we can confirm hypothesis 3: the longer survival of innovative firms is driven by the connection to the IN.

Regional Innovator Network

In the first step of our analysis, we have found a significant influence of the innovator network. However, in hypothesis 4, we state that the effect differs regionally, since regions differ with respect to their infrastructure and their innovator network. In order to start, we

therefore applied a logrank-test for inequality in survivor functions. This test reveals whether the Thuringian travel-to-work areas have the same underlying survivor function or not. As one can see in table 4, expected events (events one would observe if all travel-to-work areas had the same underlying survivor function) and observed events are by no means identical. Thus, we can conclude that survival differs in our regions.

(Table 4 about here.)

As we have found in the first step of our analysis, survival is influenced by innovativeness which in turn is influenced by the connection to the IN. Since we have found that survivor functions differ regionally, we now intend to identify those factors that influence survival in a region. Of course, we particularly pay attention to the factor RIN. Table 5 shows the results of the Cox-regression analysis.

(Table 5 about here.)

For all 12 travel-to-work areas, we first test, whether being innovative (measured as having applied for patents) and located to a certain region has a positive effect on survival. We can find significant and positive effects for firms that are located in the three travel-to-work areas Jena/Saale-Holzland-Kreis, Saalfeld-Rudolstadt and Gera/Greiz, and are innovative in the region of their location. In a second step, we then looked whether the positive effect of being innovative comes from firms that are connected in the area's network or from isolated ones. As one can see from table 5, this holds true for Jena/Saale-Holzland-Kreis and Gera/Greiz, although for Gera/Greiz isolated cases were dropped due to collinearity. We therefore have found hints that the effect of the IN on the survivability of firms differs for regions, which leads us to not reject hypothesis 4.

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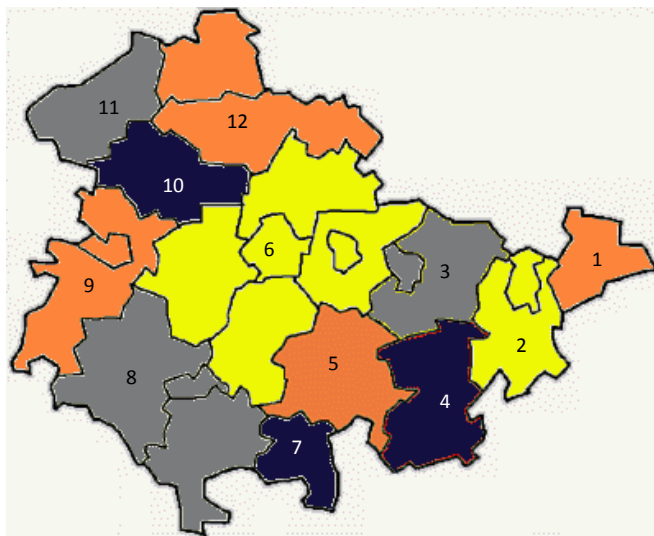
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Appendix

Figure 1 Thuringia and its Travel-to-work areas



<i>TTWA_i</i> (i=1, ...,12)	Travel-to-work areas
1	Altenburger Land
2	Gera/Greiz
3	Jena/Saale-Holzland-Kreis
4	Saale-Orla-Kreis
5	Saalfeld-Rudolstadt
6	Central Thuringia
7	Sonneberg
8	Schmalkalden-Meiningen/Suhl/Hildburghausen
9	Eisenach/Wartburgkreis
10	Unstrut-Hainich-Kreis
11	Eichsfeld
12	Nordhausen/Kyffhäuser-Kreis

Table 1 Descriptive Statistics I

Variable	Description	Ob	Mean	Std. Dev.	Min	Max
#founders	Number of founders.	4,566	1.44	0.72	0	16
#Patents	Number of patents that can be assigned to a firms' founders.	4,566	0.21	1.44	0	47
InnoConn	Variable counting the number of patents hold by connected firms.	4,566	0.19	1.42	0	47
InnoIso	Variable counting the number of patents hold by isolated firms.	4,566	0.02	0.24	0	7
Acad	Number of founders holding an academic degree.	4,566	0.12	0.39	0	9

Table 2 Descriptive Statistics II

Variable	Description	0	1	.
InnoThur	Dummy, indicating whether the founders of a firm hold patents, thus whether the firm can be called innovative.	5,781	486	2
ConnThur	Dummy variable which is 1 if an innovative firm is connected to the Thuringian innovator network.	55	246	4,265
SpinOff	Binary variable, indicating whether the firm is a spin-off from a university or a research institute.	4,468	98	0
CapComp	Dummy variable, indicating whether the firm is a capital company (1) or a private company (0).	805	3,751	0

Table 3 Regression Analysis I

	Model1	Model2	Model3
Depvar	Survival	#Patents	Survival
	Hazard Ratio	Coefficient	Hazard Ratio
#Patents	0.9289***		
ConnThur		0.5534***	
InnoConn			0.9309**
InnoIso			0.8948
Spin-off	0.1546***	-0.1145	0.1546***
CapComp	1.1437*	0.5196***	1.1434*
Academics	1.0185	0.4392***	1.0181
#Founders	0.9178**	-0.0424	0.9182**
Constant		0.0860	
Observations	All firms	Innovative firms	All firms
#Observations	4,495	300	4,495
	LR chi2(5)	Pseudo R2	LR chi2(6)
	48.32	0.0430	48.43

Table 4 Log-rank test for equality in survivor functions

	Events observed	Events expected
TTWA		
ABG	39	27,44
EaWak	86	92,15
EfSömGthlkApWe	390	393,6
Eichs	24	39,75
GGrz	78	59,38
NordKyf	59	78,11
SOK	25	19,08
SaalRud	45	39,36
ShkJ	114	103,09
SmShIHbn	128	128,96
Sonne	25	31,29
UHK	46	46,79
Total	1059	1059
chi2(11)	28,47	
Pr>chi2	0,0027	

Table 5 Regional Regression Analysis

	Model1	Model2	Model3	Model4	Model5	Model6	Model7	Model8	Model9	Model10	Model11	Model12	Model13	Model14	Model15
Depvar	Survival	Survival	Survival	Survival	Survival	Survival	Survival	Survival	Survival	Survival	Survival	Survival	Survival	Survival	Survival
	Hazard Ratio	Hazard Ratio	Hazard Ratio	Hazard Ratio	Hazard Ratio	Hazard Ratio	Hazard Ratio	Hazard Ratio	Hazard Ratio	Hazard Ratio	Hazard Ratio	Hazard Ratio	Hazard Ratio	Hazard Ratio	Hazard Ratio
Inno	0.4643**		0.000	0.5229	0.000	0.2955*		0.000	0.000	0.7362	0.6122	0.2335**		0.9378	0.6909
Conn		0.5194*						0.7656						0.2756*	
Iso		0.4921						0.000						dropped	
CapComp	0.4881***	0.4747***	0.5878	1.3831	1.1331	1.5767	1.5335	0.5017	1.1891	1.3455	1.6259	0.9701	0.9524	0.9324	1.1192
#Founders	0.7352**	0.7436**	1.1787	0.9486	0.7874	0.6933	0.6611	0.5290	0.6698*	0.8390	0.9305	0.7725	0.7738	1.0953	1.3255
Academics	0.9608	0.9093	0.9797	0.3610	2.3634**	0.4839	0.3925	4.6456	1.2148	1.1713	0.9532	2.0187**	2.0304**	0.9197	0.7378
Observations	JSHK	JSHK	Eichs	UHK	Sonne	SaalRud	SaalRud	SOK	ABG	SmShlHbn	EAWak	GGrz	GGrz	EfSöm GthlkApWe	NDHKyf
#Observations	438	438	159	158	112	157	157	84	108	487	370	250	250	1,568	286