8 ENTREPRENEURSHIP IN CLUSTER

The Surgical Instrument Cluster of Tuttlingen, Germany*

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1. Introduction

In recent years there has been intensive scientific discussion about the concept of clusters[1], in which attention has also been given to business foundings (cf. Sternberg and Litzenberger, 2004; Fornahl and Menzel, 2002). Theoretical arguments propose that the particular economic and social environmental framework conditions of a cluster have an effect on entrepreneurial activities in the cluster (cf. Feldman, 2001; Saxenian, 1994; Krugman, 1991). However, interpretations of the direction of the effect differ substantially.

Several authors argue that high founding rates observed in clusters indicate the presence of Marshallian localization economies which facilitate access to resources and information relevant to founders and reduce entry barriers (cf. Sorenson and Audia, 2000; Baum and Haveman, 1997). Additionally, the social environment of clusters offers some special features (Fornahl, 2003; Inkpen and Tsang, 2005) that could also influence entrepreneurial activities. For example, in clusters, economic ties often overlap with personal ties (Dei Ottati, 1994), resulting in dense and long-enduring networks (Rowley et al. 2000) and sometimes in cliques with a high level of redundant ties (Storper, 1993).

On the other hand, studies drawing on the organizational ecology approach stress the strong competition for resources in regional agglomerations of industries, and, thus, focus on the negative effects on entrepreneurial activity (Hannan and Freeman, 1989; Hannan and Carroll, 1992; Carroll and Hannan, 2000). In order to make an assessment of these opposing arguments, more empirical knowledge is necessary. These studies provide us with some fasci-

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1 The concept has been used and interpreted in very different ways (cf. the critique in Martin and Sunley, 2003).

nating theoretical assumptions, but they suffer from a lack of empirical data about the socio-economic mechanisms and processes related to business foundings.

In this paper, we aim to fill this empirical gap by presenting the results of a study which intend to examine the socio-economic mechanisms and processes related to the entrepreneurial activities in a cluster. Using the surgical instrument cluster of Tuttlingen as an example, we investigate the environmental conditions relevant to business foundings in the cluster and the temporal variations in the relationship between these founding conditions and the founding activity. As one of the most important conditions for the entrepreneurial activities in the cluster, we identify the social capital of founders. We examine elements of the social capital and its significance for the success of business start-ups, and identify mechanisms by which founding success is influenced by social capital. In our investigations, we use a mix of quantitative and qualitative methods.

The remainder consists of five sections. In section 2 we give some background information on the surgical instrument cluster of Tuttlingen. Section 3 contains a review of the socio-economic founding conditions in a cluster. A description of the methodology is given in section 4, and in section 5 the empirical results are presented. Finally, we summarize the findings and draw some conclusions (section 6).

2. The Case Study

Generally speaking, the notion of a 'cluster' refers to a spatially concentrated group of companies, which are specialized in some related industrial activities (Lorenzen, 2001). The cluster studied in our investigation is situated in a rural part of southern Baden-Württemberg, Germany, around the city of Tuttlingen (see figure 8.1). Concerning the surgical instrument industry, Tuttlingen is a unique phenomenon, at least in Germany.[2] The cluster is distinguished by a high concentration of some 500 mainly small or medium-sized companies producing and trading primarily surgical instruments, and to a lesser extent endoscopes and implants. Approximately 200 specialized suppliers and subcontractors complete the cluster. The concentration is limited to the county of Tuttlingen, whereas surrounding counties have virtually no companies of the surgical instruments industry. Altogether, the companies in the district of Tuttlingen represent two-thirds of all German companies engaged in this line of business; others are dispersed all over Germany. Some more figures shall indicate the significance of the cluster. In the year 2002 the cluster employed a total of 7,500 people and produced an estimated turnover of US$ 610 million. The main markets of the firms in the cluster are Germany, the USA, Europe and Japan, and the export share of firms with at least 20 employees is 64 per-

2 There is a competing cluster in Sialkot in Pakistan (Nadvi and Halder, 2002).

cent (Halder, 2004). The significance of the surgical instruments industry for the regional economy is high, with almost 15 percent of all employees subject to social insurance contributions in the county working in this line in 2002 (Sources: Job Centre Rottweil, Statistical State Office Baden-Württemberg).

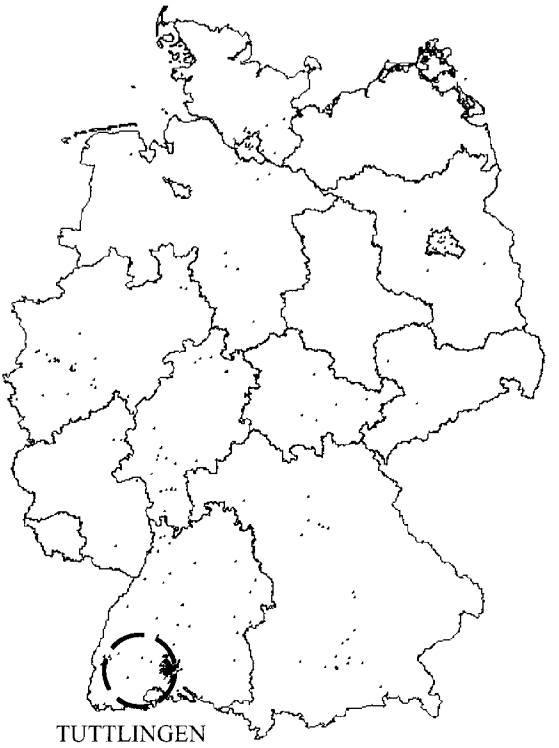

Figure 8.1: Locations of companies in the surgical instrument industry in Germany

There are a number of reasons that make this cluster an appropriate case study. First, because of its rural character, there are almost no urbanization economies that interfere with the localization economies of the cluster. Second, the origins of the cluster date back over 130 years, so changes in entrepreneurial framework conditions can be well examined. Finally, the number of firms founded is large enough to allow adequate statistical analysis.

3. Socio-Economic Founding Conditions in Clusters

According to Staber (1997), founding conditions in clusters are driven by cooperative and competitive socio-economic processes. These dynamic processes reflect inter-firm learning, operational flexibility, and innovation, and

are seen as the source of a cluster-specific economic vitality. In the following sections, we focus first on temporal variations in the relationship between general founding conditions like cooperation, competition, etc. and the entrepreneurial activity in the evolution of the cluster. Second, we investigate the social capital of business founders as one of the founding conditions in the cluster.

3.1 Founding Conditions and Entrepreneurial Activity in the Evolution of Clusters

Many studies assume a higher level of founding activity in clustered areas than in non-clustered areas (cf. Sternberg and Litzenberger, 2004; Fornahl and Menzel, 2002). Authors of the 'new economic geography' suggest that due to competitive advantages in a cluster, there are low entry barriers, and this, therefore, has positive effects on entrepreneurial activity (cf. Krugman, 1991). Nascent entrepreneurs, thus, benefit from elements of the localization economies such as skilled labor, supportive infrastructure and specialized suppliers on site (Marshall, 1890), and from knowledge spillovers (Saxenian, 1994). Studies that focus on the social environment of entrepreneurs point out the embeddedness of entrepreneurs in networks of continuing social relations (cf. Aldrich and Zimmer, 1986; Bosma et al., 2002). Mutual trust and common norms, rules, and routines for acting are a fundamental element of social relations and, thus, are a basic requirement for a well-functioning network. The pronounced 'institutional endowment' in clusters leads to 'localized capabilities' (Maskell and Malmberg, 1999) or 'untraded interdependencies' (Storper, 1997). Over time, an 'institutional thickness' evolves (Amin and Thrift, 1995) that includes formal institutions such as further education and training establishments, and trade and similar organizations that may encourage systemic trust among the actors in the cluster (cf. Bachmann, 2003).

However, as Porter (1998, 2000) notices, fierce competition among local companies is another typical attribute of clusters. The firms compete for critical resources such as know-how, skilled labor, specialized suppliers, capital, customers, etc. (Hannan and Freeman, 1989; Hannan and Carroll, 1992; Carroll and Hannan, 2000). As a result, established companies may try to hinder start-ups, and they may be closed down soon after founding, due to resource squeeze.

In conclusion, clusters are characterized by a conflicting interrelation of socio-institutional embeddedness and cooperation, on the one hand, and competition for critical resources, on the other. Stability and equilibrium in this interrelation are rare; instead, temporal disequilibria are the norm. Most empirical studies dealing with this subject use a static design. As a result, they do not capture the dynamics of how the balance of cooperation and competition evolves over time, with implications for understanding changes in entrepreneurial activity. The organizational ecology approach enables investigations

of dynamic processes like time-varying cooperation, competition, and entrepreneurial activity in the evolution of a cluster. Staber (1997) used the ecological concept of population density – i.e., the number of firms existing at a given point in time, relative to available resources in their environment – to study temporal variations in the founding activity as a function of changes in the intensity of cooperation and competition.

Organizational ecologists assume that during the early history of cluster development, when population density is low, an increase in density leads to greater legitimation, i.e., acceptance by authorities, lenders, suppliers, clients, etc. (Meyer and Rowan, 1977), and to a higher potential to cooperate (Staber, 1997), facilitating founding activity. However, an increasing density also leads to greater competition for available resources. According to the organizational ecology approach, as density increases, legitimation and the potential to cooperate increases at a slower rate and competition increases at an increasing rate. Thus, when population density exceeds a certain limit, the negative effect of increased competition for resources outbalances gains made in respect of legitimation and potential to cooperate. From this point on, founding activities decrease. From early to late stages of cluster development, these processes lead to an inverse U-shaped relationship between population density and the founding activity, assuming that the carrying capacity of the population's environment is fixed over time. Many empirical studies confirm this non-monotonic relationship between density and founding activity.[3]

An ecological analysis of entrepreneurial activity in a cluster has to consider contextual factors besides population density. These additional founding conditions are general framework conditions (such as the general business climate), industry-specific framework conditions (such as the national and international demand for products), as well as further cluster-specific conditions (such as strategies of local firms or changes in the local value chain). Additional parameters concerning the founding capability within the cluster, e.g. the number of potential founders, could complete an analysis of business foundings in a cluster.

3.2 Social Capital as an Important Founding Condition in Clusters

As discussed above, several environmental framework conditions affect the entrepreneurial activity in clusters. The social environment distinguishes clusters from other economic areas (Dei Ottati, 1994; Rosenfeld, 1997; Gordon and McCann, 2000). Hitherto, there have only been a few studies that try to combine the special features of the social environment and start-ups in clusters (Britton 2004, Westlund and Bolton 2003).

3 For reviews see Carroll (1984), Singh and Lumsden (1990), Hannan and Carroll (1992).

Studies by Halder (2004) and Nadvi and Halder (2002) illustrate the importance of the social environment for economic activities in the cluster of Tuttlingen. To include the social environment in our considerations, we can draw on several theoretical concepts, such as the social networks concept, the embeddedness model, and the social capital model.[4] The social capital model has recently been attracting much attention, and there are some studies that examine the importance of social capital for entrepreneurs (Bühler, 1999; Bosma et al., 2002; Maurer, 2003). However, the notion of social capital is used in different ways.[5] In the following paragraphs, we refer to an entrepreneur's social capital as being, first, the configuration of the whole network of his social contacts and, second, the characteristics and content of his individual ties. While the characteristics of the contacts – for example, their human capital – are not included in an entrepreneur's social capital, they do have a significant influence on the individual ties and, therefore, should also be taken into account. Thus, we adopt a structure-oriented perspective of social capital (Maurer, 2003).

Following Nahapiet and Ghoshal (1998), we distinguish three dimensions of social capital. The structural dimension contains the overall configuration of the network and includes the size of the network, its heterogeneity and its multiplexity. Extensive and heterogeneous networks are beneficial particularly for founders as they provide access to the diverse resources that are necessary for founding a firm, and can enable the entrepreneurs to overcome a lack of own resources (Steier and Greenwood, 2000, 166). Multiple ties provide founders with access to more and different resources (Maurer, 2003, 33). The relational dimension is relevant to trust and norms, each of which can serve as a control mechanism in a particular tie. Both reduce the danger of opportunistic behavior and can contribute to a reduction of transaction costs (Nooteboom, 1999).[6] The cognitive dimension includes the way actors interpret situations. The interpretation in the context of entrepreneurship relevant situations might be who are the most important competitors or which are considerable technical innovations. considerable. If there is cognitive proximity between the actors, that is, if they have common or similar interpretation schemes, the effective exchange of experience, advice and information, the interpretation of what they have, and new combinations of information are all made easier (Tsai and Ghoshal, 1998; Boschma, 2005).

The function of social capital is to enable the owner to acquire resources to attain certain goals, or to make those goals easier to reach (Coleman, 1990). The value of social capital depends on the context and, in connection with

4 For a full discussion of the network model, see the bibliography; for an extensive account of the embeddedness model, see Granovetter (1985), and Uzzi (1996). The basic idea of the embeddedness model is that economic actors are embedded in a social framework that influences their actions. This idea is also the basis of the social capital model.

5 A good summary can be found in Adler and Kwon (2002).

6 Fundamental for the transactions cost model, see Williamson (1975).

founding firms, advice about how to found them, being able to draw on capital and tangible assets, unpaid assistance and emotional support, can all be especially valuable. The possibilities and limitations with regard to access to these resources result from the position of a founder in the network and the configuration of the particular ties. The social capital of entrepreneurs who set up firms eases the acquisition of resources and, thus, influences the success of the new firm (Bühler, 1999).

As a result of these considerations, we propose several hypotheses:[7]

- The multiplexity of social roles in a dyadic relation (e.g. two persons interconnected via a business and a friendship relation) leads to an increase of accessible resources and the variety of these resources embedded in this relation (Grabher and Stark, 1997). Founders whose social capital includes a large proportion of multiplexities are more successful.
- Trust accounts for easier access to resources (Liebeskind, Oliver, Zucker and Brewer 1996; Larson, 1992). Founders with social capital characterized by trust are, therefore, more successful.
- Cognitive proximity facilitates the exchange of information and is conducive to innovation (Talmud, 1999; Boschma, 2005). Founders with ties characterized by cognitive proximity are more successful.

The hypotheses concerning the role of social capital have to be interpreted in the light of the special start-up conditions in a cluster. In a cluster, specific social capital can be built up through a combination of special local features, such as intense competition and local institutions. For clusters, Gordon and McCann (2000) see an exceptionally high level of actors' social embeddedness combined with a number of advantages - for example, lowered transaction costs as a result of trust between the actors (Enright, 2003, 105). Of course, social capital can also have a 'dark side' if it results in cognitive lockins (Portes, 1998; Putnam, 2000). In general, social capital is a fundamental component for developing 'collective entrepreneurship' in a region and, thus, may strongly influence the founding activity (Westlund and Bolton, 2003).

4. Methodology

Our research questions for this study were of explorative and of hypothesis-testing nature. Besides the testing of the hypothesis, we intended to identify mechanisms by which founding activities are influenced, and how social capital affects success of start-ups. The conceptual framework developed for the determinants of the founding activities in clusters and the relevance of social capital for entrepreneurs clearly showed that it was favorable to use a multilevel analysis and to work with a combination of quantitative and qualitative

7 In addition, a number of other hypotheses were made relating to further social capital variables and control variables.

methods. The use of ethnographic methods of data collection enabled us to check the validity of the quantitative observations (Uzzi, 1996).

To analyze founding conditions in the selected cluster, we drew on the Business Registration Index of several municipalities as our main data source for both investigations. Using those indices, we compiled a database of the surgical instrument firms that had been set up or closed down in the Tuttlingen district from 1945 to 2002, inclusively. As an adjustment, we used additional data sources (e.g. several surgical instrument manufacturer directories), and in doing so we were able to overcome several limitations of Business Registration Indices as a source of information (cf. Fritsch and Grotz, 2002). Our search produced a total of 856 firms at the core of the surgical instrument industry and 349 firms or home workers specializing in complementary activities (polishing, grinding, drilling, etc.) that had been operating for at least one year between 1945 and 2002. In this period, 621 firms were established and 294 firms were closed down at the core of the surgical instrument industry (cf. figure 8.2). Using additional archival sources, we were able to reconstruct the annual number of foundings[8] of craft firms within the surgical industry sector from 1870 to 1940.

In the empirical analysis of time-varying founding conditions and founding activity, we followed the convention in defining a population of firms as the unit of analysis and treated foundings as events in a point process, i.e. as an instant of an arrival process, for the population (cf. Hannan and Freeman, 1989). Because we used annual numbers of foundings for the period from 1947 to 2000[9], we modeled the aggregated annual event counts directly instead of analyzing event histories. Therefore, we assumed a founding rate (in terms of a stochastic hazard rate) with log-linear dependence on density and the covariates as given by the following equation:

$$\lambda_t = \exp(\alpha_0 + \alpha_1 N_t + \alpha_2 N_t^2 + \sum \alpha_3 X_t)$$

where α0 is the intercept, Nt is density, and Xt is the set of covariates. The density dependence model predicts that $\alpha 1 > 0$ and $\alpha 2 < 0$. The models of the founding activity we chose are based on the simple Poisson model.[10]

We considered the surgical instrument cluster of Tuttlingen, which was introduced in section 2, as a community of organizations in the ecological sense. The organizational population under study was the set of manufactur-

8 Unfortunately, we were not able to reconstruct the deaths.

9 We transformed the yearly number of foundings into a moving average of four years, eliminating extreme mavericks (cf. figure 8.2 and 8.3). We also estimated models with the actually observed numbers of foundings. The results of these models are similar to the results we present in this paper.

10 A complication arises if the assumption of the variance of the Poisson distribution equaling the mean does not hold. To test this assumption, the authors estimated the negative binomial regression model, which allows for over dispersion. The results from this estimation were no improvement over the Poisson model. Hence, Poisson estimates are reported below.

ing and trading firms that defined the cluster as a socio-economic entity. As a result of increasing diversification of strategies and forms of organization employed by firms, we separated the sub-population of manufacturers (MANU) from the sub-population of traders (TRADE), including some service providers. Referring to the population as a whole (ALL), and the two sub-populations, we estimated the ecological model mentioned above. We tested several environmental variables as covariates to account for the changes in the level of the founding activity. Prior business failures, for example, provided potential founders with information about opportunities and constraints. High levels of dissolutions may be interpreted as a signal that opportunities are declining, thus, repressing start-ups, whereas low levels of dissolutions should have the opposite effect. The experts we interviewed stressed the impact of the exchange rate of the US dollar on international demand for surgical instruments. Therefore, we used this exchange rate as a proxy variable for the environment's carrying capacity, in terms of demand for the surgical instruments.[11]

The regression models we calculated served as a basis for discussion in the 23 interviews conducted with local and non-local experts in the surgical instrument industry and also with representatives of recognized institutions in the cluster environment. To cross-reference our findings and to bridge the gap to the past, we analyzed archival sources (e.g. about 1,500 newspaper articles). This supplementary information was used to prepare the semi-structured interviews with established entrepreneurs. We interviewed 32 entrepreneurs who had set up their businesses between the 1950s and the 1990s, and evaluated their particular founding conditions. The selection of entrepreneurs interviewed was based on a stratified random sample.

Concerning social capital, our data base contained 147 people who had become self-employed in the surgical instrument industry in the cluster between 1998 and 2002.[12] In order to check whether a founder was appropriate for our purposes, we made telephone calls to check some of his/her characteristics:

- Entrepreneurs must have set up a firm for the first time, as those who had previously established one could probably call on networks created earlier.
- When taking over a firm, founders should not have been a long-term employee or a relative of the previous owner because in this case, it can be

11 We estimated the models with a number of additional covariates such as GNP growth rates, unemployment rate, number of insolvent firms, rate of self-employed, public expenditure for health care, export quotas of fine mechanics as well as of medical devices, number of newly-examined mechanics in surgical instruments with a master craftsman's diploma, etc. Covariates other than prior deaths and the exchange rate of the US dollar did not improve the model's fit substantially.

12 According to Knoke (1994), three possibilities can be considered for defining the networks to be studied: first, using the characteristics of the network actors; second, using the kind of relationships; and third, using the participants in certain events. In our case, the definition was based on the characteristics of the network actors.

assumed that some of the network contacts of the predecessor would be transferred.

Of the 119 people who were contacted,[13] 64 did not match all of our sampling criteria and, therefore, were not included in the sample. Of the 55 remaining people, 32 were willing to take part in an interview, representing a success rate of 38 percent. To be able to assess alternative explanatory models, we conducted 25 supplementary interviews with entrepreneurs. Those additional interview partners had established their firms in 1997, have been working as suppliers, had inherited the firm as family members or had founded a firm outside the cluster.

The data were collected by means of interviews that were guided and, to some extent, standardized. The structural dimension of social capital was captured by using indicators of heterogeneity, strength, and multiplicity of the network ties.[14] Concerning the relational dimension, we limited the study to the measurement of trust; the cognitive dimension was measured by the cognitive proximity of the other participant in the discussion. Whenever possible, we went back to reliable valid constructs used in prior studies. We determined levels of trust and cognitive proximity using open questions, and subsequently we categorized the answers. Apart from questions related to the social network, we also asked questions about the related benefits of support and about purely economic success variables.[15] In addition, we collected a number of control variables and complementary assessments from the perspective of the founders.

We gathered ego-centered network data by questioning the founders (egos) about their conversational partners (alteri) in the last six months.[16] For reasons of time, the collection of the detailed relational data had to be limited to the five most important conversational partners. The interviewees gave the names of 180 conversational partners, and we gathered detailed data on 116 of the relationships. Limiting the time of recognition to the previous six months was necessary in order to get reliable statements (Marsden, 1990, 456). For the evaluation of the qualitative interview data, we drew on the consideration suggested by Meuser and Nagel (1991).

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13 We were not able to contact 29 people, either by phone or in person.

14 The questions were oriented towards studies that had been carried out previously (cf. Bühler, 1999; Burt et al., 2000).

15 Success measures used: sales growth since the firm was founded, number of employees, and share of sales for the three most important customers (cf. for success measures for new firms, see Brüderl and Preisendörfer, 1996).

16 We limited our survey to symmetric, ego-centered, and first order networks. For the advantages and disadvantages of this method see, for example, Marsden (1990). For the basics of social network analysis, see Wasserman and Faust (1994). Since there are methodical restrictions concerning social network analysis, e.g. biases in retrospection of interviewees, we limited the investigation to founders who have set up a business during 1998 and 2002.

5. Empirical Results Concerning the Surgical Instrument Cluster in Tuttlingen

5.1 Founding Conditions and Entrepreneurial Activity in the Evolution of the Cluster

The number of firms established or dissolved varies considerably during the evolution of the surgical instrument cluster of Tuttlingen. Figure 8.2 shows cyclical variations of the founding activity as well as a secular trend of increasing business start-ups from 1870 to 2002. From 1993 on, there is a significant increase in the number of business failures. The numbers of 'births' and 'deaths' concerning the sub-populations of manufacturing firms and trading firms, including service providers, are shown in figure 8.3. In the sub-population of manufacturing firms, the numbers of births show cyclical variations but no significant trend. In the sub-population of trading firms, including service providers, the numbers of births show a significant increasing trend of business foundings, with a 'take-off' in the early 1970s.

Table 8.1 shows the maximum likelihood estimates of the Poisson model of density dependence, concerning the founding activity in the surgical instrument cluster of Tuttlingen from 1947 (1953, trader and service providers) to 2000. The baseline model ALL (1) estimates the density dependence of the founding activity in the population of manufacturers and traders, including service providers, as a whole. Models ALL (2) and ALL (3) add the covariates of prior deaths and exchange rate of the US dollar. The results of these models concerning the core of the surgical instrument cluster do not support the assumptions of the density dependence model. The coefficients of the linear and quadratic term of population density do not correspond to the predictions of the ecological approachl. The same results shows model MANU estimating the density dependence of the founding activity in the sub-population of manufacturers exclusively.

In model TRADE, concerning the founding activity in the sub-population of traders, including service providers, the first and second order effects of population density are significantly positive and negative as predicted in the ecological model. This result confirms the assumption that at a low level of population density, the addition of new organizations supports the legitimation of existing organizations and raises the potential for cooperation, thus, facilitating foundings. As density grows to a high level, further foundings intensify competition over access to critical resources, and, thus, reduce the level of founding activity.

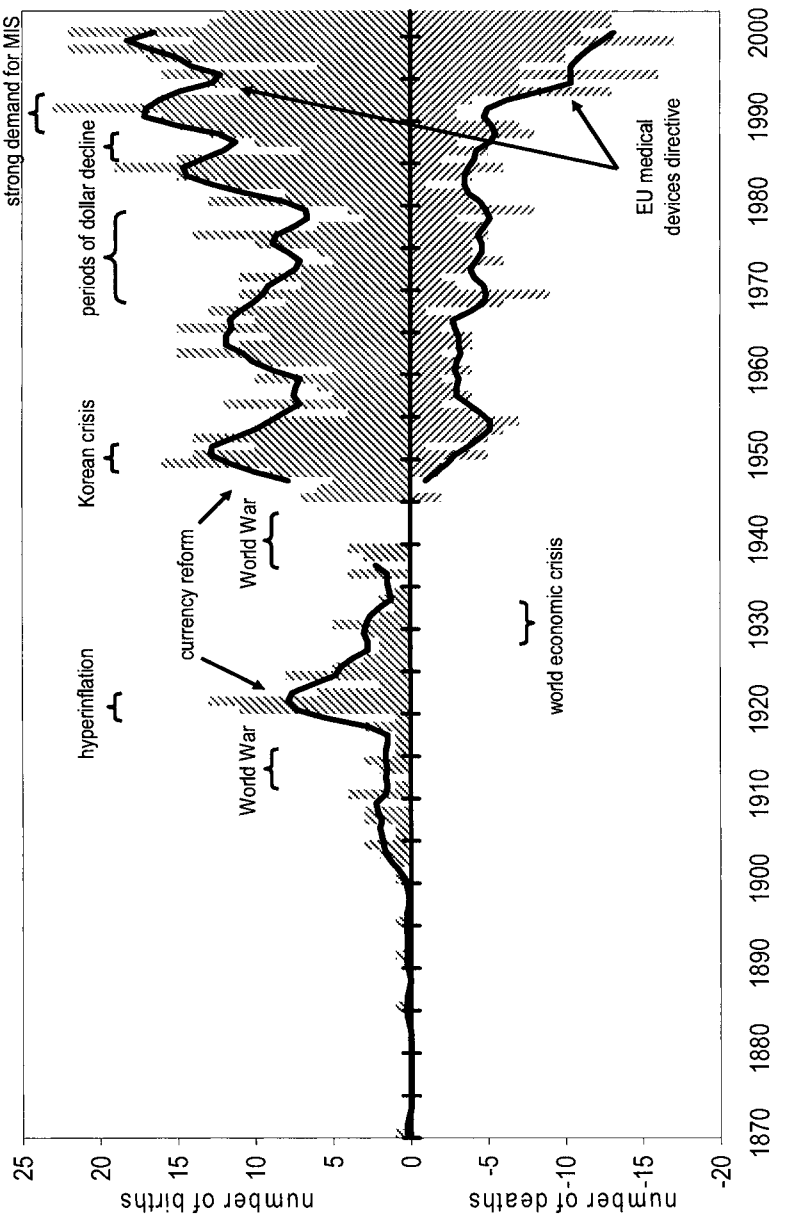

Figure 8.2: Births and deaths in the surgical instrument cluster of Tuttlingen 1870-2002 (moving average of 4 years in continuous line)

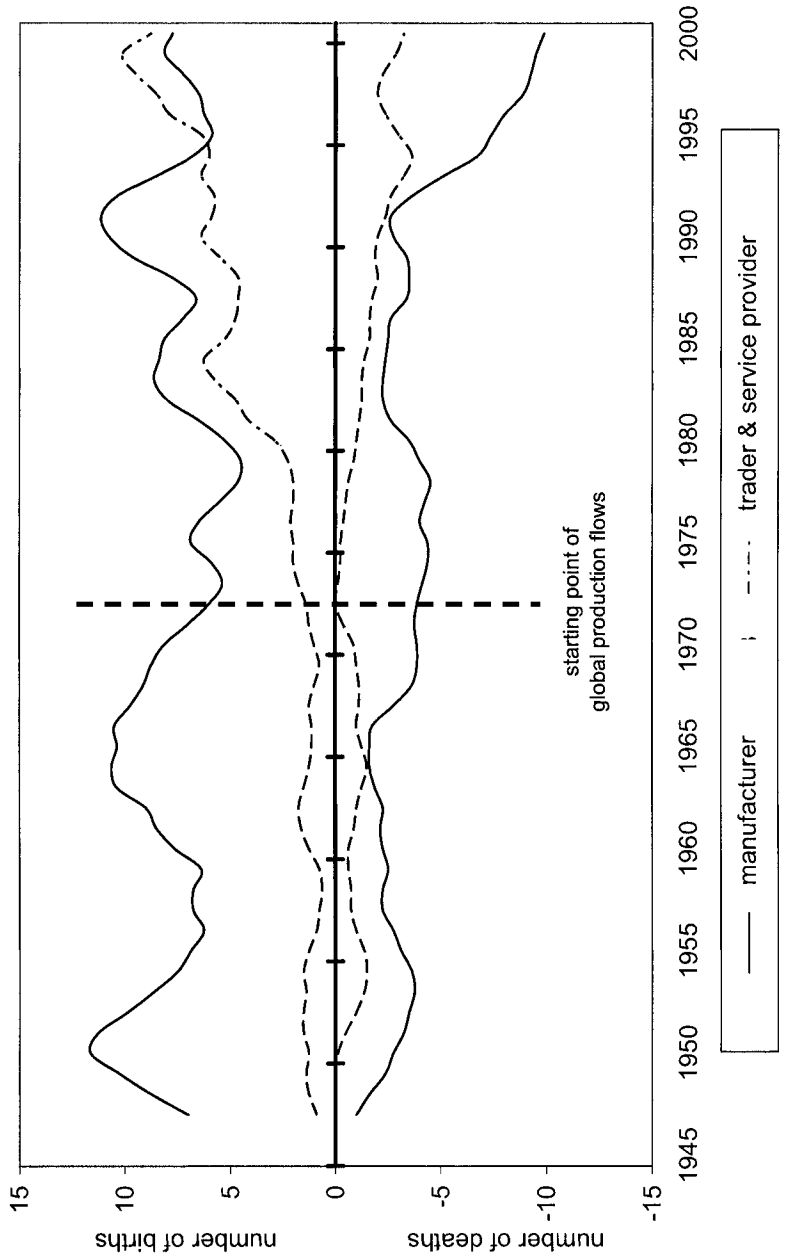

Figure 8.3: Births and deaths of manufacturers and traders in the surgical instrument cluster of Tuttlingen 1947-2000 (moving average of 4 years)

Table 8.1: Poisson regression models of the founding activity (standard errors in parentheses)

	Models				
Variables	ALL (1)	ALL (2)	ALL (3)	MANU	TRADE
Constant	2,990***	3,787***	1,684	1,667	-2,350*
	(0,500)	0,602	(1,396)	(1,529)	(1,094)
Density	-0,006	-0,011**	-0,004	-0,008	0,089***
	(0,003)	(0,004)	(0,007)	(0,010)	(0,021)
Density^2/1000	0,012*	0,020**	0,014	0,024	-0,409**
	(0,005)	(0,006)	(0,009)	(0,018)	(0,119)
Prior Deaths	-	-0,057*	-0,062	-0,067	-0,317*
		(0,027)	(0,032)	(0,034)	(0,159)
Exchange Rate of the US-Dollar	-	-	0,214*	0,293*	0,310
			(0,105)	(0,128)	(0,200)
Log likelihood	-124,54	-120,03	-106,20	-96,95	-86,87
Pseudo R^2	0,094	0,110	0,143	0,049	0,366
Period	1947-2000	1947-2000	1953-2000	1953-2000	1953-2000

Notes: Statistical significance of variables indicated by: * = 5 %, ** = 1 %, *** = 0,1 %.

In all estimated models, the covariates show the same effect. A decline in prior deaths, together with a rise of the US dollar exchange rate, increases the founding activity. Both covariates provide potential founders with information about opportunities and constraints concerning the environment's carrying capacity, in terms of the absolute level of material resources for which firms compete.

We could assume several reasons as to why the models of the population as a whole (ALL) and of the sub-population of manufacturers (MANU) do not confirm the density dependence model. One reason could be that we cannot equate the surgical instruments cluster of Tuttlingen with a population of its own. Maybe the definition of the population has to be the global surgical instrument industry, as Tuttlingen manufacturers have sourced production steps out, as well as building up external subsidiaries, especially in low-wage countries (cf. Nadvi and Halder, 2002; Halder, 2005). However, the interviewed experts confirmed the assumption that the firms in the cluster primarily interact and compete locally for critical resources. Therefore, the cluster level still has to be regarded as the appropriate level of analysis.

Another explanation might be the absence of strong cooperation and competition influencing the founding activity. In our investigation, we observed intense interaction and fierce competition in the cluster, but we could not find fundamental changes in the cooperation and competition associated with population density. Although we identified formal cooperation and 'institutional thickness' in the cluster (table 8.2), the intense competition for critical

resources such as tacit knowledge and access to customers produces a 'culture of systemic mistrust', and prevents joint action and 'collective efficiency' (Schmitz, 1995). The majority of the firms are avoiding direct competition by pursuing a niche strategy and using long-standing personal ties. For example, 89 percent of the entrepreneurs interviewed about the circumstances of their founding considered the firms in the cluster to be their biggest competitors. But only 14 percent of them considered these local competitors to be a founding risk. Moreover, access to resources derives from social ties associated with personal trust and not from formal cooperation with systemic trust (cf. section 5.2). In Tuttlingen, these social ties and the intensity of local competition are not associated directly with population density. Because in the ecological model cooperation and competition are merely inferred from density, at least in the present case, the interpretation of density dependence in founding activities is not without its problems.

A third explanation of the rejection might be the left truncation in the data set by omitting the early history in the populations' evolution before 1945 (cf. Hannan and Carroll, 1992; Carroll and Hannan 2000). Based on historical documents and sources, we can assume a very low founding activity associated with a low density in the initial period of cluster evolution, from the establishment of the first instrument factory in 1867 to 1900 (cf. figure 8.2). According to Storper and Walker (1989); in an early stage of localization, the firms cannot benefit from localization economies. In this early development stage, complete surgical instruments were manufactured in isolated firms. Thus, there was no division of labor within the cluster and, therefore, virtually no opportunity for cooperation, especially in terms of forward and backward linkages within the local value chain (figure 8.4). The entry barriers for new firms were correspondingly high. From about 1900, specialized suppliers and supporting organizations such as trade associations were established. In this period of clustering, the entry barriers fell considerably because of the localization economies associated with the diversified value chain, and, thus, a higher potential for cooperation within the cluster. In the following period of dispersion, due to increasing competition in the 'mature' product sector, in the early 1970s Tuttlingen firms turned to 'original equipment manufacture' (OEM) suppliers in low-wage countries (Pakistan, Malaysia, etc.). Henceforth, the Tuttlingen firms provide manufacturers abroad with know-how, inputs, and materials, whereas the OEM suppliers provide manufactured and semi-manufactured goods which are finished in Tuttlingen. Since this starting point of mutual global production flows, numerous trading firms have been founded, as well as specialized suppliers and subcontractors who carry out the 'finishing' of semi-manufactured goods for the traders (cf. figure 8.3). In this way, Tuttlingen developed as a kind of global trading hub.

Table 8.2: Cluster-specific institutions in the surgical instrument cluster of Tuttlingen

Institution (year of foundation)	Description
Landesinnung Chirurgiemechanik (1914)	The only craft association of mechanics in surgical instruments in Germany
Gebrüder Martin (1923)	Trade association
Medicon e.G. (1941)	Trade association
Berufliches Bildungszentrum Tuttlingen, BBT (1978)	The only place in Germany to learn the profession of a mechanic in surgical instruments
FORUM Medizintechnik (1989)	Institutionalized platform for technological learning through lectures on innovation, etc.
Ständige Ausstellung von Chirurgie-Instrumenten u. Geräten, ACIG (1992)	A permanent display of surgical instruments and medical appliances
Gewerbepark „take off" (1997)	Technology park, since 2001 focus on start-up firms in the medical technology sector
Kompetenzzentrum Minimal Invasive Medizin + Technik Tübingen-Tuttlingen, MITT (2001)	Competence and technique center for minimally invasive surgery for Tübingen-Tuttlingen
International Business School Tuttlingen (2003)	MBA Medical Device and Healthcare Management

So far, we have discussed time-varying founding conditions and entrepreneurial activity for longer periods. In consideration of the cyclical variation of the founding activity, we also have to look at fast-changing founding conditions influencing the founding activity.

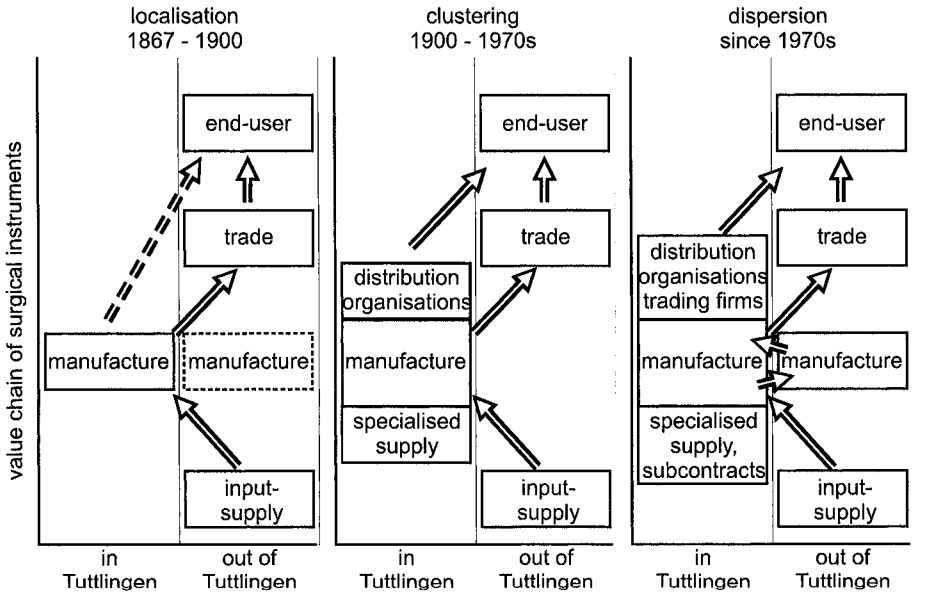

Figure 8.4: The global value chain of surgical instruments at different stages of cluster development

The surgical instrument firms in Tuttlingen have export quotas of up to 85 percent and are, thus, largely independent of the national framework conditions and the national demand for surgical instruments. On the other hand, they strongly depend on international framework conditions, including international demand for surgical instruments and the exchange rate of the US dollar. Periods of dollar decline or historical events like the two world wars influenced the founding activity significantly (cf. figure 8.2). For example, after World War I the striking increase in the founding activity was caused by the redevelopment of foreign markets associated with a favorable exchange rate for US wholesalers because of the hyperinflation in Germany (1920-1922). As a result of the currency reform and the saturation of foreign markets (1923/24-1925), many new firms were established as a matter of need, just as happened five years later because of the world economic crisis. Again, after World War II, there was a catching-up in founding activity associated with the currency reform and the Marshall Plan. According to the experts we interviewed, fluctuations in demand for surgical instruments were initially absorbed by the adjustment of capacity in the existing firms, so that new firms were only founded when these fluctuations in demand became extreme (e.g. the large orders resulting from the Korean crisis). Unlike the variations in quantity of demand, structural changes in demand have direct effects on the number of entries and exits of firms. Thus, the founding boom from 1989-1992 can be explained by the strong demand for new instruments for minimally invasive surgery (MIS). The rapid increase in the number of exits from 1993 onwards can be seen as a result of the increasing quality requirements according to the European Union (EU) medical devices directive.

To sum up the findings in this section, we notice at first that cyclical variations in founding activity were primarily caused by historical events concerning changes in the demand for surgical instruments. Second, periodical variations in founding activity were influenced by organizational changes within the value chain associated with time-varying cooperation and competition. Population density is only an appropriate indicator for measuring time-varying founding conditions for the sub-population of traders. Instead of density, firms' individual strategies and social ties are the crucial factors that have influenced entrepreneurial activity in the evolution of the surgical instrument cluster of Tuttlingen. For this reason, in the following section we describe the social capital of entrepreneurs in detail.

5.2 Social Capital as an Important Founding Condition in the Cluster

Our investigation of the social capital of founders gives us a more detailed picture of the relevance of the social environment for entrepreneurial activity in the case of Tuttlingen. Below, we depict some main findings regarding structural, relational, and cognitive aspects of our network analysis on social capital, and the benefits the founders derive from it.

The analysis of the composition of the ego-centered founder network showed that almost every one of the interviewees could draw on contacts with other entrepreneurs or employees within the industry. Only three of the interviewees did not name entrepreneurs or people with professional experience in the surgical instrument industry. In contrast, 20 of those interviewed named at least one other entrepreneur in the surgical instrument industry, and seven founders had conversations with owners and employees from this industry exclusively.[1]

Advice from members of institutions such as business development agencies, banks, or Chambers of Trade and Industry played hardly any role in discussing topics related to setting up a new firm (cf. table 8.3). Contacts with representatives of banks or chambers mostly involved superficial exchanges. Contacts with the numerous local industry promotion, research and technology transfer institutions[2] were rare exceptions. One explanation for this could be the lack of institutional trust[3] with respect to the institutions located in the cluster, as discussed in the previous section. Many representatives of the institutions had previously worked in one or other of the surgical instrument firms, or have relatives who are working there.

Table 8.3: Number of founders with contacts to institutions since start-up (n=32)

Institutions	No. of founders
Banks	20
Chambers	9
Local or regional industry promotion	4
Kompetenzzentrum Minimal Invasive Medizin + Technik Tübingen-Tuttlingen (MITT)	2
Berufliches Bildungszentrum Tuttlingen (BBT)	2
Others	9

Confidants, with whom there has been exclusive, private contact, have in many cases been acquainted with the founders for a long time. These ties were very often strong ones. Contacts that are exclusively business-related were more often new and ties were weak, but still account for less than half of all ties (cf. figure 8.5).

1 To qualify these results, 12 entrepreneurs from outside the cluster were interviewed. Seven of these said that they had no opportunities for exchanges with other entrepreneurs or employees from their industry and considered this to be a disadvantage. Those who did have such opportunities had exchanges mainly with contacts outside the Tuttlingen region. These were the contacts that were most valuable as sources of information about competitors, products and the industry.

2 As well as the chambers, these are the Landesinnung für Chirurgiemechanik Baden-Württemberg, Forum Medizintechnik Tuttlingen, Kompetenzzentrum Minimalinvasive Medizin and Technik Tübingen (MITT), a Steinbeis Transfer Centre for Medicine and Technology, and other institutions.

3 For a general survey of trust and institutionalized trust see, for example, Hardin (2002).

Concerning the variable 'trust in the contact person', ties that involve great or very great levels of trust proved to be of dominant importance (cf. figure 8.6). Very trustful ties existed in relationships where all topics – including financial questions and names of customers and suppliers – can be discussed. With ties where there was no trust, the founders kept all information to themselves that could be useful to others or that could be damaging if passed on to third parties. Two-thirds of the ties were characterized by cognitive proximity, expressed in common ideas about the surgical instrument industry and/or about independence. In a few ties, there was no cognitive proximity with regard to the industy; however, the different conceptions did lead to innovations. In one-quarter of the cases, communication with and support from the contact suffered from a lack of cognitive proximity from the interviewees' point of view.

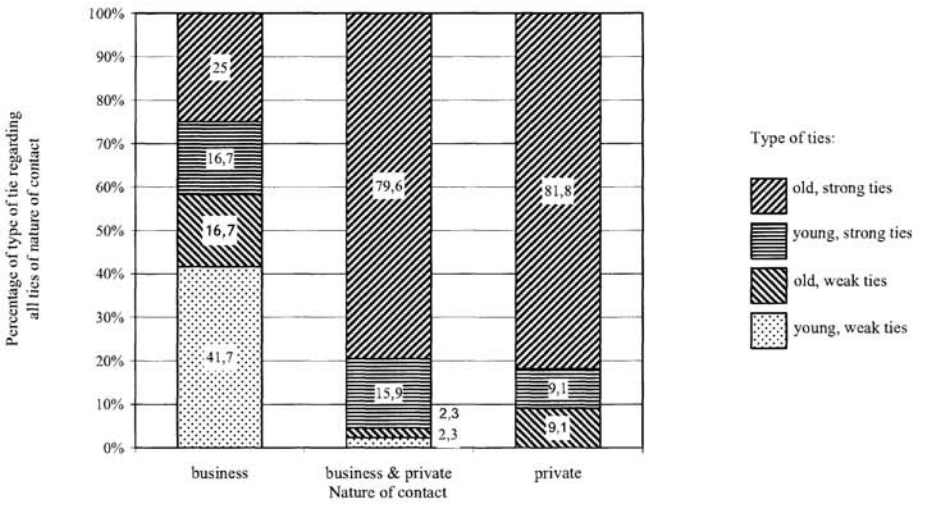

Figure 8.5: Types of founders' ties (n=113 ties)

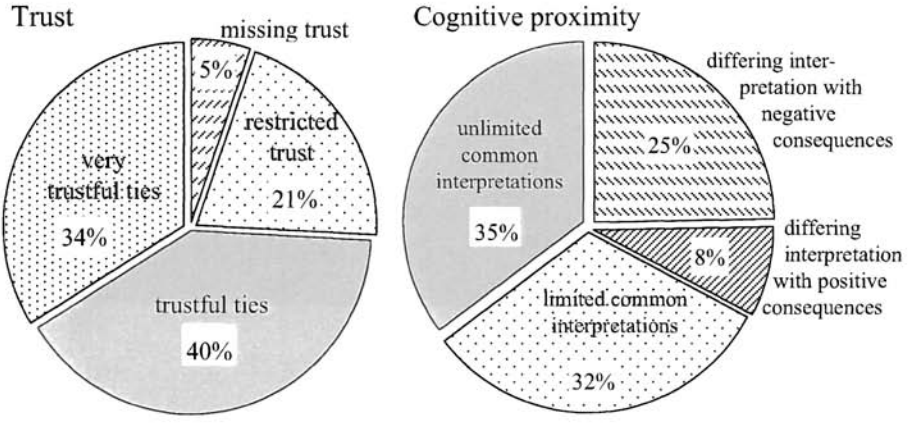

Figure 8.6: Trust (n=112 ties) and cognitive proximity (n=113 ties) in founders' ties

The interviewees often obtained a great variety of support services through their contacts (cf. table 8.4).[4] It is noticeable that almost half of the contacts had provided the entrepreneurs with emotional support. Many founders described this kind of support as very important and they referred to some situations in which emotional support was decisive for them to maintain their independence. Information about the industry and in particular about the local competition ('information on cluster') was received from 29 percent of the ties. The respondents described this information as 'tacit', absolutely necessary, and only available through contacts with industry insiders. This also applies to the know-how of other craftsmen that was obtained through 14 percent of the ties. Unpaid help and general advice were other frequently mentioned forms of support. Other forms of support were seldom received, but in individual cases they were essential for the survival of the start-up.

Table 8.4: Support services derived from contacts (n=116 ties)

Nature of support	derived from ... % of named ties
Emotional support	47
General advice	33
Information on cluster	29
Unpaid activities in founders' firms	18
Know-how transfer	14
Recommendations	6
Material, machinery for free	6
Judicial and fiscal advice	5
Financial resources	4

Analyzing the ties that provide the founders with important detailed information about the industry and local competition, it is evident that the majority gained their information through strong or very strong ties (cf. figure 8.5).[5] This result contrasts with the classical study by Granovetter (1973) on the role of weak ties in the provision of information, but it can be explained by the lack of systemic trust between the actors in the cluster, which greatly hinders an open exchange of information.[6]

[4] In an open question about the locational advantages in the cluster, 12 founders gave support from insiders as the biggest of these.

5 We measured the strength of ties following Burt (1998); that is, ties are stronger, the higher the emotional intensity.

6 This characteristic contrasts with the industrial district literature where widespread trust between local actors is said to be a major basis of interaction and cooperation (e.g. Braczyk et al., 2004).

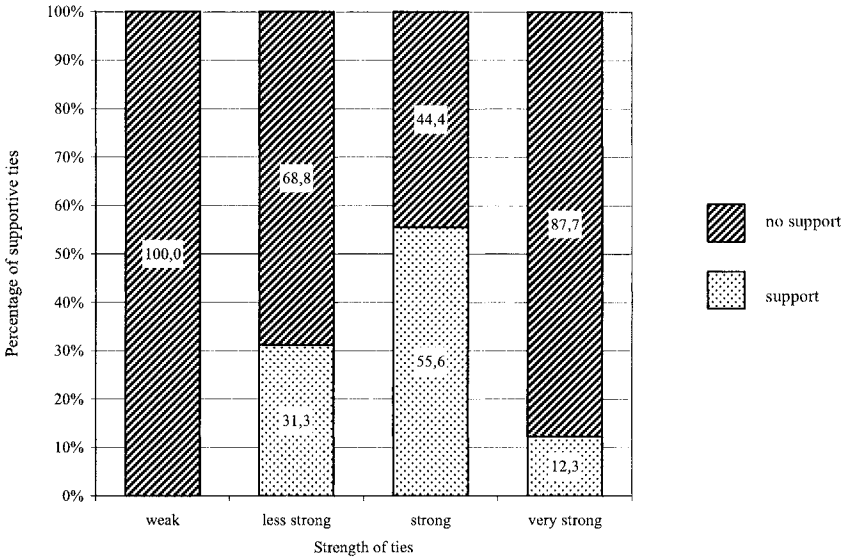

Figure 8.7: Support by strength of ties (n=113 ties)

Our hypotheses regarding relationships between social capital and the success of new firms were tested in two steps. We first calculated correlations and significance tests with the ego-centered network data and evaluated the comprehensive qualitative interview material with particular reference to the significance and function of trust and cognitive proximity. Only very low correlations between social capital and the success of new firms were found with the statistical test of our hypotheses (cf. table 8.5). The results are also very uncertain statistically, and, therefore, they have little informative value.

Despite the lack of statistical evidence for our hypotheses, the qualitative interviews enabled us to recognize the significance of social capital for the success of new firms. The founders considered the trust in their ties to be very important, given the very obvious general mistrust among the actors in Tuttlingen. Accordingly, the interviewed entrepreneurs revealed potentially important information and advice through trustworthy ties only if they were sure that the conversational partner would not pass on any of the information.[7]

7 The great degree of mistrust is expressed, for example, in the fact that no one outside the firm has entry to the production site; that delivery notes are hidden because they contain the addresses of employees; or certification of the firm is delayed so that no external person can find out the names. The collection of the names of contacts originally planned fell through and this initially hindered connecting the ego-centered network of the founder with the networks of the founders. In general, discussions were almost always agreed to on the premise that no names would be mentioned.

Table 8.5: Examples for tested hypotheses

Hypotheses	Indicators	r	p	Ties
The higher the proportion of multiplex ties in the founder's network, the more successful is his resource acquisition	multiplexity, resource acquisition	0,04	0,66	111
The higher the portion of trust-based ties, the more successful the start-up	trust, annual change of turnover	0,12	0,21	106
The higher the portion of trust-based ties, the higher the probability of support by means of unpaid help	trust, unpaid help	0,17	0,35	112
The higher the portion of ties characterized by cognitive proximity, the more successful the new firm	cognitive proximity, annual change of turnover	0,05	0,63	107
The higher the portion of ties characterized by cognitive proximity, the higher the probability of situational support	cognitive proximity, situational support	0,08	0,86	113
The more experience in the surgical instrument business a founder has, the more successful his resource acquisition	experience, resource acquisition	0,08	0,64	32 founders

And I don't trust this employee even though we are related. He keeps on saying "I'll be an entrepreneur myself one day." And when he knows everything about my business, he will go into business himself and take my customers with him. That's the problem in Tuttlingen, a lot of people become entrepreneurs themselves [...]. That's why I don't let anyone answer the phone except the apprentice. Letting all my employees answer the phone would mean letting things get out of control. (Interview 22)

Interviewees took extreme care with the names of suppliers and customers. Those names were disclosed only in extremely trustworthy and mostly long-term relationships. But if there was trust, the ties enabled the founders to get access to information otherwise kept secret.

He [a friend] has always worked in a competing company. [...]It is a very close and trustworthy relationship. Sometimes we talk about things that should never have been a subject for discussion. That's why both sides have to be absolutely sure that such information won't be passed on. [...] Utilize information, exploit it, but shield the source and keep it secret. (Interview 13)

As a result of the given information, advice and other support tailor-made for the current situation, respondents often saw network ties which are characterized by great cognitive proximity as more helpful than services provided by management consultants – combined with considerably lower costs of such relations. Twelve of the interviewees succeeded in surviving difficult phases during the establishment of their firms with the support of people who were able to assess the situation correctly because of their experience. The precondition that enabled the advantages of cognitive proximity to be used was the trust in this relationship.

Other results also show how important social capital is for the firm's founder. In nine of the 32 cases, the contacts had motivated the nascent entrepreneur to become independent, and they helped them to do so right from start. In 26 cases, founders obtained support through their network that resulted in considerable cost reductions and/or sales increases. In the following example, a contact helped the entrepreneur to achieve exceptionally large increases in sales so that the new firm was able to become a market leader in terms of sales within a few years.

I said to my business contact "I don't have the money for a huge stock". My contact said, "Can I help you in any way?" I said, "You could give me some money if you'd like." Then I got 100,000 Euros without a guarantee. My contact simply transferred 100,000 to my account. (Interview 35)

In 20 cases, respondents got advice, guidance and information about the local market that would be otherwise inaccessible, and which they considered to be very valuable.

"It's not the same as in other business sectors. You can draw up the most beautiful business plans. Your customers don't bother about your graphs if you don't have any personal contacts and experience in the surgical instrument business. If somebody enters the local market as an outsider, he'll fall flat on his face."
(Interview 18)

To summarize, it can be stated that concerning the importance of trust and cognitive proximity, trust in the interviewees' ties was a necessary condition for getting any support, and cognitive proximity between the network partners increased the effectiveness of that support. In many cases, trust and cognitive proximity made up a significant element in the social capital of founders that, in many completely different situations, was itself decisive for the success of the new firm.

6. Access to Critical Resources through Personal Contacts in an Environment of Intense Competition

In this chapter we have examined the socio-economic processes and mechanisms related to the entrepreneurial activities in the surgical instrument cluster of Tuttlingen. The entrepreneurial activity within the cluster was affected by a range of socio-economic founding conditions. Due to the high export orientation of the cluster, national framework conditions had virtually no effect on the founding activity. In contrast, the industry-specific and cluster-specific framework conditions did have and still do have a large influence. In particular, historical events concerning changes in the quantity and quality of demand for surgical instruments caused cyclical variations in founding activity. In addition, periodical variations in founding activity were caused by changing barriers to entry during the different stages of cluster evolution. Changes in the value chains associated with disequilibria of cooperation and competi-

tion affected access to critical resources, and, thus, influenced barriers to entry. Thus far, the social capital of entrepreneurs played a decisive role in securing access to the relevant resources, and, thus, was one factor in the success of business start-ups. Most of the founders interviewed fell back on strong ties, which were characterized by multiplex business and private interests and great personal trust. The majority of the contacts were embedded in the surgical instrument cluster themselves, and, therefore, were able to support the founders with particularly suitable resources, including tacit knowledge, information on local competitors, and situational advice. The latter indicated the advisors' ability to put themselves in the position of the founders, thanks to their cluster and industry-related knowledge. The prevalence of strong and trustful ties in founders' networks is very remarkable, since the social environment in the cluster is contrasted with great mistrust among the actors. It was precisely these trusted contacts that provided the founders with critical resources.

Of course, by reason of the case study design in this investigation, our results lack theoretical significance. A study of comparable clusters and a comparison with entrepreneurial activity outside clusters should, therefore, be the next step to improve the generality of these results.

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