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## The Role of New Firms for the Development of Clusters

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# **The role of new firms for the development of clusters in Germany**

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## Abstract

The objective of this paper is to analyze the direct quantitative effects of new firms on the evolution of clusters. In the first part of our paper we will give an insight into a conceptual framework which discusses the role of entrepreneurship for the evolution of clusters. The second part of the paper shows the results of an empirical analysis about the relevance of start-ups and business creation for the economic development of the three industrial clusters. The Munich Region is a growing cluster of medical technology whereas the surgical instruments cluster of Tuttlingen is a traditional centre of the medical technology industry in Germany. The cluster of textile and clothing industry in the region Neckar-Alb experiences a long-term declining process. The 'Establishment File' of the German Social Insurance Statistics is used as data source for entrepreneurial activities in Germany. The development of the number of start-ups and firm closures, new firm's survival, firm growth and accumulated gross employment effects of start-up cohorts will be analyzed in each cluster during the period 1984-2002. The results confirm that new firms play a crucial role for the emergence and growth of clusters whereas established firms are substantial for the competitiveness of clusters in the mature and declining stage.

## 1. Introduction

The focus of regional entrepreneurship research consisted of the identification of determinants influencing interregional disparities of entrepreneurial activities during the last decade. The analysis of the relationship between new firm formation and regional development was also a main topic of entrepreneurship research. However empirical results of recent studies investigating long-term economic effects of regional entrepreneurship are rather contradictory (ACS/STOREY 2004; STERNBERG/WENNEKERS 2005; DISNEY/HASKEL/HEDEN 2003).<sup>1</sup> As a result a lot of factors have been identified which explain the regional variations of founding rates. For instance, the industrial structure, a qualified working force, a high degree of agglomeration, availability of venture capital, supporting social capital as well as local support and consulting networks for entrepreneurs contribute to a favourable entrepreneurial climate in a region (BRIXY/GROTZ 2006; FLORA/FLORA 1993; REYNOLDS/STOREY/WESTHEAD 1994).

High regional start-up activities give empirical evidence for the presence of many fertile incubators in a region. The most important incubators for spin-offs are parent firms, universities and research institutions. In recent years first studies investigated the relationship between regional clusters and start-ups. On the one hand these studies prove – based on assumptions of evolutionary economics - that spin-off-activities are crucial for the emergence of clusters (e.g. KLEPPER 2002; GARNSEY/HEFFERNAN 2005; BOSCHMA/WENTING 2004). On the other hand it is supposed that clusters form seedbeds for spin-offs because of the high concentration of local incubators. DUBINI (1989) concludes that clusters build entrepreneurial hot-beds.

STERNBERG/LITZENBERGER (2004) and ROCHA/STERNBERG (2005) observed that the level of entrepreneurial activities in industrial clusters in Germany is higher than in regions without clusters. Both studies include clusters of different industries. ROCHA/STERNBERG (2005) revealed also that the existence of pure industrial agglomerations is not positively related to start-up activities. They argue that clusters provide additional factors which foster business creation due of the missing network links within industrial agglomerations. Therefore ROCHA/STERNBERG supposed that mainly the following operating factors in an industrial agglomeration are responsible for lower market entry barriers and sustain new firms to overcome their liability of newness: economies of specialization, labour supply and specialized skills (Marshallian economies). Market size effects reduce transport costs and increases the likelihood of sales for start-ups due to high local concentration of customers (KRUGMAN 1991). High density of firms in an industrial agglomeration cause intense local competition and lower market entry and exit barriers for new firms due to reduced uncertainties in terms

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<sup>1</sup> For further information see special issues on regional entrepreneurship in *Regional Studies* Nr. 8/2004 and on entrepreneurship and economic development in *Small Business Economics* Nr. 3/2005.

of prices, costs and business practices. Regional networks are therefore seen as important (additional) factor of fostering new firm formation in clusters (BOLTON/WESTLUND 2003, SORENSON/AUDIA 2000). Entrepreneurs are embedded in social networks within clusters because they start their businesses where they lived and/or worked before. New firms have better access to local resource pools via these social networks. These additional resources which are otherwise not available for new firms might be crucial to overcome the liabilities of newness and smallness. For instance, entrepreneurs might compensate their missing legitimation by the support of social network partners (e.g. former colleagues give reference to potential customers). Hence, social network theory expects higher survival rates of new and young firms within clusters. But it should be considered that the factors, mentioned above, will cause more intense competition if the density of cluster-firms increases. The organizational ecology concludes that this leads to exploitation of resources, lower rates of new firm formation and shorter survival prospects of start-ups within a cluster (STABER 2001). These contradictory theoretical assumptions refer mainly to 'working' clusters which are characterized by dense inter-firm and inter-organizational networks. Recent studies did not pay much attention to the different development-stages of clusters on the one hand and to the mutual relationship between clusters and start-ups on the other hand.

According to the concept of industry life cycles FORNAHL/MENZEL (2005) and FELDMAN/FRANCIS/BERCOVITZ (2005) developed conceptual frameworks which show the evolution of clusters as a series of several phases. The framework of FORNAHL/MENZEL (2005) differentiate between four development-stages of clusters (emergence, growth, self-sustaining, decline). The authors discuss the mutual interplay of new firms and clusters for each stage. In contrast, the model of FELDMAN/FRANCIS/BERCOVITZ (2005) includes only the emergent, growing and mature phase.

FELDMAN/FRANCIS/BERCOVITZ (2005) presume positive impacts of clusters on entrepreneurship. Some studies however identify a reverse effect. GRABHER (1993) demonstrates that lock in-effects in the Ruhrgebiet area, an old industrialized region in West Germany, arose in this cluster due to outlasting strong relationships between established firms. These lock-in-effects obstructed an economic restructuring process. These effects are considered to be one major reason for the low start up rates in the Ruhrgebiet area.

In respect of this mutual relationship FORNAHL/MENZEL (2005) distinguish between quantitative and qualitative effects. The direct quantitative effect of entrepreneurial activity on clusters consists of an increase in the number of start ups which leads to a growing number of firms in a cluster. Prerequisites for a positive quantitative effect are high survival rates and high rates of employment growth of new firms.

The resource-based view implies that the economic competitiveness of a cluster depends heavily on the competences and innovativeness of the firms situated in the cluster region. In this respect the qualitative effects of start ups are substantial for a cluster: New skills, compe-

tences, knowledge, products and services are implemented primarily by new firms (FRITSCH 2004). On the one hand these indirect qualitative effects contribute to the enlargement and renewal of the local knowledge and resource pools within the cluster. On the other hand the product and process innovations introduced by start ups are essential to sustain and improve the adaptability of clusters to changing market conditions and changing local environments (FORNAHL/MENZEL 2005). FELDMAN/FRANCIS/BERCOVITZ (2005) assume that entrepreneurs act as agents for economic changes, capable of creating and attracting the necessary resources and institutions to promote their businesses. Entrepreneurs draw upon local resources by starting their firms, but in return they add new resources to their local environment. Hence, entrepreneurs are able to interact with and shape their local environments. In their case study dealing with the Capital Region Washington D.C. FELDMAN/FRANCIS/BERCOVITZ (2005) show that firm founders succeeded in changing the local conditions from a 'sparse' to a 'munificent' environment (e.g. entrepreneurs build collective institutions to promote their interests in the cluster region).

The quantitative effect of clusters on new firm formation refers to their function as entrepreneurial hot-beds. The majority of the start-ups in a cluster are spin-offs which derive from local parent firms. These parent firms are specialized in the cluster's technological competences. Since the founders mostly start their enterprise in the business field, in which the parent company has already specialized, the start-up activities concentrate mainly within the technological borders of the cluster (qualitative effect) (FORNAHL/MENZEL 2005).

The objective of this paper is to investigate the quantitative direct effects of new firms on the evolution of clusters. In this respect the development-stages of a cluster will be taken into account. The structure of the paper is the following.

In the second part of this paper – based on the conceptual framework of FORNAHL/MENZEL (2005) – the assumptions about the direct effects of new firms on the development of the number of firms and the number of employees in clusters will be discussed. The direct quantitative effects are measured by different indicators for entrepreneurship. In addition, different theoretical assumptions in respect of new firm survival in clusters will be compared. Section 3 introduces the definitions and the data base used in the empirical analysis. The 'Establishment File' of the German Social Insurance provides longitudinal data about entrepreneurship in West Germany in the period 1984-2002. The empirical study – section 4 – consists of three industrial cluster case studies. These clusters are situated in West Germany: The Munich Region is a *growing cluster* of medical technology. The surgical instruments cluster of Tuttlingen is a traditional centre of the medical technology industry in Germany in its *maturity phase*. The cluster of textile and clothing industry in the region Neckar-Alb experiences a long-term *declining process*. The effects of new firms on cluster evolution will be investigated in each cluster during the period 1984-2002. For this reason, the development of the number of start-ups and firm closures, new firm's survival, firm growth and accumulated

gross employment effects of start-up cohorts will be analyzed. The last section compares the major results of the three regional case studies and discusses implications for further research.

## 2. Conceptual framework for the analysis of the quantitative direct effects

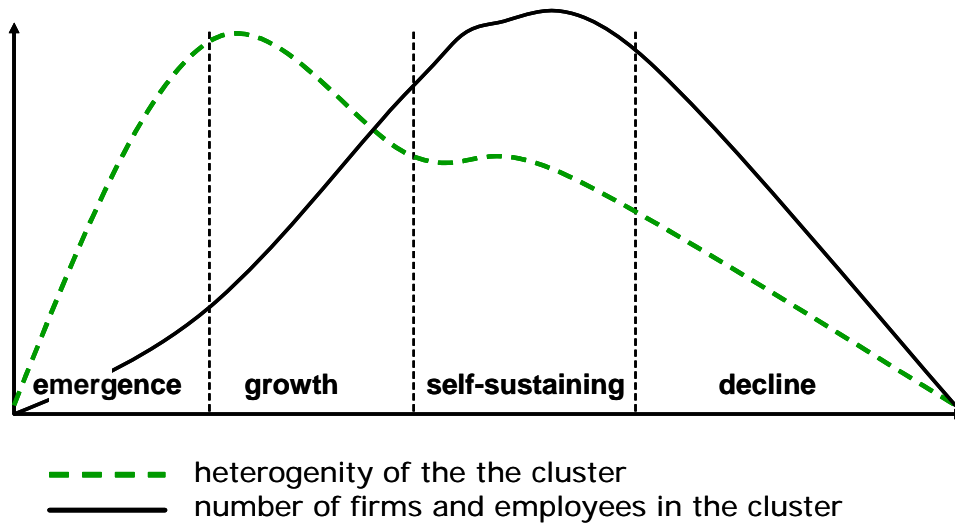
The direct quantitative effects of start-ups will be investigated by using different indicators for measuring regional entrepreneurial activities. Table 1 introduces the definitions of these indicators. A positive (negative) net market entry (balance of market entries and exits) indicates the increase (decrease) of the firm stock within the cluster whereas the turbulence (sum of market entries and exits) provides information about the intensity of entrepreneurial activities. The share of net market entry in turbulence is defined as the effectiveness of entrepreneurship. For instance, low values for the effectiveness are considered as result of occurring intraregional displacement effects within the cluster. The survival rates of new firms and their employment growth reflect the development paths of start-ups and their prospects in a cluster. The contribution of entrepreneurship to employment growth is investigated by cumulating the employment effects of start-up cohorts. As mentioned above, the conceptual framework of FORNAHL/MENZEL (2005) consists of four development-stages of a cluster: emergence, growth, self-sustaining and decline (figure 1). Below we will discuss the importance of the direct quantitative effects on cluster evolution for each phase. Our assumptions in respect of the different values of the entrepreneurship indicators in each stage are illustrated in the second figure.

Table 1: Indicators for measuring the quantitative direct effects of new and young firms

Survival rate: the share of new firms that survived up to a certain year after the new businesses have been started.
net market entry: the difference between the number of start-ups and firm closures. A positive (negative) net market entry indicates an increase (decline) in the number of firms in a region (of the stock of firms in a region).
Turbulence: the sum of the number of start-ups and firm closures High (low) values of turbulence indicate that the region experiences intense (weak) entrepreneurial activities during a certain period of time.
Effectiveness of entrepreneurial activity: quotient of net market entry and turbulence The effectiveness shows high (low) values if the stock of firms changed due to a small (large) number of start-ups and firm closures. High positive values for the effectiveness are a reference for an attractive market for new firms. In this case the risk of failure for start-ups is low due to weak competition between new businesses and established firms. If the effectiveness showed low positive values it is supposed that new firms could not survive without facing the competition with established firms (e.g. in respect of local market shares). Negative values of the effectiveness indicate that new firms would only be able to survive if established businesses exit the market (high-density displacement effects) (FRITSCH/NIESE 2004).
employment growth: The employment growth of start-up cohorts is measured by calculating the average number of persons who are employed in all surviving firms of the different start-up cohorts.
gross direct employment effect of start-ups: the share of employment of the different yearly start up cohorts in total employment at the end of the period of analysis

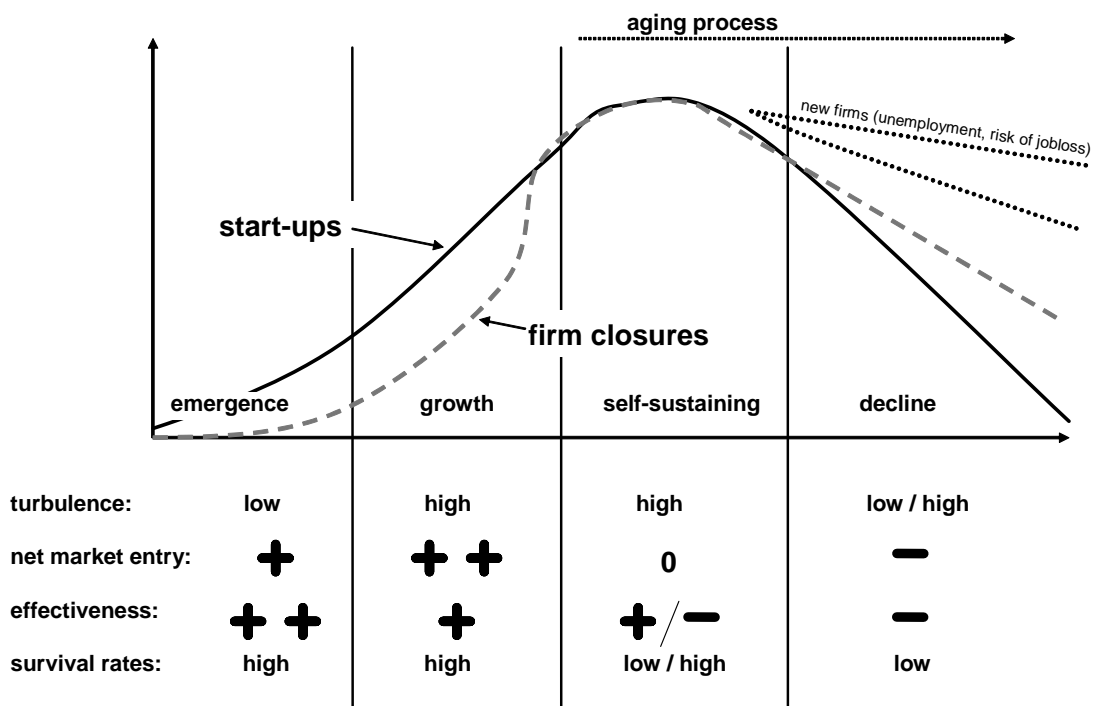
Sources: FRITSCH/NIESE (2004); FRITSCH/MÜLLER/WEYH (2005).

Figure 1: The development-stages of a cluster



Source: FORNAHL/MENZEL (2005).

Figure 2: Quantitative direct effects of new firms for different development-stages



## 2.1 Emerging cluster

The historical origins of each cluster are unique as far as the early conditions and actors involved are concerned (FELDMAN/FRANCIS/BERCOVITZ 2005). High numbers of start-ups are seen as prerequisite for the formation of a nucleus of cluster-firms. Spin-offs derive mainly from local research institutions and universities because the cluster consists only of a few parent firms (FORNAHL/MENZEL 2005). During the first phase (emergent phase) the number of firms in a cluster is still small but the firm stock is growing fast because of a high positive balance of market entries and exits. The critical mass has not yet been reached during this phase. It is expected that already a small number of new firm formations could shape the firm stock of the cluster significantly. This assumption implies high positive values for the effectiveness. Additionally, FORNAHL/MENZEL (2005) assume that high employment growth of only a small number of firms may shape the overall employment of an emerging cluster. Due to a high degree of heterogeneity within the cluster entrepreneurs start their firms in quite different market niches and technological lines which are not occupied by established firms. These niches should provide favourable survival and growth prospects for start-ups which then can realize first mover-advantages.

In ARTHUR'S (1987) spin-off-model the evolution of an industrial agglomeration is seen as an 'endless' sequence of firms giving birth to firms. The outcome of the spin-off-model depends heavily on the assumption that spin-offs locate close to their parent firms. Numerous studies proved that the spatial concentration of an industry is the result of spin-off-activities (e.g. MOSSIG 2000: machinery industry clusters/Germany; GARNSEY/HEFFERNAN 2005: high-tech-clusters Oxford and Cambridge/England). The inheritance-thesis of evolutionary economics provides an explanation for a cluster's long-term success. Spin-offs which inherit successful routines from their parent firms show higher survival rates. Therefore the existence of successful parent firms during the emergence and growth phase of a cluster is crucial for its future success. Recent studies of BOSCHMA/WENTING (2004) and KLEPPER (2002) dealing with the automotive agglomerations in Coventry (Great Britain) and Detroit (US) give empirical evidence for this thesis.<sup>2</sup> Therefore, successful parent firms play a decisive role as incubators and anchors for spin-offs within emerging and growing clusters.

## 2.2 Growing cluster

The transition of an emerging to a growing cluster is characterized by the coexistence of emerging and growing parts within the cluster. Numerous start-ups which derive mainly from

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<sup>2</sup> This inheritance-phenomenon is proved as well by the study of BUENSTORF/KLEPPER (2005) about an akron tire cluster (United States) and by the analysis of DAHL/PEDERSEN/DALUM (2005) about a tireless communications cluster (Denmark).



already established cluster-firms are crucial to achieve now the critical mass in the growth stage. This is the prerequisite for positive synergy effects and dynamic growth within a cluster (FORNAHL/MENZEL 2005). Favourable market conditions (e.g. great demand, weak market pressure) provide positive prospects for new firms in this stage. The expansion of the firm stock is the result of a positive balance of market entries and exit within the cluster. The values for the effectiveness should also be positive. In other words, a high share of net market entry in turbulence (effectiveness) might shape the growth of the cluster's firm stock significantly. Intraregional displacement effects are less likely to occur in this early development-stage because of a low density of cluster-firms. The quantitative direct effects of new firm formations are obviously substantial for growing clusters. The emergence of local networks and institutional settings might also attract external firms and branch settlements (FORNAHL/MENZEL 2005). These firms as well as new, young and established cluster-firms contribute altogether to the growth of clusters.

### **2.3 Self-sustaining cluster**

New firms implement and introduce primarily incremental innovations which improve the existing technological competences of a self-sustaining cluster. The indirect effects of new firm formations are crucial to maintain the adaptability of a cluster to changing market conditions and environments in this phase. A mature cluster is characterized by dense network relations between firms on the one hand and between firms and supporting institutions on the other hand. Successful entrepreneurs in the cluster encourage - as a positive role model - other potential entrepreneurs to start a business, too. A self-sustaining cluster which is characterized by a high local density of firms and institutions (incubators) bares great potentials for spin-off-activities (FORNAHL/MENZEL 2005).

The number of firms and employees reach both their maximum in the stage of maturity. FORNAHL/MENZEL (2005) expect that the number of start-ups should correspond to the number of shut-downs. Thus, the firm stock is not expanding anymore, although the turbulence (sum of market entries and exits) of entrepreneurial activity should show high values. Low values for the effectiveness are an indicator to occurring intraregional displacement effects. High firm density and exploited resources might cause more intense competition among cluster-firms during this phase. In respect of the sustained market positions of established cluster-firms it is assumed that new firms compete mainly with other young firms for local market shares and resources. This means that many new firms remain on the market only for a very short time (revolving-door-effect). The quantitative effects of entrepreneurship contribute primarily to the maintenance of the number of firms and employees within the cluster.

The organizational ecology provides a theoretical explanation for the decreasing survival rates in mature clusters with high firm densities. This theory assumes that competition for resources

is the main driving force for organizational action. Success and failure of firms is seen as result of the interplay between organizational forms and environmental factors. Adaptations to changing environmental conditions occur by variation and selection (competition) processes. Organizations can not respond to changes of environment because of their structural inertia. Hence, the survival and failure of new firms is bound to state of environment. Intense competition reduces the survival rates of new businesses, given the combination of high density of firms and exploited resources in mature clusters. The organizational ecology assumes that the competitive processes are most intense at local and regional levels because they are tightly bound resource arenas (STABER 2001; HANNAN/FREEMAN 1988). The intensity of the competitive effect of high-density clustering depends on the degree of overlapping needs of resources among the cluster-firms (e.g. financial support, local demand of customers). Thus, new firms should face higher risk of failure in highly specialized clusters owing to similar resources required. STABER (2001) analyzed the risk of failure of start-ups in industrial districts within the textile industry in Baden-Württemberg. His study proved that survival rates in more diversified clusters were higher, probably due to cross-industry effects (e.g. heterogeneity of knowledge flows) and resource spillovers (STABER 2001). Therefore, the competitive effect of high-density clustering could reduce the survival rates of new firms in mature clusters. A study of SORENSON/AUDIA (2000) investigating spatial concentrations of the shoe industry in the United States prove that firms in isolated locations are characterized by lower hazard rates. BRIXY/GROTZ (2006) ascertain a negative correlation between start-up activities and new firm survival on the regional level in Western Germany during the last two decades. All these studies give empirical evidence for the conjectures of the organizational ecology.

The start of a new firm depends on several aspects, for instance establishing relationships to potential customers and suppliers, recruiting workers and seeking for financial investors providing risk capital. The entrepreneur must convince a lot of constituents to invest in a new and risky business. Normally, entrepreneurs start their firms in the location where they lived or worked before, because moving to another location causes high social costs. Entrepreneurs with prior industry experience are considered to have an advantage in assembling all these required resources to set-up a new business. Thus, it is assumed that those entrepreneurs are tightly bound to social networks and should have already many contacts to the above mentioned constituents. For instance, it is possible that an entrepreneur might persuade former fellows to begin a job in his firm. Social network theory suggests that these social ties and the resources embedded in these personal relationships (social capital) are crucial for the success of start-ups (ALDRICH/ZIMMER 1986; SORENSON/AUDIA 2000; WESTLUND/BOLTON 2003). These additional resources – only available via social networks – sustain the entrepreneur to overcome the liability of newness and smallness of his new business. Given the fact that most entrepreneurs within a cluster should have prior industrial experience, the start-ups of such entrepreneurs should have favourable survival prospects in a cluster.

## 2.4 Declining and aging clusters

FORNAHL/MENZEL (2005) assume that declining clusters experience a decrease in the number of established firms and in the number of employees. They suppose that only a few new firms would be set-up in such clusters due to an unfavourable entrepreneurial climate. For instance, a decreased market demand raises the risk of failure for young and established firms in this phase. The consequence is an increase in the number of firm closures. Therefore, the net market entry and the effectiveness show highly negative values while turbulence and survival rates will diminish. In this phase the quantitative direct effects of start-ups for a cluster should be meaningless.

Numerous firm closings are responsible for the rise in the number of unemployed persons within the cluster. The decreasing market demand implies that the labour force of the still existing cluster-firms have to face higher risks of losing their jobs. It is supposed – in contrast to the assumptions of FORNAHL/MENZEL (2005) – that the rise of unemployment and job insecurity might foster business creation in a declining cluster although market and environmental conditions are unfavourable for the start of new firms. The following reasons sustain this assumption. A declining cluster is characterized by a lack of adequate job offers provided by firms engaged in non-cluster-related activities - given the bias of firms specialized in cluster-related competences within a cluster. Corresponding to the needs of the cluster-firms the workforce is highly specialized in cluster-related activities. Job changes between cluster-firms and firms engaged in non-cluster-related fields imply a great loss of specific human capital that can not be transferred to the new job. Therefore it should be more efficient for a non-cluster-firm to recruit non-cluster-workers. Consequently a shrinking cluster should show a high turbulence due to high numbers of market exits and entries.

The existence of old industrialized areas is an evidence for the decline and ‘death’ of clusters. Nevertheless some declining clusters experienced successful economic restructuring processes. TÖDTLING/TRIPPL (2004) investigated the renewal of the metal and automotive clusters in the old industrial region Styria (Austria). The automotive cluster has experienced a transition phase from a fragmented towards a more integrated system while the metal cluster has broken up its institutional inertia by organizational change. But not every aging cluster is a continuously declining cluster. TICHY (2001) concludes that the ‘vulnerability’ of a cluster passing through process of decline heavily depends on its individual characteristics. As mentioned above, old industrial clusters (e.g. textile and shipping industries) showed declining processes during the last decades in West Europe. Resource-bound clusters could decline as well if the physical resources of the cluster-firms are exhausted. But clusters with a diversified industrial structure, a flexible response to changing market conditions or a specialization in cross-sectional technologies are less ‘vulnerable’ for declining processes, in turn the aging process will last longer in clusters with such features.

### 3. Database and definitions

The 'IAB Establishment Register' – also called sometimes the 'German Social Insurance Statistics' – is used as a data source for the number of new firm formations and closures, the development paths and employment effects of new firms. The characteristics of this database are documented by FRITSCH/BRIXY (2004). This database comprises all enterprises employing at least one employee who is obliged to be a member of the German Social Insurance. Therefore, small start-ups without an employee in their first year are not included in the analysis. New businesses which have more than 20 employees are excluded as well. It is assumed that larger start-ups could be the result of outsourcing and reorganisation processes in larger established firms. Hence, these larger start-ups are not considered as original start-ups. This data source comprises longitudinal data of the number of employees in the firms. Thus, it is possible to study the employment growth of new firms. The 'Establishment File' provides information about entrepreneurial activity in West Germany for the time period 1984 to 2002. In this study established and old firms are defined as businesses which had already existed in the clusters in the first year of the period of analysis (1984-2002). But it is acknowledged that the period of analysis in this study comprises only a short period considering the long-term evolutionary process of a cluster including all development-stages.

In respect of the fuzziness of the cluster-concept and the problems dealing with the identification of clusters discussed in recent literature the choice of the clusters for the regional case studies is bound to the following prerequisites.<sup>3</sup> The first criterion is a high degree of industrial agglomeration. Regional concentrations of a single industry are measured by location quotients based on employment (LQ). The values of the location quotients in the selected clusters must be above the average location quotients over all counties of Western Germany during the period of analysis (1984-2002). But the identification of growing clusters is not bound to this criterion. Other main features of clusters are the presence of inter-firm and inter-organizational networks and local institutional settings (e.g. chambers of commerce, educational institutions, universities, research institutes) (ENRIGHT 2000, 2002; STEINER 1998). Several studies proved that the selected three clusters in this paper are characterized by these key features.

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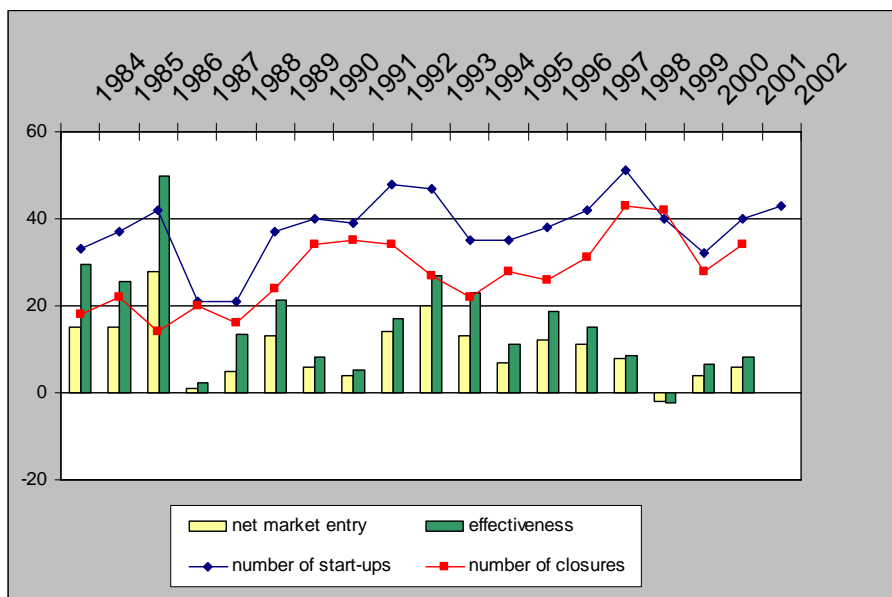
<sup>3</sup> See for critical literature reviews on cluster research MARTIN/SUNLEY (2003) and STEINER (1998).

#### **4. The Munich Region – a growing cluster of medical technology**

The medical technology industry is an innovative one which during the 1980s and 1990s experienced high growth rates in the number of firms, employees, sales and exports in West Germany. Due to a high degree of product differentiation in medical technology and weak market pressure the firms of this industry offer highly specialized products and services. Medical technology is a cross-sectional technology which depends heavily on different related technological competences (e.g. software technologies and life sciences). The economic activities of this industry are highly concentrated in space because most of the medical technology-based firms are located only in a few regions of West Germany. The Munich Region is an example of an emerging and growing cluster of medical technology which has experienced an increase in the number of medical technology-based firms and a dynamic employment growth since the mid-1980s. During the period 1984-2002 the number of medical technology-based firms increased by 42.7 % (1984: 431 firms; 2002: 615 firms) in the Munich Region. The number of employees rose from 4.6 thousand (1984) to 7.7 thousand (2002). This increase of 66.6 % (+3.100) is above the national average employment growth rate of this industry in this period (West Germany: 19.2 %). The region of Munich is a metropolitan area in South Germany and consists of the city of Munich and the surrounding areas. This region is one of Europe's leading high-tech-regions. On the one hand traditional export-oriented technologies (e.g. automotive engineering, aerospace and mechanical engineering) are concentrated in this region. On the other hand nearly all important related technological competences to medical technology are highly concentrated in this region as well (e.g. semiconductor industry, software technology, life sciences [in particular biotechnology, new materials, microsystem technology] and nanotechnology). The firms of these related technological lines build a seedbed for potential spin-offs in medical technology. Most of the medical technology-based firms in the region of Munich are knowledge-intensive small- and medium-sized enterprises. These firms operate mainly in diagnostic systems, medical software and in therapeutic and surgical instruments. The firms of the medical technology cluster act as bridging entrepreneurs between the related regional technological competences. Most of the larger firms are young firms and they are located in the surrounding areas of the city of Munich. For example, the BrainLAB Corporation which was founded in 1989 is one of the largest firms with 350 employees. This company is specialized in software and minimal invasive therapies. The research unit of General Electric, one of the world's leading companies in medical technology, is located in the Munich region as well. Many of the medical technology-based firms are engaged in bilateral business and research agreements with other firms and research institutions. The objective of the Central Institute of Medical Technology (CIMT) and the Innovation Centre for Therapeutic Medicine (ITEM) consists of promoting related technologies and business

networks in this region. Additionally the ITEM offers R&D and consultancy services and cooperates with the University of Munich. Furthermore medical technology firms have access to a highly qualified workforce and venture capital is provided by over 35 financial institutions. Certifying agencies for the products of medical technology are located in the Munich region as well (e.g. TÜV Product Services Company). A consulting and supporting infrastructure for entrepreneurs was established in the 1990s (BMBF 2005, LANDESHAUPTSTADT MÜNCHEN 2004). Below, I analyse the role of new and young medical technology-based firms for the development of the cluster in the Munich Region.

Figure 3: Entrepreneurship activities in the Munich Region 1984-2002



In the time period 1984-1989, on average 31.8 new medical technology-based firms were set-up yearly whereas in the periods 1990-96 and 1997-2001 it was an average of 40.0, i.e. 41.8 start-ups per annum (table 2, figure 3). During these three periods an average of 19.0 i.e. 25.4 i.e. 35.6 medical technology-based firm closures was counted annually. Firstly, the increase in the number of start-ups and firm closures causes a more intense turbulence (sum of start-ups and market exits) in Munich's medical technology. Secondly, the positive values of the net market entry (balance of market entries and exits) declined at the end of the 1990s due to a strong increase in firm closures in these years. Accordingly, new firms which were started during the 1980s and the first years of the 1990s make up the current pool of medical technology-based firms in the Munich Region.

Table 2: Entrepreneurship indicators - Munich Region and Tuttlingen

Indicators	Munich Region			Tuttlingen		
	1984-89	1990-96	1997-01	1984-89	1990-96	1997-01
Number of start-ups	31.8	40.3	41.0	18.7	16.3	12.6
Number of firm closures	19.0	29.4	35.6	14.0	22.6	20.4
Net Market Entry	12.8	10.9	5.4	4.7	-6.3	-7.8
Turbulence	50.8	69.7	76.6	32.7	38.9	33.0
Effectiveness	25.2	15.6	7.0	14.3	-16.2	-23.6
Density of firms <sup>a</sup>	4.8	5.2	5.7	77.8	76.0	63.3
Entry rate	0,33	0,39	0,38	4,3	3,4	2,7
Exit rate	0,20	0,28	0,27	3,2	4,8	4,3

a: the number of firms in medical technology/10 thousand employees.

The share of net market entry in turbulence (effectiveness) shows strong positive values in the 1980s, whereas the values of this indicator were less positive in the 1990s. This means that already a small number of new firm formations shape the pool of businesses in Munich's medical technology cluster. The positive values for effectiveness, however, have declined since 1993. It is possible to assume that due to the rising number of firms in the young medical technology cluster, the high-density clustering effect causes more intense competition between the cluster-firms. New firms compete with one another and start-ups have to face competition with established firms as well. The impact of start ups on the development of the cluster's firm stock declined during the period of analysis because the positive values of the net market entry and of the effectiveness decreased during the 1990s.

Table 3: Average survival rates of start-ups – Munich Region and Tuttlingen

Start-up cohorts	Munich Region	Tuttlingen
	Survival rates in percent	Survival rates in percent
1984-86	73.9	69,4
1987-89	72.2	53,8
1990-92	72.1	64,8
1993-95	82.9	40,5
1996-97	60.5	50,0

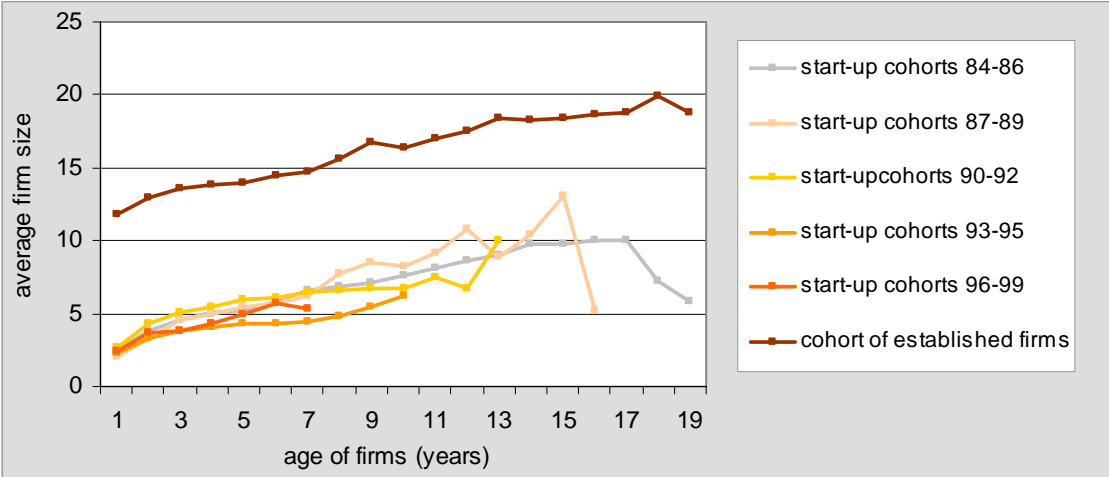
The survival rates of start-ups in Munich's medical technology cluster are extraordinarily high (table 3). On average over 70 % of all new firms of the 1984-1992 cohorts survived the first five years on the market. The five year-survival rate of the 1993-95 cohorts is with 82.9 % even higher<sup>4</sup>. In contrast, only 60.5 % of the new medical technology-based firms which were

<sup>4</sup> These survival rates are extraordinarily high. Usually only every second start-ups in West Germany survives the first five years on the market (BRIXY/GROTZ 2006).

started in the period 1996-97 were not shut down during their first five years. These results principally confirm the assumption that favourable market conditions are responsible for high survival rates of new firms during the growth phase of a cluster. The survival rates of medical technology-based start-ups in Germany are rather high, since the increased demand of the health care economy provided them with a prospective share in the market. Only those of the youngest cohorts (1996-97) display a lower survival rate. There is an increased risk of failure for new firms in the medical technology cluster in the Munich region at the end of the period of analysis: the start-ups of the younger cohorts (1996-97) show higher exit rates and the effectiveness is declining. These developments might point to a growing local competition in the Munich medical technology scene.

All these medical technology companies are considered as 'old' and 'established' firms which already existed in the year 1984. The year 1984 is the first year of the observation period of this study. About half of these established firms (47.4 %) survived on the market until 2002. Taking into account that 60 to 80 % of all new firm formations in medical technology already exit the market after five years, the long-term durability of these established firms is remarkably high.

Figure 4: Average firm size of surviving start-ups and established firms – Munich Region

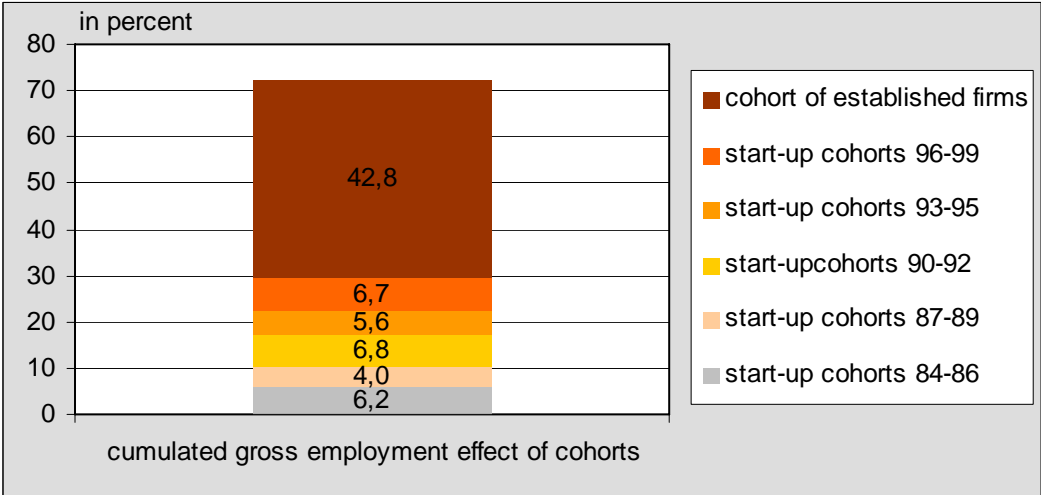


The combination of high survival rates and high employment growth contributes a decisive share to the development of the overall employment of start-up cohorts. The average firm size of a start-up cohort is defined as the average number of persons who are employed in all sur-



living firms of this cohort. Thus, employment growth of start-up cohorts is measured by the changes of the average firm size. In figure 4 the average firm size is always displayed and summarized for three or four cohorts together. All start-up cohorts show long-term growth. In their fifth year of existence, the surviving medical-technology based start-ups in the Munich region employ on average five to six persons, in their tenth year on average six to eight persons. In case of the oldest cohorts (1984-1986) the average firm size only ceases to increase from the fourteenth year of existence, and the number of employees only declines from the seventeenth year on. The average firm size of the 1986-89 cohorts declines in the sixteenth year, too. The average firm size of the established firms (cohort of old firms) increased from 11.8 (1984) to 18.8 (2002) by the factor 1.6. The surviving established firms experienced high rates of employment growth between their first and thirteenth year of existence, later on the growth rates decreased. In sum, the new, young and established firms in Munich's medical technology cluster show a successful long-term growth during the period of analysis.

Figure 5: Cumulated gross employment effect of cohorts in 2002 – Munich Region



The employment effects of start-up cohorts in the medical technology cluster of the Munich Region play a decisive role for local employment growth. The gross direct employment effect is defined as the share of employment of the 1984-1999 start up cohorts in total employment in 2002. In total the start-up cohorts 1984-1999 employed 2.3 thousand persons in 2002. This corresponds to 29.4 % of all working staff in Munich's medical technology (figure 5). Almost every third job in this industry in the Munich Region is in an established enterprise which had already existed in 1984 and managed to survive on the market until 2002. These surviving established firms employed in 2002 3.3 thousand persons, i.e. 42.8 % of all employees in Munich's medical technology. The new, young and established firms provide for altogether 72.2 % of all jobs liable to social insurance deductions within this industry. There is a remaining 27.8 % which is not accounted for. The definition of new firm formations, used in this paper,

excludes larger spin-offs as well as branch settlements, because new firms with more than 20 employees within their first year of existence are not classified as start-ups. For this reason, 27.8 % of all employees in the medical technology cluster of the Munich Region work in larger spin-offs and branch plants, which were set-up in this cluster within the period of observation and survived until the year 2002.

This case study shows rather clearly that direct quantitative effects of new firm formation play a substantial role for the increase in numbers of firms and employees during the growth phase of a cluster. These positive quantitative effects are based on the combination of high founding rates, low hazard rates and high rates of employment growth of new medical technology-based firms within the Munich Region. Additionally, established organizations and external plant settlements contributed substantially to the employment growth of the medical technology cluster in the Munich Region. These results indicate that a growing cluster provide favourable conditions for the development of start-ups, established organizations and external firms.

## **5. Tuttlingen – a mature cluster of medical technology**

Tuttlingen is a traditional and unique cluster for surgical instruments manufacturing in Germany. The cluster-firms are mainly located in the city of Tuttlingen and in its surrounding areas. This cluster is situated in the South of Baden-Württemberg. It emerged in the second half of the 19th century. The first manufacturer of surgical instruments was set-up in 1866. Since its founding, the Aesculap Corporation has become one of today's most well-known manufacturers of medical technology products world-wide. Other local large-scaled enterprises are e.g. the Karl Storz Corporation (endoscopes) and the Binder Company (temperature cabinets). This cluster developed into a "world centre of medical technology" in the first half of the 20th Century. After World War II the cluster-firms succeeded in regaining and maintaining their former leading positions on the world market. At present, this cluster is characterized by a high concentration of 500 small- and medium-sized firms which are engaged in the production and trade of surgical products. About 200 suppliers and subcontractors are located in Tuttlingen as well (BINDER/SAUTTER 2005; BMBF 2005). The following indicators give evidence of the singularity of this cluster: The location quotients of medical technology which amounted to 17.9 in 1984 and 22.6 in 2002 are extraordinarily high in the county of Tuttlingen. In addition, the founding rate of new medical technology-based firms in Tuttlingen exceeds the average values of all West German counties in the 1980s and 1990s by a multiple.

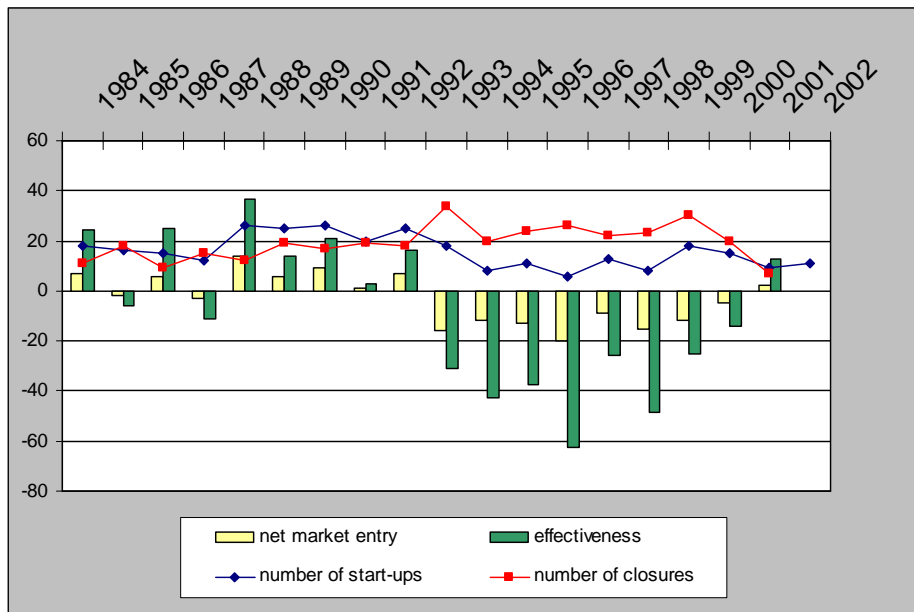
In the beginning of the 1970s the medical technology cluster in Tuttlingen experienced a structural change due to intense competition on the world market. Manufacturers of surgical instruments situated in developing countries were producing at lower labour costs. The clus-

ter-firms of Tuttlingen responded to their competitive disadvantage by shifting standardized and labour-intensive production units to developing countries with low production costs. For instance, they have set-up approximately two dozen joint-ventures in Pakistan in the last thirty years. Thus, the cluster-firms concentrated their activities more and more on the distribution and sales of products. Surgical instruments produced in low-cost countries are re-imported and refined primarily by local small crafts enterprises of surgical instruments (e.g. polishing and grinding of the instruments) in Tuttlingen. Afterwards, these refined products are re-exported by distributors in the cluster (vgl. HALDER 2005). These structural changes caused an increase in the number of suppliers and distributors in the cluster. In this way the medical technology cluster of Tuttlingen has been integrated step by step into global production chains and trading networks.

Most of these suppliers are very small craft firms which produce and refine surgical instruments for large-scaled producers. The latter have bound the suppliers by contracts to sustain their firm-specific competitive advantages. These networks are characterized by close and dense social relations between producers and suppliers (BINDER/SAUTTER 2005; SAUTTER 2005). The Competence Centre of Minimal Invasive Medicine and Technology acts as an interface between regional research institutions and enterprises. But the supporting infrastructure for start-ups in this cluster is considered as insufficient. This is the result of a study investigating regional concentrations of medical technology industry in Germany (BMBF 2005).

It is clear that the medical technology cluster in Tuttlingen has experienced a process of concentration. Firm stock and employment has developed in opposite directions: the number of firms decreased by 14 % from 327 (1984) to 282 (2002), while the number of employees increased by 57 % from 4.6 thousand (1984) to 7.3 thousand (2002). This increase is much above the national average employment growth of medical technology in West Germany in this phase. On the one hand, this outcome raises the question as to what extent this concentration process could be seen as the result of expanding market shares of established producers in the cluster. On the other hand, this concentration process might give evidence for the assumption that the direct quantitative effects of new and young businesses are meaningless in mature clusters.

Figure 6: Entrepreneurship activities in Tuttlingen 1984-2002



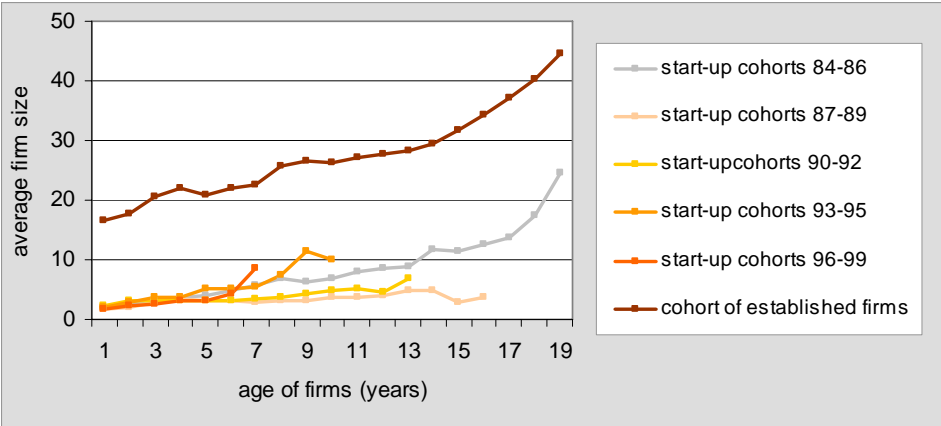
In the period 1984-1989 18.7 new firms were set-up on average per annum (figure 6). In the periods 1990-1996 and 1997-2001 only 16.3 and 12.6 new businesses were started on average each year. In contrast, more and more firms were shut-down. During these three phases an average of 14.0 (1984-89), 22.4 (1990-1996) and 20.4 (1997-2001) businesses were closed annually. The balance of start-ups and shut-downs (net market entry) shows positive values from 1984 to 1992, except in 1985 and in 1987. These results indicate that business creation contributed substantially to the rise in the number of medical technology-based firms in Tuttlingen.

The results were quite different in the following years (1993-2002): The net market entry was negative due to the increase in firm closures and the decline of foundings, except in 2001. The number of medical technology firms in Tuttlingen dropped from 389 in 1993 to 282 in 2002. The negative values of the effectiveness might indicate that competition among cluster-firms became more intense in this phase. This could cause higher risk of failure for new and young firms. On average only 40.5 %, i.e. 50.0 % of all new medical technology-based firms of the 1993-95 and 1996-97 cohorts survived the first five years on the market (table 3). In contrast, the survival rates of the older start-up cohorts were higher, except of the 1987-89 cohorts. A half (50.9 %) of the established cluster-firms which had existed already in 1984 survived until 2002. The stock of established firms dropped from 273 in 1984 and to 139 in 2002. This high survival rate of the established cluster-firms is a proof of their sustained position on the market. SAUTTER (2005) gives several explanations for the decrease in the number of new firm

formations in the period 1993-2002. He assumes that new manufacturing firms could only succeed on the market by introducing highly innovative products. The close and dense social networks between producers, suppliers and distributors prevent external firms from getting access to the cluster. The introduction of a new law for medical technology products at the end of the 1990s could have caused the decline in the number of start-ups in Tuttlingen as well. This law implied rising costs of product certification and declining profits, in spite of great demand for certified high-quality products on the world market.

The survival rates of new and young medical technology-based firms are substantially higher in the Munich Region than in Tuttlingen. In the former cluster medical technology-based start-ups are highly innovative and knowledge-intensive. In contrast most of the new medical technology-based firms in Tuttlingen are small suppliers and crafts enterprises. Such start-ups are characterized by a lower requirement for venture and risk capital and for specific investments in human capital (BMBF 2005). In other words, the market entry and exit barriers for new firms are lower in Tuttlingen than in the Munich Region. This difference may be seen as a reason for the shorter survival prospects of new establishments and the higher rates of new firm formation in Tuttlingen.

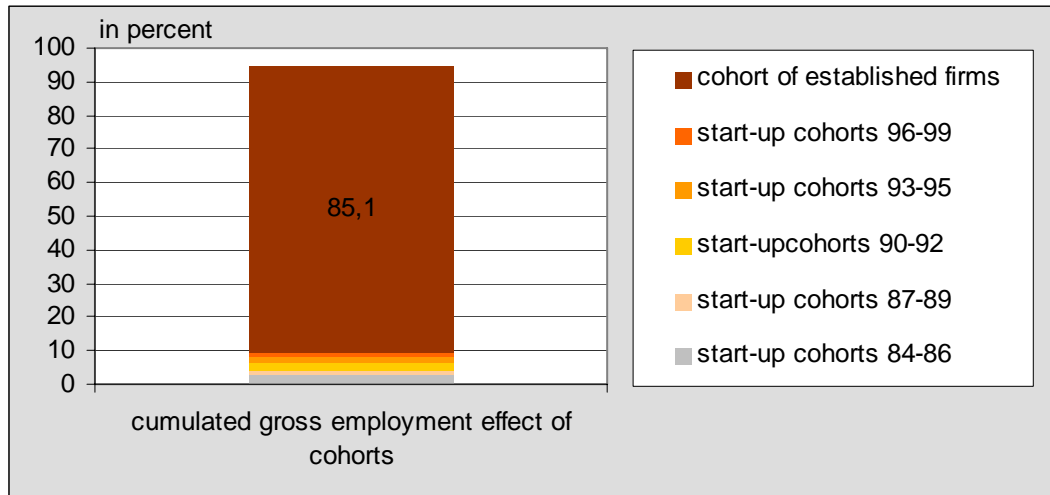
Figure 7: Average firm size of surviving start-ups and established firms – Tuttlingen



In the first six years most of growth paths of all start-up cohorts agree with one another (figure 7). In the sixth year the average firm size of the cohorts amounts to between four and five employees. In the following years, firm growth of the cohorts show divergent development paths: Firm growth of the 1987-89 and 1990-92 cohorts stagnated, while the growth path of the 1993-95 and 1996-99 cohorts continued until the ninth and seventh year. The average firm size of the oldest cohorts (1984-86) grew from the sixth to the nineteenth year by a factor of 5.0. The established cluster-firms also experienced a dynamic growth in the number of employees. The average firm size of the established firms rose from 16.7 (1984) to 44.5 (2002)

by a factor of 2.7. Clearly the established firms could sustain and expand their market position in the cluster due to high rates of survival and high rates of employment growth.

Figure 8: Cumulated gross employment effect of cohorts in 2002 – Tuttlingen



This assessment is confirmed by calculating the gross employment effect of the cohorts. The number of persons employed in established businesses grew from 1984 (4.6 thousand) to 2002 (6.1 thousand) by 35.7 % (+ 1.5 thousand jobs). Therefore most of the employees (85.0 %) within the medical technology cluster of Tuttlingen worked in established enterprises in 2002 (figure 8). In this year only 9.5 % (687 persons) of the workforce in medical technology were employed in surviving start-ups of the 1984-1999 cohorts. Accordingly, 95 % of all employees within the medical technology cluster of Tuttlingen worked in surviving start-ups and in established enterprises in 2002. Thus only 5 % of all medical technology jobs in Tuttlingen accounted for larger spin offs or branch settlements in this year.

In sum, the results confirm the assumption that the direct effects of new firm formation contribute to sustain the firm stock and existing labour market in a mature cluster. But the hub-and-spoke-structure of the medical technology cluster in Tuttlingen implies that established firms play a crucial role as well. The process of concentration within this cluster was based on high survival rates and dynamic employment growth of the established firms during the period of analysis. These old organizations succeeded in sustaining their market position, for instance by integration into international production chains and by building close social ties to small local suppliers. These close social networks prevented external firms to locate within the cluster. Only 5 % of all employees worked in external plants in 2002. The number of market exits do not correspond to the number of market exits as expected by FORNAHL/MENZEL (2005). The structural change within Tuttlingen's medical technology industry caused strong

competition among local supplier firms. The decrease in the number of start-ups, the shortening of the survival prospects and the stagnation of firm growth of the small supplier firms are considered as proofs for the high density clustering effect, particularly in the 1990s. But in turn, low barriers of both market entry and exit of small suppliers of surgical instruments explain the remarkably high rates of new firm formation, in spite of slightly declining entrepreneurial activities in the last decade. The future prospects of the producers and suppliers in the medical technology cluster of Tuttlingen depend on the following factors: the changes in the national healthcare system, the international market demand for surgical instruments and the break up of social networks between producers and suppliers in order to prevent lock-in-effects.

## **6. Region Neckar-Alb – a declining cluster of textile and clothing industry**

The region Neckar-Alb has been a traditional and leading centre of textile and clothing industry (t&c-industry) in Germany since the mid-1850s. This region is located in southern Baden-württemberg and consists of the counties Reutlingen, Zollernalb and Tübingen. The world's first technical college of textiles was set-up in Reutlingen in 1800. It became one of today's most popular universities of textiles worldwide. The former success of the t&c-industry-cluster in Neckar-Alb was based on the spatial concentration of small t&c-businesses deeply embedded in social networks and integrated in local cooperations with other firms. Most of the cluster-firms employ only the owner himself or a few employees. This smallness is the result of inheritance processes lasting over generations within local families owning the enterprises (HAAS/HESS/SCHERM 1983; HAAS/ZADEMACH 2005; STABER 1997, 1998). The region Neckar-Alb was particularly affected by the decline of this industry during the last decades. The number of jobs decreased from 36.3 thousand in 1984 to 11.2 thousand in 2002 by 69 %. The share of t&c-industry in overall employment in Neckar-Alb dropped from 17.9 % to 5 %. The number of t&c-firms declined from 821 (1984) to 304 (2002) by -63 %. The t&c-industry is however still highly concentrated within this region. The location quotient of t&c-industry amounted to 6.94 in 2002. For instance, the location quotient in the county Zollernalb (12.8) is the highest among all location quotients of all counties in West Germany within this industry.

Since the beginning 1960s intense competition has occurred on the world market of textiles due to competitive advantages of manufacturers situated in low-wage-countries. The small and specialized cluster-firms were considered to be most affected by intense international competition. Since the end of the 1970s transport costs were declining. Therefore, local t&c-firms in Neckar-Alb began to shift production units (e.g. refining activities) to low-cost-countries (e.g. in Eastern Europe) and to set-up joint-ventures and cooperations with local producers of these countries. Meanwhile most of the local t&c-firms are integrated into global

production chains. Additionally, their activities shifted therefore more and more to distribution and selling of textiles and clothing products (HAAS/ZADEMACH 2005).

Nevertheless some cluster-firms in Neckar-Alb succeeded in maintaining their position on the international market by specializing in technical textiles. Main customers of these highly innovative products are the automotive and the healthcare industry which are highly concentrated in Neckar-Alb and in the surrounding areas. Additionally the spatial proximity to specialized research institutes, suppliers of chemical textiles and textile machinery producers provide favourable environmental conditions for firms specialized in technical textiles. Meanwhile refinement firms act as important bridging entrepreneurs within the local networks of production and innovation. But the competitiveness of these firms is threatened by high prices for energy because they are characterized by great demand for energy (water) (INDUSTRIE-UND HANDELSKAMMER REUTLINGEN 2005).

Figure 9: Entrepreneurship activities in Neckar-Alb 1984-2002

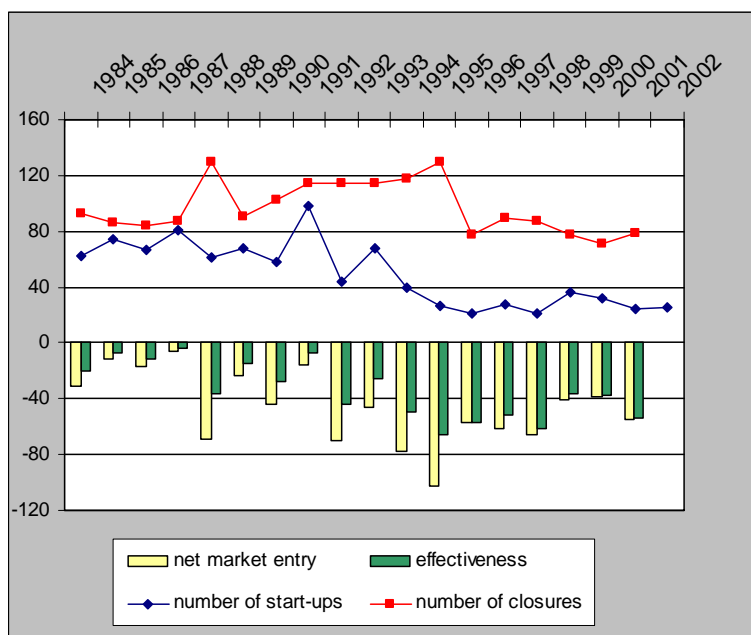


Table 4: Entrepreneurship indicators – Region Neckar-Alb

Indicators	Region Neckar-Alb		
	1984-89	1990-96	1997-01
Number of start-ups	67,3	49,7	28,2
Number of firm closures	96,1	111,3	80,6
Net Market Entry	-28,9	-61,7	-52,4
Turbulence	163	161	109
Effectiveness	-18	-38	-48
Density of firms <sup>a</sup>	58,8	44,5	28,2
Entry rate	3,14	2,21	1,30
Exit rate	4,49	4,96	3,71

a: the number of firms in textile & clothing industry/10 thousand employees.

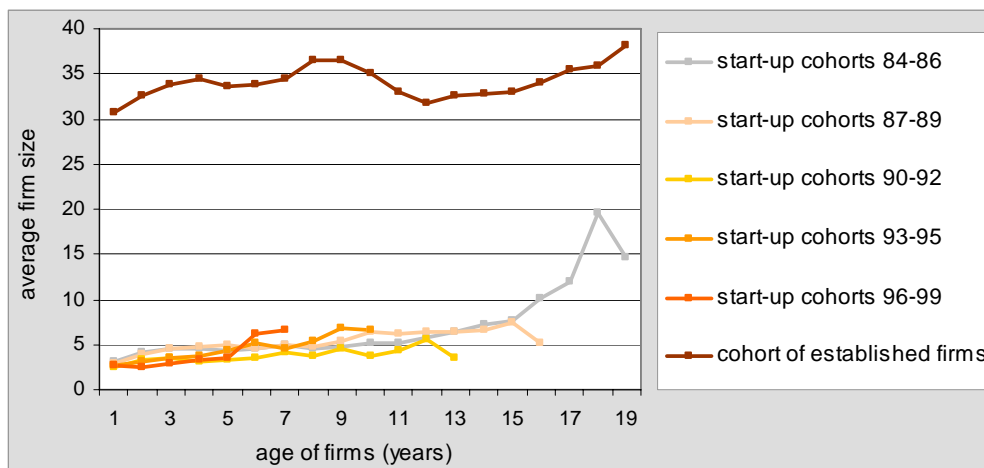


Table 5: Average survival rates of start-ups – Munich Region and Tuttlingen

Start-up cohorts	Region Neckar-Alb
	Survival rates in percent
1984-86	53,7
1987-89	52,9
1990-92	40,1
1993-95	33,3
1996-97	29,1

In the period 1984-1989 on average 67.3 new firms were started per annum within the t&c-industry of Neckar-Alb (table 4). In contrast, in the periods 1990-1996 and 1997-2001 only 49.7 and 28.2 start-ups were set-up yearly. In these three periods it was an average of 69.1, 111.3 and 80.6 shut-downs in every year. Thus, the negative values of the net market entry and of the effectiveness increased during the 1990s whereas the values of the turbulence declined (figure 9). The density of t&c-firms dropped from 63.1 (1984) to 23.4 (2001) within the cluster. On average over the half of all start-ups of the 1984-86 and 1987-89 cohorts survived the first five years on the market. The survival prospects of new firms shortened during the 1990s. Only 33% i.e. 39 % of the firms of the 1993-95 and 1996-97 cohorts did not exit the market during the first years (table 5). These results give altogether evidence of the deterioration of market and environmental conditions for new firm formation in Neckar-Alb, particularly during the 1990s. Additionally, only 22 % of all established firms which had already existed in 1984 survived on the market until 2002. Thus, the declining process affects all firms - irrespective of their age.

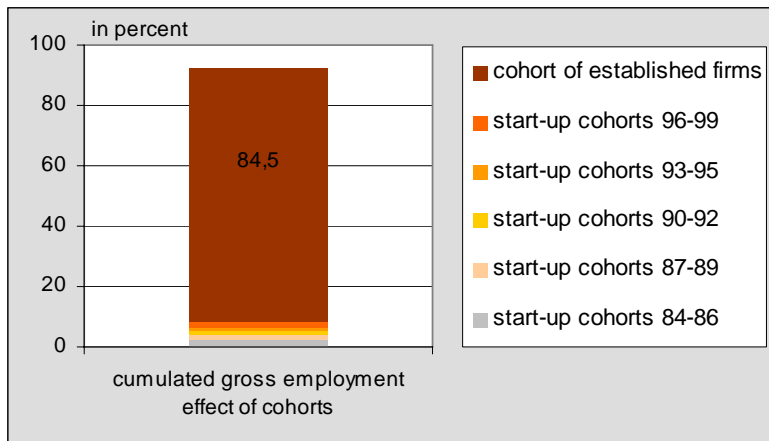
Figure 10: Average firm size of surviving start-ups and established firms – Neckar-Alb



In sum, all start-up cohorts show only slight employment growth in Neckar-Alb (figure 10). The surviving t&c-firms employ on average four to eight persons. Only the oldest start-up cohorts (1984-86) show dynamic firm growth from the 15th to the 18th year. The average number of employees in the surviving established firms grew from 30.8 (1984) to 38.1 (2002).

A closer look reveals that the average firm size of the established firms declined between the 9th and 12th year and increased afterwards continuously. This temporary decline might indicate that the established firms adapted their organizations to structural changes - for instance by diminishing the number of their employees via shifting production units to low-wage-countries.

Figure 11: Cumulated gross employment effect of cohorts in 2002 – Neckar-Alb



The established cluster-firms which had already existed in 1984 and survived until 2002 are the most important employers. These organizations accounted for 84.5 % of all workers within this cluster in 2002 (figure 11). The cumulated gross direct employment effect of start-up cohorts is of minor significance for the local labour market. The share of the 1984-1999 cohorts in total t&c-employment in Neckar-Alb amounted only to 7.9 % in 2002. Hence, spin-offs and branch plants employed 7.6 % of all t&c-workers within this cluster in 2002.

These results show rather clearly that the quantitative effects of new firm formation are negligible in a declining cluster. The strong decrease in the number of start-ups and the increase in the risk of failure for new firms give evidence of the deterioration of the entrepreneurial climate within the cluster, particularly during the 1990s. In contrast, the old organizations are the most important employers in the cluster although the firm stock of established firms diminished, too.

## 7. Conclusions

The three clusters showed high founding rates above the average rates of all counties in Western Germany within the respective industries during the period of analysis (1984-2002). For instance, given the decreasing entry rates in the declining t&c-cluster of Neckar-Alb, the founding rates of start-up-activities in this cluster exceeds the rates of other regions in Western Germany by a multiple. This result might indicate that even shrinking clusters still bare great potentials for spin-off-activities. But it is possible that insecure jobs and unemployment

might contribute to these strong entrepreneurial activities taking into account the long-term economic restructuring of this traditional cluster due to the crisis of t&c-industry.

Organizational ecology postulates – in contrast to institutional economics and social network theory – high survival rates of new firms in ,working' clusters with high density of firms and extensive local networks between the actors. This assumption of organizational ecology is confirmed in respect of the low survival rates of new firms in the mature medical technology cluster in Tuttlingen. Additionally, the increased density of firms implied shorter survival prospects for start-ups within Munich's growing cluster of medical technology during the 1990s. But these results are not surprising because several studies proved that high density clustering causes increased risk of failure for start-ups (e.g. BRIXY/GROTZ 2006). The combination of decreasing founding and survival rates within the t&c-cluster of Neckar-Alb give evidence of its unfavourable entrepreneurial climate during the declining process.

One interesting result of this study is that established firms play different roles for the evolution of clusters. The two case studies of the medical technology clusters in Munich and Tuttlingen showed that the long-term survival rates of the established cluster-firms were extraordinary high. SORENSON/AUDIA (2000) assume that old organizations appear to be less vulnerable to local competition within industrial agglomerations. They give three explanations for this conjecture. 1. The access to local resources is particularly critical for the success of firms when they are young. Established businesses embedded in local networks are routinized in setting up relations to get access to resources. 2. This effect might be caused by firm size. Large enterprises do not have to face intense competition in contrast to small firms. 3. Established firms are used to responding to structural changes and competitive threats. It is possible that these strategic experiences enable old firms to reduce their future risk of failure. But the survival prospects of the old and traditional t&c-firms in Neckar-Alb were quite shorter compared to the long-term success of established cluster-firms in the Munich Region and in Tuttlingen. One reason for the lower survival rates of the old t&c-firms in Neckar-Alb might be seen in their structural inertia. It is possible that these firms were not able to response successfully to structural changes within the t&c-industry. Another reason could be seen in the intense cost pressure on the world market, particularly by low-cost-producers of East Asia.

The established firms which succeeded in sustaining their position on the market during the period of analysis (1984-2002) are the most important employers within the clusters of Tuttlingen and Neckar-Alb in 2002. The established organizations contributed decisively to the overall employment growth of medical technology in Tuttlingen whereas the old t&c-firms in Neckar-Alb showed only slight growth. The long-term cumulated gross employment effects of start-up cohorts and of external firm settlements are – compared to the role of the old organizations - negligible for the labour markets in these two clusters. In contrast, established

firms as well as start-ups and external businesses contribute altogether substantially to the growth of Munich's medical technology cluster during the 1980s and 1990s.

This study is seen as a first step to reveal the direct quantitative effects of entrepreneurship on the evolution of clusters. The conceptual framework of FORNAHL/MENZEL (2005) was a useful scheme for the analysis of the effects of entrepreneurial activities in different development-stages of a cluster. However the case of the medical technology cluster in Tuttlingen considering its hub and spoke-structure indicates that the individual features of clusters matter as well. The comparison of entrepreneurial activities between a growing, mature and declining cluster showed that new, young and established firms play different roles for the evolution of clusters in respect of their development-stage. It should be taken into account that this investigation of start-up activities in clusters refers only to a short period of time (19 years) due to restrictions of the database. But it is supposed that the different development-stages of a cluster – particularly the mature and declining phase – will last much longer than the period of analysis in this paper. It is acknowledged that the aging process of a cluster depends on the interplay of several factors - for instance the individual characteristics of a cluster (e.g. structures of local networks), the strategic behaviour of the established cluster-firms and the specific environmental and market conditions. A comparison between the development paths and survival prospects of cluster-firms and isolated businesses may reveal further systematic results.

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