CO-DEVELOPMENT OF FIRM FOUNDINGS AND REGIONAL CLUSTERS

Dirk Fornahl*, Max-Peter Menzel**

*Max Planck Institute for Research into Economic Systems, Evolutionary Economics Unit
Kahlaische Str. 10, D-07745 Jena, Germany
Phone: +49-3641-686822, E-Mail: fornahl@mpiew-jena.mpg.de

**Economic Geography and Regional Studies Group, Institute of Geography, University of Bern
Haller Straße 12, CH-3012 Bern, Switzerland
Phone: +41-31-6318877, E-Mail: menzel@giub.unibe.ch

ABSTRACT: Although firm foundings and the formation of regional clusters are two processes that have separately attracted a lot of scientific attention during recent years, not much research has been conducted to analyse the interrelation between these two processes. This paper gives some new insights into this relation and a framework is presented into which empirical observations and theoretical considerations can be placed. The core elements are the effects the two processes have on each other in the different stages of cluster formation and development.

ZUSAMMENFASSUNG: Obwohl Firmengründungen und die Entstehung von regionalen Clustern in den letzten Jahren viel wissenschaftliche Aufmerksamkeit auf sich gezogen haben, wurde der Zusammenhang dieser beiden Prozesse bisher kaum analysiert. Dieses Papier stellt neue Erkenntnisse bezüglich dieses Zusammenhangs vor und präsentiert einen analytischen Rahmen, in den empirische Beobachtungen und theoretische Betrachtungen integriert werden können. Die Kernelemente sind dabei die Effekte, die die beiden Prozesse in den unterschiedlichen Phasen der Clusterentstehung aufeinander haben.

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JEL CLASSIFICATION: D83, L21, M13, R12

1. Introduction*

During recent years some economically successful regions with a significant increase in employment, population and economic strength have attracted the attention of researchers and politicians. These regions often contain a high concentration of firms and employees from one or a few (related) industries, so called regional industrial clusters (RIC). Various case studies have analysed this phenomenon, e.g. for computer software and biotechnology in the Boston area (Bathelt, 2001), software and microprocessors in Silicon Valley (Saxenian, 1994), mobile telecommunication in Aalborg (Dalum, 1995) and biotechnology in Oxford (Lawton Smith et al., 2000). Besides these "high-tech" and (in most cases) newly established clusters, there also exist clusters in mature industries (e.g. textile-clothing in Prato (Bellandi & Romagnoli, 1994)). Therefore, it seems that the phenomenon of clustering is not new but is an integral part of economic development. For example, the cotton textile industry in southern Italy already emerged in the nineteenth century (A'Hearn, 1998). The same holds for the car manufacturing and the so called 'rustbelt' in the USA (Krugman, 1991). Thus, it can be summarised that regional clusters have formed in many different industries in different countries over the last centuries. In most cases such a clustering has, at least for a certain period of time, economic benefits for the firms involved as well as for the regions in which the clusters form (Porter, 1998).

A second phenomenon drawing recent attention is the increase in the number of firm foundings in some regions (Longhi, 1999). A lot of research was conducted to explain why some regions have such a high start-up rate (Reynolds, 1994, Braunerhjelm & Carlsson, 1999, Cooper & Folta, 2000). While firm foundings have a positive impact on regional economic development in general (Audretsch & Thurik, 2000), the number of foundings is also often linked to clustering because it is considered to be one of the important elements of cluster formation (Feldman, 2001).

Based on these empirical observations, including the fact that clustering and firm foundings both have a positive effect on local development, policy makers have tried to support these processes over recent years. However, in many cases the policy measures applied have lacked a profound theoretical basis and have focused on one special aspect, such as financial or human capital, which they attempted to influence with more or less success (e.g. Dohse, 2000). Since causes for firm foundings and reasons for the successful formation and development of RICs are manifold and many different variables and factors are mentioned and discussed in the literature (Bhidé 2000, Prevezer, 1998, Zeller, 2001), a deeper theoretical understanding would be helpful to the development of

appropriate instruments and windows of opportunity for different kinds of clusters (Brenner, 2003). An attempt to give a coherent theoretical framework for the political support of clusters is made in, for example, the edited volume by Fornahl & Brenner (Fornahl & Brenner, 2003). Despite its importance for understanding the processes of clustering, there are only very few analyses of the interrelation between firm foundings and RICs (Feldman, 2001, Cooper & Folta, 2000). However, in these studies it is mostly the impact of RICs on firm foundings that is studied, neglecting the opposite effect new firms have on cluster development. Thus, at the moment, a coherent theoretical framework explaining the interrelation between firm foundings and cluster development is missing. In this paper we try to add some new insights into this relationship as well as some new elements to the explanation of cluster formation and change.

It will be argued that a regional cluster passes through different kinds of stages during its development and that these stages are the central determinants of the interrelation between firm foundings and RICs. The aim of the paper is to explore the empirical observations and to present an analytical framework in order to structure theoretical arguments on which, in turn, policy measures can be built.

The paper proceeds as follows. In the second section the basic theoretically derived interrelations between clustering and firm foundings are described. In section 3 stylised stages of RIC development are presented and the interrelations identified in section 2 are applied to the different stages of a RIC. The last section presents a conclusion and gives an outlook.

2. Interrelationship between Firm Foundings and Cluster Formation

This section deals with the basic interrelationship between firm foundings and cluster development. These general processes are used in the next section to analyse the special interrelationship in the different stages of cluster development.

The relevant processes influencing the development of clusters are the impacts of firm foundings on the variety and the growth of the RIC. The number of firms changes dramatically during the development of the cluster. On the one hand firm foundings are the core element for the emergence of the cluster, and on the other hand the number of firms already present in the region influences the number of start-ups. The same holds for the variety of knowledge: It also differs between the stages. The RIC only emerges and grows if a common regional trajectory (Menzel, 2003) is found, and which persists for a long time if the variety is high enough to be able to adapt to changing environmental

conditions. These processes are strongly influenced by new firm foundings. Viewed from the other way around, the knowledge base of the RIC and the existing variety has an impact on the number of firm foundings and on their business concepts. The variety and number of firms will be the central variables that distinguished the different stages from each other, as described in section 3.

Bresnahan et al. (2001, 836) measure the success of a cluster "... by the ability of the cluster as a whole to grow, typically through the expansion of entrepreneurial start-ups". Additionally, Brenner (2000) identifies the entrepreneurial processes in a region as one of the important elements for the formation of regional clusters. This importance of firm foundings for cluster development can be separated into two different effects, namely quantitative and qualitative ones. Quantitative effects are related to the number of firms and employees in the RIC, whereas qualitative ones relate to knowledge and competencies of the RIC. Both these effects can be further divided into pure and systemic effects. The pure effects describe the addition of quantitative and qualitative factors to the cluster. The systemic effects show the influences of the addition of new elements to the whole system. These effects result from pure effects and take into consideration that a new firm is part of a whole production or innovation system and thus potentially has linkages to or impacts on other systemic agents.

The formation of new firms has the pure quantitative effect that the number of firms in the region grows. This initiates systemic quantitative effects such as the growth of awareness of the cluster in the regional population and a growing ability for collective action. Politicians may introduce policy measures to support the cluster formation. The higher the number of firms, the more impact this group of firms has in articulating its needs and wishes and the higher the likelihood that other parties (such as politicians) positively react to them. Furthermore, research institutes and universities might orient their work in favour of the cluster.

In addition to the quantitative effects new firm foundings have, there are also qualitative ones. Through the formation of new firms, new knowledge, competencies and skills are introduced into the cluster. New products or services are added to the already existing stock. The introduction of new knowledge, skills and novel products might be caused by the fact that new agents, such as entrepreneurs or employees, enter the region. Furthermore, novelty might result from a new and innovative re-organisation or recombination of competencies already present inside the existing firms. In this latter case it is not the individual agents in general who hold new competencies, but the

regional system as a whole. The new firms are the respective carriers of knowledge and competencies in the first place, and in turn they might, in the longer run, influence the individual competencies of the workers.

The systemic effects are based on these pure qualitative ones: the possibilities for regional co-operation, regional customer-supplier relations and thus the formation or strengthening of regional value chains increase. Through the introduction of new competencies and especially through the resulting interactive and collective learning processes, the potential for incremental but also for radical innovation increases and new directions of (re-)search can open up. Although already established firms can also change competencies as well as products and/or introduce new ones, we concentrate on the impact of new firms because these firms contribute most to the production of new competencies and to the reorganisation of the regional production system (Cantwell & Fai, 1999; examples in Saxenian, 1990 and Bathelt, 2001). One example of such a systemic impact of new firms on an existing cluster is the start-up of foreign firms in the Midwest of the USA. These foundings influenced the whole regional production system because these new firms used new forms of organisation that were adopted quickly by other firms present in the region (Florida, 1996). Table 1 sums up the processes by which firm foundings influence cluster formation and development.

	Quantitative Effects	***Qualitative Effects***
Pure Effects	• Growth of number of firms in the cluster • Growth of employment in the cluster	• New knowledge, skills and competencies in the cluster • Implementation of new products and services into the cluster
Systemic Effects	• Growing awareness and support • Growing ability for collective action	• Increasing possibilities for co-operation • Increasing possibilities for regional customer / supplier relations • Interactive and collective learning processes

Table 1: Influence of firm foundings on cluster formation.

After describing the influences new firms have on a cluster, the opposite direction, the different impacts of RICs on firm foundings, is analysed in the following.

First, social and cluster related networks emerge which diffuse knowledge, create an industrial atmosphere and generate sensitivity to market and technological opportunities on which new firms are based (Becattini, 1990). Although many new firms, especially in niche markets, produce for global markets, regional customer and supplier relations are still very important. They are more flexible and the transaction costs are lower because of easier face-to-face interactions and common knowledge about the specific capabilities of other regional agents (e.g. Belussi & Arcangeli, 1998, Lorenzen & Foss, 2003). These processes are of high importance in regional customer-supplier relations because "sophisticated regional customers" take an active part in innovation and development in the supplier firms (Lundvall, 1988 and Lissoni & Pagani, 2003). Usually such relations already exist before the new firm is started. Sometimes the firm is even started because the founder has contacts to future customers, who support the founding.

Second, the cluster provides supporting infrastructure for new firms in general or even special infrastructure for cluster related foundings ranging from legal support or informal information networks to the provision of space. This is also linked to the observation, mentioned earlier, that political agents try to develop local infrastructure to support the RIC or foundings.

Third, it can be observed that in successful RICs it is easier to find capital to finance a new start-up. This financial capital can be provided by firms from inside the cluster or from venture capital firms, that were attracted to the region because of its success.

Fourth, the number of firms and employees increases the number of regional positive examples, which serve as role models, and which in turn increase the propensity of other economic agents to found a firm (Fornahl, 2003).

The fifth and last point that should be mentioned is the knowledge and competence base that the cluster provides and which influences foundings. Many new foundings are built on the knowledge of the cluster and represent a new characteristic of the existing competencies. This is due to the fact that the likelihood of choosing cluster-related work or receiving cluster-related education or training is high and research and higher education institutions are themselves part of the RIC and thus might have a tendency towards cluster related research or education. As Maskell states:

> It is reasonable to assume that the cluster's particular set of institutions has emerged as a response to the special requirements of the activities performed in the cluster. There is thus

> a fundamental *interdependence* between the economic structure and the institutions of the cluster as they have developed over time (Maskell, 2001, 934).

Furthermore, availability of partners, advice and role-models is influenced by the existing orientation of the cluster. Thus, there exists a bias both in the founding activities and in the development of the cluster as a whole as a result of the knowledge already present in the cluster.

3. The Interrelation between Firm Foundings and RICs on Stylised Stages of Development

As has been shown, there exist various processes by which firm foundings influence cluster formation and development and vice versa. In this next section how these processes differ in the stages of a cluster is described.

We start with the very general definition of a regional industrial cluster given by Porter: “Clusters are geographic concentrations of interconnected companies and institutions in a particular field“ (Porter, 1998, 78). This definition contains the main elements relevant in this paper. A cluster contains companies *and* institutions, meaning that the cluster and its institutional environment, consisting of organisations as well as of formal and informal norms, are connected because of their historical co-development and cannot be considered separately. Furthermore, there exist interconnections in the form of exchange relations regarding goods and knowledge between firms on the one hand as well as between firms and their institutional environment on the other hand. These exchange relations are made possible through technological proximity based on horizontally and vertically complementary technological activities. And finally, these processes are geographically concentrated.[i] For the purpose of this paper, a cluster must additionally have gone beyond a critical mass during its development, measured by the number of firms or employees. This enables it to steer endogenously relevant development processes (Bresnaham et al., 2001).

The definition of a cluster in this paper thus reads as follows: A cluster is a geographic concentration of interconnected organisations and institutions in a particular field *beyond a critical mass*.

In order to structure the argument we assume that a cluster develops through stylised stages (emerging, growing, sustaining and stagnating/declining), which are described in the following. This stage based approach serves as an analytical tool in order to show

that the basic interrelations between firm foundings and RICs work differently in different stages and should not be regarded as a deterministic life cycle model. The different stages are separated here by two main factors: first the number of firms in the region and respective industry (including related ones) and second the variety of knowledge used mainly in the region.

Clusters need not have linear development through the stages and not all clusters have to decline. Nevertheless, there exists evidence that these stages occur in reality. Brenner (2000) develops a theoretical model by which these stages of cluster formation can be described. Maggioni also develops such a model but additionally supports his theoretical argument by empirical evidence (Maggioni, 2002, Gambarotto & Maggioni, 1998). Furthermore, a lot of case studies exist that describe regional clusters in different stages of their development (see e.g. Fornahl & Brenner, 2003). Therefore it is possible to subdivide and characterize different stages of cluster development. However, it might be difficult to assign a cluster to a certain stage if this cluster is in transition between two stages. The phase of transition is a fuzzy process. Parts of the cluster remain in the former stage while others are already in the new stage. Nevertheless, it is assumed that after the phase of transition, the cluster as a whole reaches a new developmental stage.

Besides the stages of cluster development, the process of cluster formation is idealised as well. There exist various prerequisites that determine whether and where a cluster emerges (see e.g. Brenner, 2000, Brenner & Fornahl, 2002). These are, for example, market conditions, technologies, the ongoing globalisation process, industry- or regional-specific characteristics such as infrastructure, the organisation of the regional innovation process (Cooke, 2002) or differences in regional business culture (Saxenian, 1994). We concentrate here on just a few of these processes, namely the co-development of firm foundings and cluster development within the different stages and the impact this development has on the variety of regional knowledge and the number of firms. Nevertheless, we bear in mind other endogenous and exogenous processes which might influence cluster formation.

In the following we apply the processes of cluster formation and firm foundings presented in section 2 to the idealised stages of cluster development. For each stage we describe its general properties and the interactive relations between firm foundings and the RIC. The conditions that each stage of cluster development offer for individual firm foundings and founding activity in general are described. Additionally, the influences of firm

foundings on the respective RIC stage are shown. Two aspects are central to our argument: On the one hand, it is assumed that the stage of the cluster has an important influence on the amount and type of firm foundings, as the conditions for firm foundings change from stage to stage. On the other hand, as the founding of a firm has an effect on a whole regional production system, the outcome of this event is not only dependent on the type of the firm but also on the type of the production system. The characteristics of the influence of foundings are also considered to be highly dependent on the stage of the RIC.

3.1 Emerging clusters

The stage of emergence of a cluster is difficult to define, mainly because it is not yet a cluster according to the definition above. The critical mass has not been reached and respective organisations as well as connections between the firms may not be existent at this stage of development. A geographical concentration of related firms is hardly recognisable. The respective economic activity in the region resembles those regions without a cluster.[ii] It is possible that the emerging cluster remains unrecognised, and therefore the stage of emergence often can only be described in a review (e.g. in Bresnahan et al., 2001). Although a region containing an emerging cluster may show average economic activity, it can be distinguished from other regions by two peculiarities. First, the existence of one or more firms as focal points (see for example Sugden, 1995 or Lorenzen & Foss, 2003 on “focal points”) that create sustainable visions about the future trajectory, and second, the existence of certain factors such as a respective regional science base or government intervention, which influence the potential to reach the critical mass.

The origin of growing clusters is based mainly on the exploitation of new technologies and markets (see Saxenian, 1994, Prevezer, 1998, Bresnahan et al., 2001). At the stage of emergence, the technological variety of the few, already existing firms as bearers of competencies is widely spread. At this stage, the competence areas of the future cluster may be existent. However, within these boundaries[iii] competence gaps are present due to the technological distance between the firms that hinder them in exploiting synergies (Cohen & Levinthal, 1989). Success stories in the emerging cluster are possible, even probable. Nevertheless, the cluster as a whole remains in the state of emergence if these success stories are isolated and are not linked to the regional institutional environment.

There are two different possibilities for the end of this phase. First, the transition into a growing cluster due to a closure of competence gaps by further firm foundings or shifts of existing firms. Second, the emerging cluster loses its potential to become a functioning one. This could happen if the possibilities for exploiting synergies between the firms vanish. Decisive for this are two reasons. One is the loss of the common focal point of the emerging cluster. The firms develop in different technological directions and the technological distance between them extends. Orsenigo (2001), for example, describes an Italian case in which the biotechnology firms in the analysed region in fact tended to cluster, but this (emerging) cluster failed to reach a critical mass because, among other reasons, of its heterogeneity. The second reason is the disappearance of existing firms from the emerging cluster. These 'lost' firms leave competence gaps in the emerging cluster and this also diminishes possibilities for regional co-operation. In the end the firms of the formerly emerging cluster might completely disappear.

As the emerging RIC strictly speaking does not exist yet, the cluster itself, including its environment, has little influence on firm foundings. A cluster-related institutional infrastructure in the form of venture capital, support programs or respective social networks is not per se available (see Feldman, 2001 and Bresnahan et al., 2001), but may be established exogenously through political intervention. Few regional role models inspiring the potential founders exist, but an awareness of isolated success stories during the emergence of the cluster is possible. Due to the absence of many factors that may lead to the attraction of external firm foundings, such as benefits and synergies from other relevant technology-based firms (Bresnahan et al., 2001), the emerging cluster is mainly endogenously driven. The most important source for cluster-relevant entrepreneurial activity is the regional human capital. The regional science base is especially crucial for the first steps of the RIC, as shown for example by Zucker et al. (1998) and Prevezer (1998). Within this regional science base the technological opportunities that may build the basis for the future cluster are created and lead to the first foundings.

Whereas the RIC itself has little influence on firm foundings, even single firm foundings may have a significant influence on the cluster development in manifold ways. As the emerging cluster usually bears small employment numbers,[iv] firm foundings contribute in an essential way to the growth of the emerging cluster. They also have a significant effect on an emerging general awareness of the cluster that may result in further support.

Additionally, they enhance the capabilities of the cluster to articulate its needs and to undertake the first joint actions that aim to improve of the institutional environment.

On the qualitative side the emergent cluster is characterised by a nearly absent or diffuse trajectory. Firm foundings are rather influenced by exogenous developments or by technological opportunities that can be created endogenously within a strong regional science base. Often a large range and variety of competencies of the established firms exist, co-operation with firms within the cluster is fragmented and synergy effects between existing firms are scarce. Therefore, not only a strong science base, but also synergies between the science base and the new firms are important (Shohet, 1998).

As Bresnahan et al. state: ”nascent clusters, and the entrepreneurs operating there, have to bet on new trajectories before they manifest their potential” (Bresnahan et al., 2001, 845). Firm foundings during this stage are considered to be highly focused on the exploitation of new markets and especially on new technological opportunities. Hence, during this stage, they mostly occur in fields not occupied by other firms but are rather widely distributed. Every single firm founding has a significant impact on the nascent boundaries of the trajectory. It contributes either to the widening of the boundaries of the regional trajectory (foundings in new technological areas), or is complements of the trajectory within existing boundaries (foundings within existing technological areas). New and successful firms establish sustainable visions and focal points, trigger development and serve as role models for further firm foundings, as for example, shown by the founding and early development of Hewlett-Packard in Silicon Valley (see Saxenian, 1994, 20).

Additionally, they create the first possibilities for regional co-operation between firms and synergy effects within the cluster and through this they contribute essentially to the survival and growth of the existing firms of the emergent cluster.

However, the cluster at this stage has little ability to satisfy its needs. Therefore a growing political awareness may trigger further development and help to create cluster relevant organisations that may become important elements in the future (Breschi & Malerba, 2001). It is additionally possible that firm foundings, by widening the possible trajectory, open new competence gaps. This brings the danger of blurring the vision for a common future trajectory, losing the focus of the emerging cluster and making the achievement of a critical mass, which is necessary for extensive synergy effects and sustainable growth, more difficult.

3. 2 Growing clusters

The transition phase from an emerging to a growing cluster is, to a large extent, blurred. Parts of the cluster are in the growing phase while others are still in the emerging one. It is assumed that the cluster's overall inherent processes of co-operation, collaboration and the effect of the cluster on its institutional environment change significantly during this transition. The transition can be discontinuous and recognisable or continual and unnoticed. It is probable that in the beginning of this transition only the parts of the emerging cluster are relevant that contain some *interconnected* firms that, in their further development, are able to create the environment for growth processes of other parts of the cluster. But it is also often the case that some success stories remain isolated without having any effect on the cluster development and without considerable contribution towards reaching the critical mass necessary for a growing cluster. Isolated success stories in emerging clusters may occur because of the specific history of these firms: at the time of their establishment (that may mark the beginning of the emergence of the cluster) and first growth, there were no other firms available for co-operation and collaboration. Therefore it was necessary for these firms to search for other partners in other regions. Due to the path dependency of inter-firm networks, these external partnerships remain stable, in spite of the establishment of new suitable regional partners. However, it is possible that these firms embed themselves through spin-off processes in a regional context.

The cluster at the growth stage shows a strong increase in employment that results from a strong growth of existing firms and a high number of firm foundings. These are caused mainly by spin-offs from existing firms and by the attraction of external firm foundings. Both types of new firms are normally absent in an emergent cluster. The reasons for this are that in this kind of cluster the incumbent firms are still too small and/or too young for spin-offs. Furthermore, the attraction of external foundings is difficult for the respective regions: As the possible external founder is free to choose his site within a range of different RICs, it is likely that he chooses a site with a functioning cluster to gain the respective advantages, not to mention the question how the possible external founder would find out about the emerging cluster’s existence.

The boundaries of the growing cluster are, in contrast to the emerging one, definable. Through the succees of a “dominant cluster design” (see Utterback & Abernathy, 1975 for the concept of “dominant designs”), it is possible that the overall variety of competencies within the cluster decreases as firms at the edge of the cluster may either shift toward the

focal point of the RIC (and thereby narrow the regional trajectory) or follow a different path, independent of the RIC, and therefore do not belong to the cluster anymore.

Although an endogenous and continual transition from the emerging stage to the growing stage is possible, mainly during the growth of markets in which the incumbent firms are well positioned, often the crucial push stems from single events and a sudden change in some exogenous factors. In the Capitol region around Washington, D.C. (USA), for example, a bundle of events, e.g. new regulations and government intervention, led to the growth and take off of the cluster (Feldman, 2001). Also in Sofia Antipolis a changing economic environment (transition from fordism to postfordism) caused the restructuring of the incumbent firms, including dismissals of highly qualified employees, that in the end led to the transition from a so-called “satellite platform” (Markusen, 1996) to a growing RIC in software and telecommunications (Longhi, 1999).

With regard to firm foundings, the growing cluster contains many success stories and thus role models that are able to increase the propensity to found.[v] The social and cluster related networks are open to new entrepreneurs and the number of their participants increases. Growing regional markets offer easy access to potential customers and, more important, specialised suppliers. Saxenian (1994) shows examples for this in the Silicon Valley[vi] and the Route 128 region. In the latter the development of the minicomputer cluster led to the establishment of “technical and management consulting firms and other providers of business services. This infrastructure was an important resource that supported both established firms and start-ups” (Saxenian, 1994,19).

Due to the growth of the RIC, specialised research institutions are founded and the incumbent higher education institutions offer additional cluster-related education. Therefore, the likelihood of the regional population to receiving such education and training is higher than in other similar regions. This is additionally reinforced through an increasing propensity of the regional population to choose cluster-related education and work because of widespread role models. Furthermore, agents with interests in receiving such education are attracted from other regions. These effects enlarge the pool of potential entrepreneurs significantly. Therefore, the growing RIC leads to a strong bias in the overall founding activity in the region containing the cluster.

The cluster, once established, acts as a selection device, attracting particular kinds of economic activity comparable with the incumbents and reducing the ambiguity and costs

> facing local entrepreneurs when keeping close to the activities already present. This selection device carries with it a set of constraints that might hamper future prosperity when external changes make readjustment necessary (Maskell, 2001, 937).

The pure quantitative impact of firm foundings on cluster development is simply the increase in the number of firms in the cluster. The growth of the RIC leads to a high awareness of the cluster with positive effects on its development, e.g. political support, organisations that provide cluster-related infrastructure or the attraction of external firm foundings. Prevezer (1998) shows, for example, that an incubator in the biotechnology cluster in North Carolina was established when the cluster already contained around 100 small firms. Feldman (2001) described for the Capitol region around Washington, D.C. that venture capital did not lead to the development of the RIC but followed it. Furthermore, cluster-related curricula in this region were not offered by the regional universities until *after* the cluster's emergence. "The draw has been the number of workers seeking additional training, the opportunities for industry-funded research and interaction with industry" (Feldman, 2001, 884). Longhi (1999) gives a similar example with Sofia Antipolis, where a university with cluster-related education was established in Sofia Antipolis *after* the first growth phase of the site.

The RIC is more and more able to articulate its needs and to create the infrastructure necessary for collective action. An example described by Saxenian (1994, 21) may clarify this point: In the 1940s a larger chunk of national defence spending in the USA went to the companies on the east coast, compared to the west coast. This ratio further increased as some defence contracts went from the west to the east coast. Subsequently, an association was formed in 1943 by the Californian electronic companies that "sought to promote their industry, particularly by lobbying for a share of defence contracts that were going to eastern companies" (Saxenian 1994, 21).

The scientific infrastructure (research institutes, universities, etc) is, to a lesser extent than in the emerging cluster, the origin of new firms. Firm foundings occur in most cases through spin-off activity from existing firms (see examples in Saxenian, 1994 or Klepper & Sleeper, 2002). These firm foundings build upon the existing competencies of the parent firm and therefore upon the competencies of the cluster. Thus, most firm foundings are a result of the regional trajectory. The input of new competencies and products along the trajectory leads to their strengthening and completion. Increasing synergies between the firms through an increasing "thickness" of competencies within the trajectory leads to

more possibilities for co-operation and innovation. The growing number of products in the RIC promotes the emergence of specialised regional markets and the emergence of regional value chains. Firms are able to choose between various similar regional suppliers that foster the competitiveness of these firms.

At this stage of the cluster, the co-development between firm foundings and the cluster subsequently leads to a bias of regional competencies towards the RIC. The RIC, in turn, influences endogenous and market driven firm foundings by its success. New as well as incumbent firms exploit technological and market opportunities along an established trajectory. In addition new firm foundings create increasing possibilities for regional value chains and co-operation through implementation of supplementary competencies, by which the competitive advantage of the RIC is enhanced. Since founding activities have a positive impact on the development of a growing RIC *and* vice versa, a self-reinforcing process exists.

3.3. Sustaining clusters

The sustaining cluster is the anomaly in this typology. The cluster is still able to adapt to changing environmental conditions and transform itself while sustaining a high level of economic activity. Thus, a kind of equilibrium state exists. The transition from a growing to a sustaining RIC can result for various reasons and in different market environments. It is possible that RICs in both growing and declining markets become sustaining clusters. Clusters in growing markets can be locked-into a niche and be unable to shift to more promising products, nevertheless they are successful within their niche. On the other hand, RICs in declining markets may retain their potential through a shift into other already existing markets or through exploring new markets The transition to a sustaining cluster can occur as a result of a reduction in the former growth dynamics, for example because of stagnating market developments, the emergence of new competitors or the exhaustion of the endogenous potential.

It is assumed that older clusters in well established markets are able to preserve their competitiveness despite growing centrifugal forces normally leading to geographical de-concentration. Due to changing conditions in the economic environment, the factors that led to the original process of clustering may vanish because of technological progress. Therefore, to sustain itself, the original, outdated competencies often have to be transformed to meet current conditions in order to retain competitiveness (examples for such a RIC in Tappi, 2003). Measures to achieve this are, for example, upgrading

employees' competencies, implementation of new technologies and incremental innovations. In addition, continual firm foundings as a means of rejuvenation may be an important part in this process of transformation and adaptation to changing conditions. Since as outdated competencies disappear, new competencies occur or are produced, the variety of competencies in the cluster remains quite constant. Therefore a sustaining cluster shows neither rapid growth nor remarkable decline. Fluctuations are rather of a cyclical than of a structural nature. Nevertheless, sudden changes in the numbers of firms and employment through sudden restructuring processes may occur.

A sustaining cluster normally exists in a region for a long time and was and still is able to shape its institutional environment to its specific needs (Maskell, 2001). During development a positive entrepreneurial attitude towards the cluster is established because of a high number of (historical) role models deeply embedded in the regional business culture. Large and diverse business and social networks with easy access for those who are involved in the regional “milieu” lead to the absorption of new information and opportunities for firm foundings that mostly occur in niches to avoid direct competition. Additionally, through these networks new firms have knowledge about, and access to, a large and specialised regional supplier base as well as contacts to potential customers. Furthermore, a cluster contains specific infrastructures, such as technology transfer agencies, banks and chambers of commerce with special competencies in cluster related foundings. External firm foundings are attracted by the existence of an expanded infrastructure and competence base. As in a growing cluster, but to a larger extent, a sustaining cluster’s strong bias in the regional knowledge base is the source of a high number of potential firm founders. This is the basis for a stable number of firm foundings that helps to preserve the number of firms and employment. Thus, firm foundings during this phase contribute to sustaining the critical mass of a cluster, necessary for the ability of a cluster to act collectively regarding continual renewal of the institutions created and the replacement of outmoded institutions.

Firm foundings at this stage result in mainly incremental innovations regarding the regional technological trajectory. However, these innovations can include new technologies that may find their way into many incumbent firms of the cluster leading to further innovation. External firm foundings, in particular, are considered to have such an influence on incumbent firms (see Florida, 1996). In addition, this type of firm founding may also bring connections into global networks and global markets for the regional firms.

Therefore, in general new firms, contribute to the preservation of variety in the cluster and thus to the long-term ability to adapt to changing environmental contexts by continually renewing the RIC.

As in the growing cluster, in the sustaining one positive feedback loops exist between RICs and firm foundings. However, changes in the cluster's competencies through firm foundings only take place on an incremental level. Foundings contribute to sustaining the adaptability of the RIC rather than to growth processes as they are, to a large extent, restricted to the knowledge base and the technological trajectory.

3.4 Stagnating / Declining Cluster

This stage can occur either after the stage of growth or after the sustaining stage . This type of cluster is marked both by a decline in employment due to bankruptcies and rationalisation and by a strong decline in the number of firms resulting either from bankruptcies or a growing number of mergers. At the same time fewer firms are founded, which leads to a negative net effect. Often only a few firms contain the whole variety of competencies in the RIC.

A declining RIC has lost its potential for endogenous renewal and its ability to sustain its variety of competencies and therefore its capability to adjust to changing conditions. Especially important is its loss of ability to react to saturated markets. If the respective markets are saturated or even shrinking, the cluster has to adapt in order to survive. If such an adaptation is not possible, the survival is threatened. It is assumed here that the narrowing of the technological variety of the regional trajectory is the cause for the subsequent decline and not the result. In spite of its decline, competitive pressure can force high innovation rates in the cluster's firms (e.g. in Grabher 1993). However, these innovations occur *within* a narrowing trajectory and do not lead to a preservation of the range of variety.

Due to a former success of a certain trajectorial pattern, the RIC is focused on a further development of the former successful trajectory. Disregarding developments in other places, a lock-in may result (Saxenian, 1994, Grabher, 1993). Saxenian (1994) points out that the decline of the formerly fast growing minicomputer industry in the Route 128 region is the result of its inward focus and of the reliance on factors that were the cause for its past success. Additionally, firm foundings were missing, partly because of a cultural environment that did not reward entrepreneurial risk takers. Grabher (1993) similarly describes the reasons for the decline of coal and steel cluster in the Ruhr area. The case

of the Ruhr area shows, in particular, that the “trap of ‘rigid specialization’” (Grabher, 1993, 256) as a result of a former success may hinder the formation of new clusters and industries.

Thus, a region containing a declining cluster is marked by a strong cluster-oriented bias marked by its specific knowledge base and a highly specialised qualified workforce. Therefore, although a large number of potential entrepreneurs exist, firm foundings are a rare event. The reasons for this are declining markets along with closed firm networks and high barriers to market entry resulting from the (partial) application of active prevention strategies by the incumbent firms. These factors connected with missing positive role models or even an increase in negative models lead to diminished incentives for potential firm founders.

As a result, endogenous firm foundings are almost non-existent. The endogenous foundings that nevertheless occur remain mainly isolated, so that these firm foundings have almost no quantitative or qualitative influence on the cluster. Different effects would be expected from exogenous firm foundings, such as branches of multinational companies, but the status of the RIC is a deterrent to these firms.

Because of negative feedback loops between the RIC and firm foundings, inputs of new competencies through firm foundings are also lacking. Coupled with a solidifying and exhausted trajectory, the variety of the RIC further diminishes.

However, the processes of a declining cluster outlined so far do not usually determine the disappearance of the central firms or the loss of competencies or the loosening of the cluster’s critical mass. The often deeply, regionally embedded competencies of a declining RIC are particularly marked by strong inertia (Seri, 2003). They remain in the region although many firms decline or disappear and thus carry both the danger of critical regional lock-in and the basis for new growth processes within a similar trajectory. Saxenian (1990), for example, shows how a threatening decline of the semiconductor industry due to increasing rigidity of the large chipmakers resulted in a new wave of firm foundings in the form of spin-offs from engineers discontented with the prevailing conditions. These new firms extended the variety of the cluster and led to new growth. In particular, external foundings, such as branches of multinational companies, may cause a shift in the trajectory of the RIC and contribute essentially to its renewal.

4. Conclusions and Outlook

This paper describes some central processes of firm foundings that influence the formation and development of a regional cluster, as well as processes by which a RIC influences founding activities. This relationship between RICs and foundings is dependent on the stage of the cluster's development. The aim of this paper was not to develop a coherent theory in order to explain the interrelationship of RICs and foundings but to present a framework with some core mechanisms. Into this basic framework already existing or future concepts as well as empirical cases might fit. Using this base, the research in this field might be sped up.

Furthermore, some policy implications can be drawn. Since in the four stages different processes take place, policy measures must take the stage of the cluster into consideration and must also be adapted to the development of the cluster (Brenner & Fornahl, 2003). In policy measures aimed at developing a cluster by supporting firm foundings as one core element of cluster formation, the number as well as the orientation of new firms are important. Such support might be based on pecuniary or other direct support for new firms as well as on an institutional environment that favours foundings. With regard to the different stages, some examples for policy measures are presented in the following. For cluster formation, in the step from an emerging to a growing cluster, a critical mass must be overcome. On the one hand the number of firms is relevant here, but on the other hand the orientation or the firms is also important in order to develop synergies. Foundings must be focused around a few technological opportunities. Policy can influence this by the formation or support of specialised incubators or the necessary infrastructure. The problem is to identify the not yet existing cluster. In the growing cluster, due to the self-reinforcing mechanisms, almost no political or external support is necessary. Policy could try to sustain a certain level of variety by supporting firm foundings in general, but also by supporting firms or start-ups with business concepts that add to the already existing ones and that broaden the development path. The possible measures resemble those of the emerging cluster. However, to find the "best level of variety" seems quite problematic for policy makers who only have limited knowledge about the processes. For the sustaining cluster it is essential that the cluster is able to adapt to a changing environment. One core element is the rate of new firm foundings. On the one hand these new firms are based on the existing knowledge base and are linked to the old firms, but on the other hand they introduce new technologies and competencies and thus (slightly) shift the development trajectory. Policy measures might support

foundings and the introduction of new knowledge, e.g. by supporting research institutes or universities and the co-operation between firms and these institutions. In any case policy makers should not protect industries from the need to adapt to changes and they should try to reduce the regional inertia, not increase it. Since the development path of a (declining) cluster is hard to change by any means, including policy intervention, policy makers should not try to support the old cluster but rather they should encourage the formation of a new one, which could build upon the competencies of the old one.

This paper is a first step to analyse more deeply the interaction between foundings and cluster development. A lot of research still has to be done including deeper theoretical analyses of the underlying processes and closer consideration of the external environment, as well as more empirical studies to support the theoretical framework or through which the framework can be adapted.

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[i] Supra-regional clusters, such as the European space industry, are according to this definition, not a cluster but a network. See e.g. Cooke (2002, 119f) for differentiation between networks and clusters.

[ii] However, emerging clusters often develop in regions that still contain an existing older cluster.

[iii] The term "boundaries of competencies" describes the knowledge of the cluster. This includes on the one hand the whole spectrum of technological knowledge of the respective cluster. On the other hand, the term contains the knowledge necessary for the firms in the cluster. The latter knowledge may not be existent in the cluster. The knowledge needed, but not existing marks competence gaps *within* the competence boundaries.

[iv] Not all emerging clusters have small employment numbers. A different case is for example the transformation of a „satellite platform" into a functioning cluster as for example described by Longhi (1999) for Sofia Antipolis. In this special case, the "satellites" resemble the firm foundings in the emerging cluster as they mark the boundaries of the possible future cluster but fail to create considerable synergy effects between them. The reasons are technological distance and, more convincing, the embeddedness of the satellites in

different firm networks. Some studies, like the one mentioned, show that firm foundings contribute to overcome these distances.

[v] Saxenian mentioned the example of two firm founders who “became the leading role models for entrepreneurs in the route 128 region” (Saxenian 1994, 19).

[vi] Saxenian (1994) further noted that this infrastructure emerged because the growth of the cluster meant that the firms were no longer forced to produce their manufacturing instruments themselves but were able to divide this task. This additionally led to further spin-off activity.