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Driving forces of cluster evolution – growth and lock-in of two German packaging machinery clusters.

Ivo Mossig and Lars Schieber

1 Introduction

In recent years the focus of research on clusters has taken a turn towards the dynamics of cluster evolution. The applied approaches reach from a non-deterministic evolutionary perspective with regard to adaptation, path dependence and contingency (Belussi and Sedita, 2009; Parker, 2010; Martin, 2010) to a more systemic perspective of cluster life cycles that seeks to identify triggering factors and mechanisms of change in clusters (Brenner, 2004; Bergman, 2008; Menzel and Fornahl, 2010).

This paper investigates the evolution of two packaging machinery clusters in the German regions of Schwaebisch-Hall and Mittelhessen between 1998 and 2010. Recent conceptual approaches with a dynamic perspective on cluster evolution will be applied for the case studies. We have collected a unique comparative empirical data-set to examine the remarkably divergent cluster trajectories. The Schwaebisch-Hall cluster recorded an increase in employment of almost two thirds while employment in the Mittelhessen cluster declined by about fifteen percent. A large strand of literature points out potential advantages of clusters for the constituting firms (Porter, 1998; Malmberg and Maskell, 2002; Benneworth and Henry, 2004). **(← p. 594)** But significant differences in terms of localisation economies within the two researched clusters were not observed. The firms in both clusters characterised the specialised local labour market as an important and contemporary benefit. They indicated that there is knowledge bound to the personnel of the two clusters which is available nowhere else in Germany. Furthermore, the firms acknowledged the high availability of suppliers and service providers. However, in order to explain the differing dynamics of the clusters during the period of twelve years it is apparently not sufficient to analyse distinguishing effects from localisation economies, because they are conceptualised in a static way.

The first aim of this article is to investigate why the two packaging machinery clusters exhibited such divergent trajectories and thus to tackle the lack of comparative in-depth longitudinal case studies with regard to cluster evolution. Accordingly the article secondly exemplifies empirically driving forces from conceptual approaches, which influence cluster evolution on the three different levels firm, relation and system.

The next section provides an overview of the quantitative changes of the two clusters by depicting the individual firm developments and the family trees of the packaging machinery clusters. Section three discusses recent conceptual approaches to change in clusters in order to identify theoretical processes and driving forces for cluster evolution. After briefly summarising the applied methodology in chapter four, section five presents the findings of the qualitative empirical research. The driving forces of the distinctive cluster evolutions will be identified and linked to our theoretical considerations. In the final section we draw conclusions from our findings.

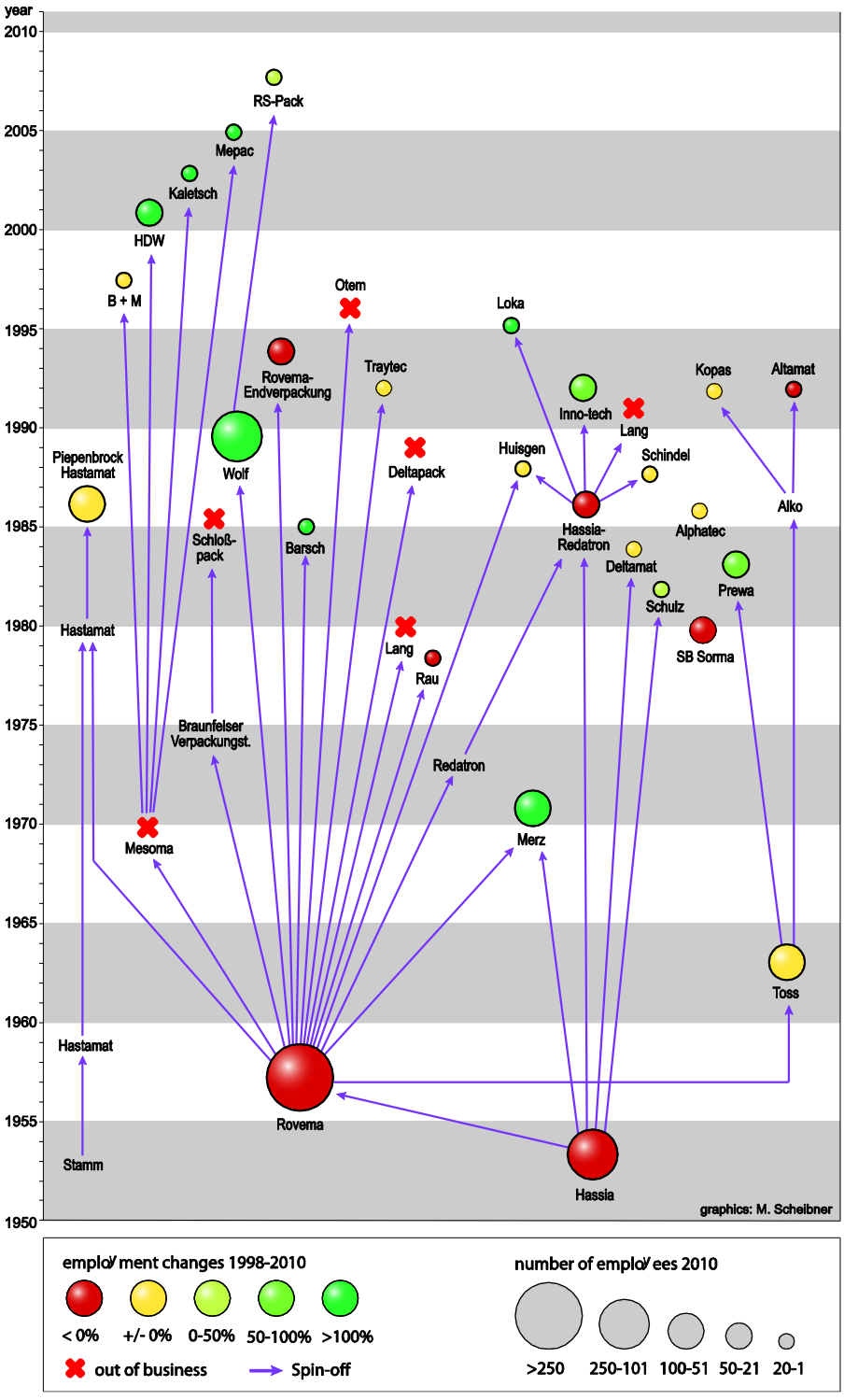
2 Development of the packaging machinery clusters in Germany

The analysis presented is based upon a study from 1998, which focused on the spin-off processes that led to the emergence of two clusters of the packaging machinery industry in Schwaebisch-Hall and Mittelhessen (Mossig, 2000, 2005). The packaging machinery sector is a subsector of the mechanical engineering industry, which represents a classical field of engagement of the German economy. It consists of mainly small and medium sized enterprises with about 27,500 employees. Most of the packaging machines are customized and constructed to the specific needs of the customer firms. The German firms are global market leaders with very high export rates of approx. 80%. Most of the German firms relevant to the sector are located in the two clusters at hand. Comparability of the

data from the two cases is assumed, as both regions belong to the same overarching German institutional system and both clusters are located in rather rural regions with similar distances to their economic centres.

Figures 1 and 2 show the family trees and employment changes of the respective firms in the two clusters. The size of staff declined in the Mittelhessen cluster by 15 % during the twelve years from 1260 to 1070 employees (Fig. 1). Only seven firms increased their firm size, while six firms cut jobs, including the two biggest key players of the cluster. Another six firms went out of business or were relocated, while nine firms stagnated. These losses in employment and companies can not have been compensated for, as only four new firms were founded out of the existing ones. With regards to the structure of the family tree, essentially one firm forms the root of the cluster. Former employees founded nearly all of the other existing firms out of that root. Thus, the firms in Mittelhessen pursue a similar product orientation. In trying to boost the competitiveness of the packaging machinery firms, a formal cluster initiative calling itself “Verpackungscluster Mittelhessen” was founded and supported by the Federal Ministry of Economics in Hessen in 2009.

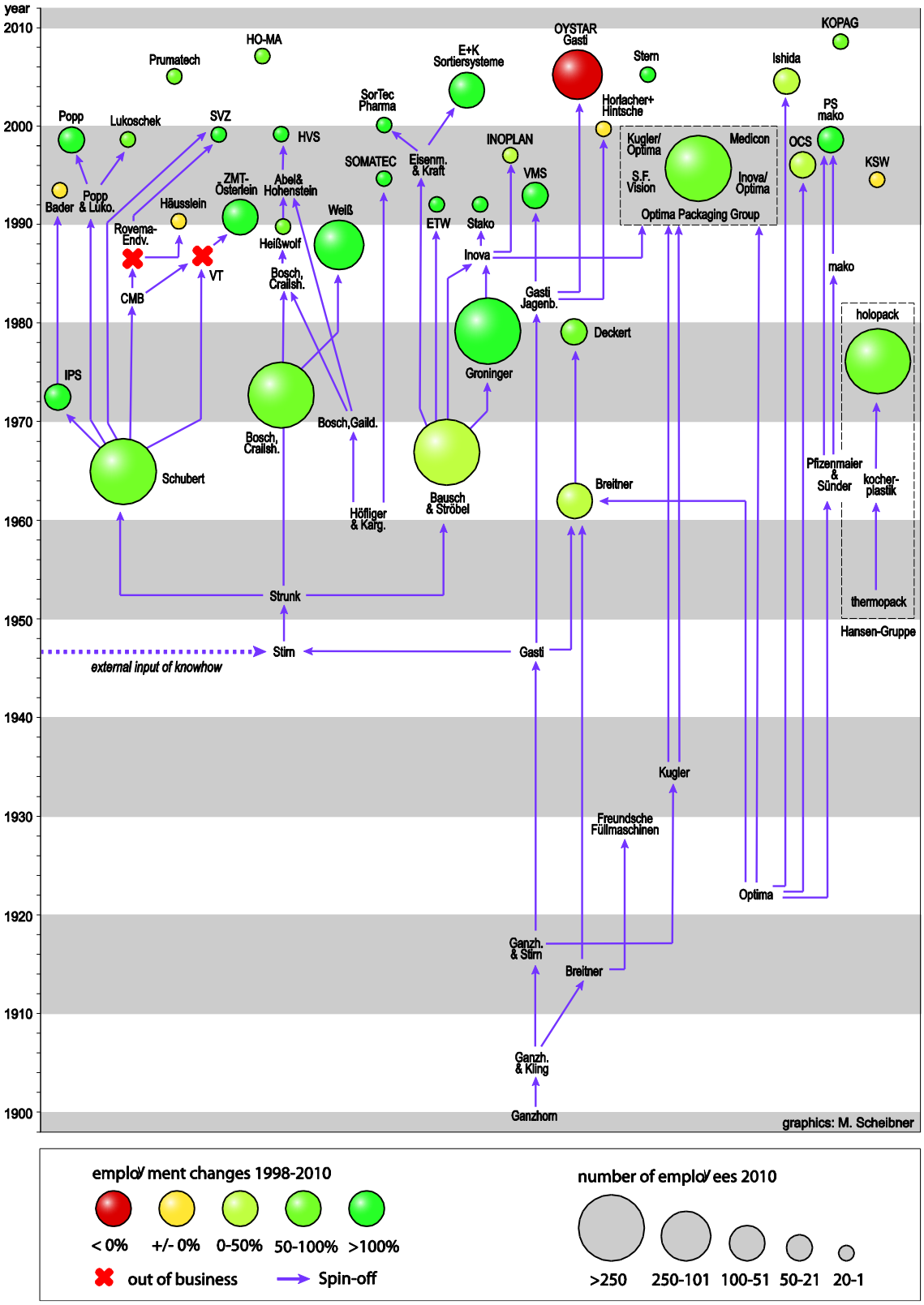
Fig. 1: Family tree and evolution of the packaging machinery cluster Mittelhessen



Source: own survey

(← Figure 1 p. 596)

Fig. 2: Family tree and evolution of the packaging machinery cluster Schwaebisch-Hall



Source: own survey (← **Figure 2 p. 597**)

Yet, cluster development was much more successful in Schwaebisch-Hall (Fig. 2). Employment increased by more than two thirds from about 3500 to 5900. Not only some dominant firms, but the cluster as a whole grew constantly. Thirty firms increased their number of employees while there was only one firm that cut jobs. Four firms stagnated during the twelve years. Only two firms went out of business, but eleven new firms were founded. This cluster originates from a broader seedbed of three roots (Mossig, 2000, 2005) and hence there are several deviating technologies **(← p. 595)** and products as well as market orientations pursued by the firms. In contrast to the Mittelhessen cluster several specialised suppliers in Schwaebisch-Hall have themselves begun to build machines and move up the value chain. Like in Mittelhessen, a formal cluster initiative ("Packaging Valley") was set up to improve networking, cooperation and marketing for the members in 2007. The Schwaebisch-Hall cluster also displayed a higher performance in growth, compared to the average rates of the packaging machinery industry in Germany (increase of 10 % from 1998 to 2010).

The recent conceptual approaches to cluster dynamics from which possible driving factors for cluster evolution are derived will be discussed in the following section. These approaches are then implemented in the empirical case studies to shed light on the reasons for the divergent cluster trajectories.

3 Conceptual approaches to cluster dynamics

Until recently, cluster literature focused on static snapshots analysing possible advantages of spatial concentration. Geographical research, however, has shown that the advantages resulting from a concentration of economic activities cannot simultaneously be responsible for their coming into existence (Bresnahan et al., 2001; Mossig, 2000).

Moreover, cluster advantages do not have to be permanent but might even turn into disadvantages, which can contribute to the shrinking and possible lock-in of a cluster. In path-dependent processes of cluster evolution three types of negative lock-ins can occur: a functional, a cognitive and a political lock-in. The functional lock-in describes a high stability of firm relations and the adherence to established (or outdated) products and processes, which makes it unlikely for the cluster actors to look for new solutions apart from traditional paths. A cognitive lock-in indicates that the actors exhibit a bounded mindset due to homogenous networks and similar mentalities, hampering the ability to adequately react to new challenges. The political lock-in characterises a strong focus of political actors on a specific industry because of longstanding activities (e.g. lobbying, infrastructure), which aims at conserving the existing structures (Grabher, 1993; Isaksen, 2003; Hassink and Shin, 2005; Hassink, 2010). (1)

The theoretical discussion in recent years focusses on processes and factors driving cluster evolution. This is underlined by special issues for example in European Urban and Regional Studies (Lorenzen, 2005) and in Regional Studies (Boschma and Fornahl, 2011). As an important question it is discussed, if cluster evolution runs through "(…) unpredictable courses of change" (Martin and Sunley, 2011: 1304) due to numerous contingent and co-evolutionary processes particularly by individual actors. This needs to be contrasted with the alternative assumption of general drivers governing cluster evolution, which allow for analysis and identification of development stages building temporarily and logically on one another. However, until now there is no consensus about the correct methodology concerning explanatory approaches for cluster evolution drawing on evolutionary economic geography (Boschma and Frenken, 2006; Maskell and Malmberg, 2007; Martin and Sunley, 2010; Boschma and Martin, 2010) and cluster life

cycles (Brenner, 2004; Bergman, 2008; Menzel and Fornahl 2010), as "(…) the cluster evolution literature is still in search of an appropriate analytical framework" (Boschma and Fornahl, 2011: 1296). It is not intended to develop such a framework in this study, but to apply these recent conceptual approaches to the exploration of the case study sites to understand why the two clusters at hand exhibit such differing trajectories.

Starting from the constituent characteristic of a cluster, namely that it is made up of numerous actors and that their individual decisions result in growth or shrinking, the level of the actors – and most important the firms – is to be investigated. But a cluster is by definition more than just the aggregated sum of firms' development and thus exhibits effects on a systemic level. The connections between firms and system are made up by relations.

The discourse on cluster evolution can thus be summarised to focus on three levels, on which dynamics take place: firstly the firm, secondly relations among actors and thirdly the system. Albeit partly overlapping, the driving forces are depicted along these three lines. **(← p. 598)**

3.1 Driving forces on the level of the firm

Two driving forces stand out on the level of the firm: (organisational) routines and spin-off processes. **Routines** are an important concept for evolutionary economic geography and can broadly be summarised as company specific competences, their repeated interaction patterns, operational processes or simply the memories of firms where these competences are stored (Nelson and Winter, 1982; Becker et al., 2005; Metcalfe, 2005; Frenken and Boschma, 2007; Kinder and Radwan, 2010). Routines determine the activities of firms consciously and unconsciously. Due to their individual routines, firms differ in learning and adaptation processes, in creating or storing knowledge and in

operating on markets. These firm specific routines lead to divergence in their economic performance and competitiveness. “Firms compete for market shares on the basis of their specific routines that they built up and improved upon in the past” (Boschma and Frenken, 2009: 152).

In terms of Darwinian principles the existing variety of routines in an economy represents the selection basis. Competitive pressure forces firms to develop technological or organisational innovations in order to modify their existing routines and experiment with new routines. These routines are acted upon by the selection principles of market selection that decide which routines currently fit best. Firms with poorly adapted routines are pushed out of market competition with a higher probability. In an economic system the principle of heredity occurs through the reproductive mechanism of transferring well-adapted firm routines to subsidiaries, branches or spin-offs (Metcalfe, 2005; Essletzbichler and Rigby, 2007; Wenting, 2009). In this context routines are sometimes paraphrased as organisational DNA. During the process of transfer from the incubator organisation, modifications and gradual adjustments (mutation) are made either by conscious and unconscious search-, learn- and experiment processes or by intended imitation of successful examples. These processes of gradual adjustment emphasise that current routines usually build on structures of their antecessor routines but often deviate in parts from them. Hence, **path dependencies** based upon the development, modification and transferring of successful organisational routines are in place, which are typical for evolutionary economic processes (Nelson and Winter, 1982; Metcalfe 2005, Frenken and Boschma, 2007; Maskell and Malmberg, 2007).

Highly competitive routines are created not only by innovation processes but also by **spin-off processes**, when in the process of new firm foundations modifications of already well adapted routines are taking place (Mossig, 2004; Boschma and Frenken 2006).

Competition as a selection device also drives the ongoing search for new competitive routines and thus creates novelty.

The importance of this purposeful search for economic evolution represents an important argument for analysing the strategic actions and decisions of the individual firms empirically. Thus, it has to be examined whether the individual firm specific routines in the packaging machinery clusters in Schwaebisch-Hall and Mittelhessen differed significantly in terms of their variety and adaptability to the selection context and thus constitute an explanatory factor for the observed differences in cluster development. If there are differences, then it is crucial to look at the reasons for their distinctiveness. According to the reasoning above heredity via spin-off processes as well as the adjustment of firm specific strategies have an impact on the firm specific routines. Thus, a perspective on individual actors is crucial in order to understand changes in clusters (Belussi and Sedita, 2009; Martin and Sunley, 2010; Boschma and Fornahl, 2011).

3.2 Driving forces on the level of relations

Relations among actors represent a constitutive element of clusters. The change of these relations therefore influences cluster evolution in general, too. Three driving forces are discussed: localized learning, rivalry and trust relationships, as well as cluster policy. (2)

Localized learning (via 1. direct interaction; 2. monitoring of rivals and combining the results with own knowledge; 3. social neighbourhood effects; 4. labour mobility) explicitly focusses on the transfer of knowledge through intended or unintended relational processes (Malmberg and Maskell, 2002, 2010). These processes are spurred by cognitive and **(← p. 599)** spatial proximity and facilitate the exchange of implicit knowledge, especially. This way cluster advantages can be exploited. In the same vein they tend to

lead to a reduced variety between competitors in a cluster because knowledge is adjusted to the knowledge of other firms when learning from them (Malmberg and Maskell, 2010). The concept of *functional myopia* from cognitive psychology illustrates that firms are bounded rational and especially locally biased in searching for optimal solutions: "Local exploitive search, i.e. looking for answers close to already existing solutions while utilising existing routines is preferred (….)" (Maskell and Malmberg, 2007: 606). Thus, the creation and acquisition of knowledge by localised learning processes in clusters constitute an important driving force over time.

Maskell and Kebir (2006) identify building blocks from various sources of the cluster literature (Marshallian Economies, Porter, Innovative Milieus) and demonstrate how **rivalry and trust relationships** constitute important driving forces. They systematise the respective arguments into a temporal and logic sequence of three stages: existence, extension and exhaustion. With focus on competitiveness, Maskell and Kebir (2006) point to the importance of rivalry between co-located firms of the same industry, where the easy diffusion of knowledge and signal effects prove promising for other firms or entrepreneurs in the early stages of the industry and reinforce the cluster´s growth. Eventually, intra-cluster forces like decreasing domestic rivalry among other factors, can cause the exhaustion argument (Porter, 1998; Maskell and Kebir, 2006). By contrast the perspective of Innovative Milieu (Camagni, 1995) stresses that pre-existing social capital and local sets of values reduce the uncertainty and offer possibilities for cooperation, collective innovation and learning processes. Relational capital is created by cooperation and interaction between the actors of a region. During extension, the resulting local and regional networks (and thus their evolution) define which actors constitute the local co-ordination system and which do not. Exhaustion in turn can occur "[…] when

opportunistic behaviour causes defiance or again when outward openness remains inadequate to ensuring enlargement of the new co-operation relationships or the replacement of technologies“ (Maillat, 1998: 119).

In recent years **cluster policy** has become a highly fashionable tool for economic development and innovation policies. Although it is difficult to evaluate the effects of activities and hence critical voices are growing, national as well as regional and local governance actors have been eager in promoting and implementing cluster-oriented policy actions (Raines, 2002; Borras and Tsagdis, 2008; Brenner and Schlump, 2011). Albeit offering a plethora of possible intervention fields for cluster policy in principle, a key measure is the support for network structures in regional clusters to improve cooperation, often concentrated on funding for cluster management organisations and similar infrastructures. It is widely accepted that clusters cannot be created from scratch but, depend on many different factors, in what way policy drives the further cluster evolution, such as the commitment of actors, the respective industry and the activities tailored especially to the targeted cluster and (Brenner and Schlump, 2011; Schieber, 2013). As in both clusters very similar cluster policy activities are carried out, a comparison seems appropriate.

3.3 Driving forces on the level of the system

From recent conceptual approaches we can derive a third perspective on cluster evolution by implying the existence of driving forces on the level of the system. These include superior ordering principles which in turn affect the firms and relations, namely processes on markets and the change of clusters' heterogeneity.

At first the **market** as systemic driving force implies that there is an increase in demand as most important driving force for an industry in which the cluster actors are active in. In the industry life cycle approach, clusters are considered to be beneficial environments for firms in an early stage of an industry compared to dispersed firms due to emerging positive local externalities. As the industry matures, technologies and production processes become more standardised. Thus, the advantages of co-localisation change and become less important. Global competition and disadvantages of agglomeration come into **(← p. 600)** play and finally the firms of the industry disperse spatially (Arthur, 1994; Audretsch and Feldman, 1996; Klepper, 1997; Swann, 1998; Press, 2006; ter Wal and Boschma, 2011).

Therefore, cluster evolution is also driven by the evolution of the respective industry which is driven by technological development, but does not follow on a one-to-one basis. Risking oversimplification, one can say that the growth of an industry is accompanied by growing clusters, while the maturing or decline of an industry is accompanied by shrinking clusters. In addition, different industries and firm populations exhibit specific market conditions (e.g. innovation-driven vs. cost-driven, international vs. local) and these conditions affect the purposeful search for new routines and the adjustment of existing firm routines. Therefore, the interplay between markets and individual firms, and mutual reactions on changes to them, theoretically contribute to cluster evolution. However, both clusters of our case study belong to the same industry. But the positive development of the packaging machinery industry in Germany in general has resulted in two distinctive cluster developments. This phenomenon can only be explained by segmentations within the industry and different consequences of the market towards the two clusters.

Menzel and Fornahl (2010) have developed a seminal model of cluster life cycles, in which the key factor is the changing **heterogeneity of competences** existing in a cluster. This results in a cluster life cycle with four distinct stages: emergence, growth, sustainment, and decline.

During the process of a cluster life cycle quantitative and qualitative changes occur. The quantitative dimension describes the economic development of a cluster, for example in terms of numbers of companies or overall employment. By comparison qualitative changes relate to a connection between growth and the heterogeneity of existing competences in a cluster. Heterogeneity is understood as technological distances between the companies and institutions of a cluster. Tichy (2001: 186) refers to this connection as a *cluster paradox*, because a narrow specialization of a cluster enhances its efficiency, but it makes it more difficult to generate radical innovations. If firms exhibit technological similarities, the likelihood of making use of synergies between them is higher, but it is less likely that more radical innovations occur due to the lack of diverse inputs. Hence, the danger of a negative technological lock-in is evident. Meanwhile, when clustered firms are technologically more heterogeneous, it is difficult and less probable for them to generate synergy effects. But the cluster as a whole displays a more diverse development path and is thus more capable of adjusting to dynamic challenges. Furthermore, the probability of radical innovations would be higher due to the availability of various possible inputs.

From the connection between quantitative and qualitative development of a cluster Menzel and Fornahl conclude that the "…heterogeneity of its knowledge is the foundation of its development. The cluster decreases when its heterogeneity cannot be sustained" (Menzel and Fornahl, 2010: 218). But they also argue that there is no inevitable

determination for a cluster to end in the declining stage based on its shrinking heterogeneity and thus they add feedback loops to the model due to the possibility of an increase in heterogeneity.

In a second step they demonstrate that the processes of localized learning (Malmberg and Maskell 2002, 2006) are of crucial importance for cluster firms to exploit existing heterogeneity of the cluster. In turn localized learning affects the heterogeneity of the cluster. When learning from each other firms move into technological directions of other firms (*myopia*, ch. 3.2). Especially successful firms serve as examples. This may lead to a dominant design within the cluster. Thus, technological distances and hence heterogeneity between the firms declines. In order to sustain heterogeneity, integrating new knowledge and thus learning processes are necessary. These take place especially outside the technological or geographical boundaries of the cluster. International knowledge sources can be accessed via global pipelines and can be integrated into local networks of a cluster (Bathelt et al., 2004).

According to this line of reasoning the technological distances of the clusters` firms have to be researched in order to explain the distinctive evolutionary trajectories of the clusters. Thereby it has **(← p. 601)** to be tested if the clusters exhibit differences in the utilisation of their heterogeneity. To what extent have the four processes of localized learning been exercised in both clusters and do different consequences result from this by narrowing or broadening the heterogeneity over time? In investigating these processes it is also necessary to examine the relations across technological and geographical boundaries of the clusters for the integration of external knowledge keeping the heterogeneity high.

From the threefold reasoning above we can identify guidelines for the empirical research explaining the differing trajectories of the two packaging machinery clusters in Schwaebisch-Hall and Mittelhessen. Firstly on the level of the firm, referring to the conception that the firm specific routines are a decisive factor in competition for market shares; we have to analyse evidence of more successful routines in Schwaebisch-Hall than in Mittelhessen as well as the origins of these routines. Therefore, processes of heredity and firm specific strategies should be detected. Secondly on the level of relations, we have to analyse to what extent the processes of localized learning took place. Furthermore, a change of rivalry and trust relationships should be considered in our analyses of cluster dynamics. Moreover, cluster policy as attempt to facilitate cooperation and create benefits should be considered in the empirical part. Thirdly on a systemic level, our discussion of the industry driven approach to cluster life cycles prompts us to investigate technological difference between both clusters, as well as consequences of market developments and how the clusters actors reacted to this. Finally the cluster's heterogeneity and how it can be utilised and renewed has to be considered. Thus, processes of localized learning and the integration of external knowledge sources need to be researched as explanatory factor for the diverging development, too.

Tab. 1: Driving forces of cluster evolution derived from the conceptual approaches

Driving force	**level**
Adjustment of routines	Firm
Spin-off processes	Firm
Localized learning	Firm, relation, system
Change of rivalry and trust	Relation, system
Impact of cluster policy	Relation, system
Change of cluster´s heterogeneity	Relation, system
Markets and competition	System

Source: Own compilation.

4 Data and methodology

In order to capture the complexity of the various mechanisms and potential causal relations for cluster evolution which have been deduced from the theoretical considerations in chapter three, semi-structured interviews were conducted with executives of the cluster´s firms and additional governance actors. In 1998 and 2010 case studies were carried out and each was conceptualised as complete survey of all identified packaging machinery firms respectively in both clusters. The case study of 1998 mainly focused on localisation effects, firm-specific characteristics and spin-off processes that led to the emergence of the clusters. In Schwaebisch-Hall, 21 semi-structured interviews with firms were carried out in this first investigation. Only four firms refused their participation. Another three firms were subsidies of already interviewed companies with the same CEO as potential interviewee. In Mittelhessen 24 of the identified 27 firms answered the questions. In addition to that seven firms located outside the two case study clusters were interviewed as control group. Therefore, the total number of interviews in this first investigation was 52 (Mossig 2000, 2005).

The second survey in the two clusters was carried out in spring and autumn 2010 and included several aspects from 1998 for a comparison, but also additional questions derived from the literature of cluster dynamics. Again, all firms identified were asked for an interview. In effect, 25 interviews with packaging machinery firms in Schwaebisch-Hall were conducted. 14 of these firms were surveyed twelve years ago. Four additional interviews were carried out with governance organisations supporting the cluster. The number of interviews in Mittelhessen was 24 (19 firms and 5 governance organisations, of which 13 firms had been surveyed in 1998 and **(← p. 602)** 2010). A further cluster initiative called "Packaging Excellence Center" was set up in the greater Stuttgart Region during the observation period. An additional 22 interviews (17 firms and 5 governance organisations) were carried out in 2010. The information from this part of data collection mainly serves to verify the observations on processes in the context of the addressed research questions in this paper and can therefore be seen as a control group. In total 75 interviews were carried out during the second investigation. Qualitative data from the face-to-face interviews was aggregated and thus the development of the cluster´s firms could be reconstructed as well as cluster-specific processes were identified. Furthermore, secondary data was collected from various sources like the German Engineering Federation (VDMA), the ministries of economics and commercial databases (Schieber, 2013).

5 Factors for differing cluster evolution

At the outset of the introduction, attention was already drawn to the fact that actors in both clusters have perceived classical localisation economies in terms of labour market

pooling and intermediate inputs positively. The contrasting development in Mittelhessen and Schwaebisch-Hall therefore illustrates that these factors constitute a necessary, but not a sufficient condition for positive cluster growth. In the following chapter, empirical results concerning the reasons for the contrasting trajectories are depicted alongside the factors, which have been deduced from the conceptual considerations presented in chapter three.

5.1 Results: The firm level

According to the theoretical considerations, one could expect the Schwaebisch-Hall firms to be in possession of distinctively stronger **routines**, resting on evolutionary economic principles of heredity and path dependency. The family trees (Fig.1 and 2) demonstrate that nearly all firms are spin-offs. Major parts of the routines are adopted by **spin-offs** through the process of foundation from their incubators. Thus, both clusters are characterised by strong path dependencies with regard to employed technologies, organisational processes or customer industries (Klepper, 2002; Boschma and Wenting, 2007; Belussi and Sedita, 2009; Menzel and Kammer, 2012). The family trees clearly reflect that out of the less successful incubators in Mittelhessen only few successful spin-offs were founded. In Schwaebisch-Hall the most important incubators, as well as their spin-offs have grown on a wider base. In Mittelhessen, only one firm functioned as a central root of the cluster, whereas the seedbed in Schwaebisch-Hall is based on three different sources. As a consequence the two clusters differed according to their employed technological techniques and products right from the start. This has not been changed in Mittelhessen since then, as the same type of machine is still mainly produced by nearly all of the firms. The firms simply narrowed their focus to this type to the point where only marginal improvements are possible. One quote proves that

"[most of the firms in Mittelhessen have] found their inferior, but at least a position in the market and no one has come up with the idea of doing anything else." (Interviewee MHE-4)

Those few firms that developed successfully in Mittelhessen, broke out of the dominant technological principle and started building different machines or switched to different organisational structures.

The narrow focus in Mittelhessen and the broader orientation in Schwaebisch-Hall were already observable in 1998. The relatively bad performance of the packaging machinery industry in Mittelhessen can apparently be traced back to the lack of a second or third technological line, of which fruitful cross connections and innovation can stem from. The danger of a negative lock-in due to the lack of differentiation, low heterogeneity and adhering to old routines was mentioned several times during the survey. The following quote underlines that:

"In a business where you feel at home you know where the land lies. If I start something new, I step into a terrain with competition. That is a risk that keeps people away from doing so." (Interviewee MHE-6)

In Schwaebisch-Hall by contrast, the employed technologies were differentiated. The firms of the **(← p. 603)** cluster built upon a broader and more sophisticated knowledge base and were able to absorb and integrate a variety of inputs. In this process, the firms were driven by high margins and demands of their customer industry. By doing so, new niches for spin-offs and firm foundations were created and the firms more often originated

from more than one parent, thus combining and utilising more diverse knowledge (as can be seen in the family trees). There were eleven spin-offs and firm foundations since 1998 in Schwaebisch-Hall. In Mittelhessen only four new firms were founded, of which three resulted from the decline of the same mother firm.

A further example for the interplay between inherited firm characteristics and their further development through firm strategic decisions is the implementation of new organisational firm routines. For example, spin-offs usually apply the focus on specific customer industries of their incubator firm when establishing their own business. The firms in Schwaebisch-Hall had a much higher strategic growth orientation and set up more professional business structures. In general, when firms grow, they reach certain thresholds that require reorganisation of business structures like human resources, sales management or marketing that in turn reinforce their growth (Lloyd and Dicken, 1972; Taylor and Thrift, 1983). This has rarely been achieved in Mittelhessen. Most firms are still organised like craftsman´s firms. This lack of structural adjustment impedes company growth in Mittelhessen, while firms in Schwaebisch-Hall succeeded in adjusting their organisational routines.

Furthermore, the clusters differ in their M&A activities. The leading packaging machinery firms in Schwaebisch-Hall followed a strategic growth orientation of acquiring their competitors, to internalise their market access and know-how and to profit from scale effects for company growth. In contrast, five firms in Mittelhessen were bought by external rivals. Two firms were acquired by Italian competitors and three firms by German competitors. Due to external acquisitions, know-how was shifted away and jobs

were relocated because the new owners removed important business functions away from the firms in Mittelhessen and transferred them to the company headquarters.

5.2 Results: The level of relations

The four mechanisms of localized learning were observed in both clusters with the following results: At first there are **direct cooperation activities** in Schwaebisch-Hall. Some of them can be attributed to the cluster policy initiative "Packaging Valley". This mainly concerns the fields of marketing, joint purchasing and the exchange of experience. Except for four bigger firms, all relevant cluster actors are members of the cluster initiative. 94 % of the surveyed member firms confirmed to have had better personal-informal relations with the other cluster members and 80 % reported of a higher willingness to cooperate because of the cluster initiative. Further cooperation on a horizontal level between the packaging machinery producers only exists if the firms work in complementary fields. These complementary competences are then brought together in order to provide the customer with complete machine lines from a single source. However, such cooperation is usually induced by the customer and doesn't include strategic activities intended by the packaging machinery firms like joint developments or the purposeful exchange of innovation-relevant information. On a vertical level between the packaging machinery producers and supply firms, as well as service contractors, some attempts are made to find joint solutions for problems encountered. In Mittelhessen hardly any cooperation activities are verifiable. On a horizontal level, cooperation takes place only if the enterprises work in complementary fields, too. Some enterprises in Mittelhessen regret this.

„With regard to cooperation, if it comes to develop a machine jointly or to collaborate in sales, [...], no, forget about it (...). Everyone here is always frightened to get nicked off something. It really is a pity. Since there are firms here, which are specialised on something and others on something else. At this point good cooperation could be possible." (Interviewee MHE-18)

On a vertical level, cooperation is more intensive. Altogether, the direct cooperation relationships in Schwaebisch-Hall are both more pronounced on horizontal and on vertical level than in Mittelhessen. **(← p. 604)**

The second mechanism is the **monitoring of competitors and combining the results with internal knowledge**. Roughly 68 % of the interviewed firms in Schwaebisch-Hall confirmed that they benefit from being located in the agglomeration because of such learning processes. In Mittelhessen, this kind of localized learning takes place to a lesser extent. Only 47 % of the firms confirmed this. One interviewee pointed to the effect of spatial proximity when monitoring the competitors as follows:

"You get to know faster what is going on at the competitors." (Interviewee SHA-11)

The third mechanism of localized learning is based upon **social neighbourhood effects**. There is lots of evidence validated by several similar quotes that this is taking place in both clusters, particularly due to frequent meetings at private or public occasions. A catchy example in Mittelhessen has been given on how this local buzz had very specific consequences of knowledge exchange:

"Of course, you try to keep new developments secret […] But you simply have no control over the information flows, because some people of firm X play football together with firm Y and sometime later, also firm Y develops the same machine as firm X had done short before." (Interviewee MHE-3)

Moreover, the important actors know each other due to spatial proximity and they can therefore get information in a faster and easier way informally.

Labour mobility acts as the fourth mechanism of localized learning. Albeit not quantifiable in a reliable way, employees who change jobs between firms of the packaging machinery industry carry knowledge which they have acquired over years and thereby act as media of localized learning processes.

"Everything circulates due to the change of staff. Every firm somehow cross-fertilizes the other firms. (…) Know-how is exchanged, too. Now, there are a lot of rumours about what has been exchanged. Rather unpleasant. So then you are better off if you are located somewhere where there is no competitor nearby. There, this problem will hardly appear." (Interviewee MHE-3)

The latter quote illustrates a particular scepticism towards such intended or random exchange processes in Mittelhessen which could be noticed in several interviews. In contrast, firms in the Schwaebisch-Hall cluster rate the effects of these exchange processes more positively than the firms in the Mittelhessen cluster.

The **balance** of **trust**, local networks and cooperation on the one hand, and competition as well as **rivalry** on the other hand can also be identified as a relational driving force for the distinct cluster evolutions in Schwaebisch-Hall and Mittelhessen.

The study conducted in 1998 concluded that attempts of cooperative relationships could be noticed only occasionally in both clusters. If cooperation took place, it was usually in terms of market relations between suppliers and customers. Accordingly, relationships sparsely based on partnership were criticised in both clusters (Mossig, 2000). This has changed noticeably in Schwaebisch-Hall. Altogether, the cluster underwent a change towards greater openness. This is reflected in the cluster initiative of Packaging Valley which can simultaneously be regarded as a result of stronger cooperation, as well as a medium for further partnership. Some activities conducted under the heading of the Packaging Valley initiative were unthinkable at the time of the first study in 1998. Exchange of experiences and information, joint marketing activities including trade-fair participation or training courses are effective in building stronger trust, as well as obtaining pecuniary benefits for the firms. Point of departure for the cluster initiative was a joint lobbying of firms to attract a university of applied sciences to the city of Schwaebisch-Hall. In the meantime, likewise joint activities have been undertaken to secure and expand the vocational training capacities for the packaging machinery industry in Schwaebisch-Hall. As a response to the open question about changes in cooperative relations, 68 % of the surveyed firms stated altogether that the relationships within the cluster have improved.

> *"Fifteen years ago you couldn't have done the cluster initiative. Back then, the entrepreneurs were more narrow-minded." (SHA-23)* **(← p. 605)**

On the other hand, the local competitive environment in Schwaebisch-Hall is regarded to be very pronounced. Many worldwide leading producers of packaging machines are located in close proximity to each other. This actually spurs and motivates many firms and acts as a driving force for an increase in productivity (Porter, 1998). One quote represents many opinions:

> *"Our employees are motivated completely differently than if the competitor was located in China. The employees meet the colleagues of our competitors in the tennis club or in the pub in the evenings […]. Every day you are reminded that there is a firm close by which also wants to be successful." (Interviewee SHA-10)*

Yet, cooperative relationships beyond market relations still hardly exist in the cluster in Mittelhessen. In 2009, a cluster initiative was set up and financed by the Federal Ministry of Economics in Hessen to bring together the existing strengths. But only one relevant firm of the packaging machinery industry participated in this initiative. All the other key players didn't want to take part, especially due to distrust and rivalry between the firms and because they did not expect any benefit. In trying to implement almost the same cluster policy activity like in Schwaebisch-Hall, this attempt to improve relations between actors turned out as a negative example of how an inward looking mind-set and distrust among actors can inhibit positive effects of cluster policy implementation as a successful driving force. Altogether, there has been no change towards greater openness and exchange in Mittelhessen as two assessments prove:

"It´s even getting worse. There´s so much isolation here." (Interviewee MHE-18)

"It was hard rivalry already back then, but it has not become more open. Quite the contrary, they have all grown ten years older. Such personality structures rather intensify and grow worse." (Interviewee MHE-4)

Summarising, none of the interviewed firms from Mittelhessen responded to the open question about change that the relationships among each other have improved by tendency, against the comparison of 68% in Schwaebisch-Hall.

The local environment is regarded as highly competitive in Mittelhessen. In contrast to the situation in Schwaebisch-Hall, this is not valued as a motivation or spur. Predominantly, the cluster is associated with intensified rivalry for orders and employees, which leads to a strong personal distrust.

5.3 Results: The systemic level

The **market** as a systemic driving force exhibits some major observable implications which affect the clusters´ evolution on superior level. In Mittelhessen most of the packaging machines are constructed for the food industry, while in Schwaebisch-Hall the major part is constructed for the pharmaceutical industry. This has three severe consequences: Firstly, pharmaceuticals had much higher growth rates during the last years than the food industry. Thus, firms in the Schwaebisch-Hall cluster could grow simultaneously. Secondly, the firms could benefit from higher profit margins in the pharmaceutical industry. And thirdly, the pharmaceutical industry poses much higher

technological requirements than food industry. Clean room technology, much more refined measurement techniques, optical control systems, higher safety demands and control technologies lead to higher innovation efforts for the producers in Schwaebisch-Hall. The customers demanded more innovation and the Schwaebisch-Hall firms could fulfil these demands. Thus, there is a reciprocal connection between the challenges imposed by markets and the reactions from individual cluster actors.

The Schwaebisch-Hall firms are more innovative and manage a much broader technological range than the firms in Mittelhessen. The technological advantage in the Schwaebisch-Hall cluster underlines the finding that cluster life cycles within one industry can vary significantly when such technological differences exist. As a consequence, the firms in both clusters are confronted with distinctive challenges from the international competitive environment on their respective markets. Surveyed firms in Mittelhessen rate the changes in the international competitive environment during the **(← p. 606)** observation period from 1998 to 2010 as much fiercer than the Schwaebisch-Hall firms did (see Tab. 2).

Tab. 2: Rating of surveyed firms in the Mittelhessen and Schwaebisch-Hall clusters how international competition evolved over the last 12 years

	much weaker ←					→ **much more fierce**	**Average**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	
Schwaebisch-Hall	4%	11%	29%	21%	29%	7%	**3,8**
Mittelhessen	- -	- -	- -	36%	61%	4%	**4,7**

Source: Own survey.

Many interviewees emphasised strongly that the intensification of international competition mainly results in cost pressure for the Mittelhessen firms. On the other hand in Schwaebisch-Hall the firms reported that the international competition is mainly decided by innovations. Firms in Schwaebisch-Hall built up the required expertise and competences to satisfy the demands for higher quality of their customer industry, with appropriate innovations. Thereby, they succeeded in achieving worldwide quality and technology leadership over time. In Mittelhessen mainly the price is the decisive competitive factor. Innovations are less crucial, but incremental adjustments of the prevailing machine type towards the specific needs of the customers´ products usually take place. Two interviewees commented on this:

> *"Nowadays, you have only few opportunities in terms of technology because it is so matured and everybody knows everything. That becomes a question of price." (Interviewee MHE-5)*

> *"Often innovation pressure [in the food industry] fails because of feasibility and the price which the packaging constitutes relative to the product price." (Interviewee MHE-4)*

Also the second systemic driving force of **change of the cluster´s heterogeneity** was investigated on during the case studies. The four mechanisms of localized learning took place in both clusters (*ch.* 5.2). Particularly direct cooperation occurred more intensively in Schwaebisch-Hall compared to Mittelhessen and the firms in Schwaebisch-Hall consider effects of localized learning more positively than in Mittelhessen. According to Menzel and Fornahl (2010) the competences in a cluster converge when the firms

intentionally or unintentionally learn from one another. The heterogeneity would decline. But in Schwaebisch-Hall, several factors supported the heterogeneity to be renewed and stay high, while in Mittelhessen the heterogeneity among the firms in the cluster decreased.

As observable in the family trees, the Schwaebisch-Hall firms expanded quantitatively and technologically based on the initial higher variety and greater heterogeneity. Innovation demands from customers urged the firms to integrate new technologies and processes, as shown above. The cluster actors thus retrieved the accessible and circulating knowledge, because the producers of packaging machines as well as their suppliers were constantly confronted with new challenges. In fulfilling these demands they upgraded their competences. This process was supported in exchange with sophisticated and innovative international customers, which is an important source for external knowledge:

> *"We have a very close contact to the international pharmaceutical global players. […] We are tapping into their know how and integrate it for ourselves. This results inevitably from that because you talk to them at eye-level and get to know lots of things." (Interviewee SHA-8)*

The firms in Mittelhessen notice these innovation demands to a much lesser extent. Furthermore, the integration of new knowledge via external cooperation as well as M&A from key players was carried out to a higher degree in Schwaebisch-Hall than in Mittelhessen. And because of the greater demand, more external service providers and suppliers with new competences settled in Schwaebisch-Hall. Asked to rate various

sources of innovation, these external service providers and suppliers are valued significantly higher in Schwaebisch-Hall (3,0) than in Mittelhessen (3,6). (3)

Finally, sources of innovation external to the cluster were rated as more important in Schwaebisch-Hall when compared to Mittelhessen. In particular **(← p. 607)** the cooperation with research institutions and universities in concrete projects (SHA 3,2 – MHE 4,0) as well as the attendance of trade fairs to screen technologies from competitors or related industries (SHA 2,4 – MHE 2,7) were rated more important in Schwaebisch-Hall than in Mittelhessen. The integration of such external knowledge sources in a cluster is extremely important in order to avoid a negative lock-in due to the exclusion of new knowledge. In Mittelhessen, there is clear evidence of the cluster facing such a functional lock-in. External knowledge generation and new inputs from outside are scarce and thus the heterogeneity of the cluster has decreased:

> *"You can see that the machines are getting more and more the same. Is it now firm X or firm Y? Firm Z also builds them in the same way now, they had been completely different before." (Interviewee MHE-5)*

This does not mean that the cluster inevitably has to diminish and disappear, because as shown in the family tree, a few firms still exhibit positive developments. Nevertheless a severe risk of losing the competitiveness is considered evident for most of the cluster actors.

6 Conclusion

The example of the packaging machinery industry in Germany shows that clusters do not grow per se. We derived driving forces from recent conceptual approaches to cluster dynamics, which guided the empirical analysis. By means of qualitative interviews with CEOs of cluster firms and further governance actors we exemplified these driving forces empirically, showing how the driving forces are at work for two concrete case studies. This way we identified the main reasons for the distinctive cluster evolutions over a period from 1998 to 2010. Processes on three levels (firm, relation, system) take place and can explain the more successful cluster trajectory in Schwaebisch-Hall, albeit they are highly interdependent and partly overlapping.

Firms in the Schwaebisch-Hall cluster have much more successful **routines** which have developed path-dependently due to **spin-off processes** in combination with purposeful strategic decisions of the firms. The cluster in Schwaebisch-Hall is based on three different strands while in Mittelhessen there is mainly one technology as basis for spin-off processes. Only few firms in Mittelhessen were able to develop out of this narrow technology path.

The balance between **rivalry** and **trust relationships** is more positive in Schwaebisch-Hall than in Mittelhessen. The mind-set in Schwaebisch-Hall has become more open but positive motivating effects of local rivalry are nevertheless in place. Relationships in Mittelhessen have grown worse towards even more distrust. Local competition and rivalry is not seen as motivating but as leading to isolation. The implementation of **cluster policy** in the same vein has very different outcomes, although activities are more or less the same. Relations are not improved through the policy in Mittelhessen, while the cluster initiative in Schwaebisch-Hall facilitates aspects such as cooperation and joint marketing.

The more successful routines are also reflected in the focus on specific customer industries (pharmaceuticals vs. food products industry), the strategic growth orientation through M&A activities and the purposeful set up of more professional organisational business structures. Altogether, a higher technological variety and a more innovative firm behaviour in the Schwaebisch-Hall cluster could be observed. Accordingly, **markets** impose different challenges to the two clusters being an important driving force and cause an interplay with firm specific routines which drives cluster evolution. International competition is perceived in Mittelhessen as more fierce and leading to increasing cost pressure. In Schwaebisch-Hall, most of the firms perceive the international competition as causing innovation pressure. The four processes of **localized learning** take place in both clusters intentionally as well as unintentionally. This leads to the exploitation of the existing heterogeneity, so that the firms can make use of local externalities. But external knowledge sources are better integrated in Schwaebisch-Hall and this maintains **high heterogeneity**. Thus, the Schwaebisch-Hall cluster is still situated in the growth stage of the cluster life cycle. The Mittelhessen cluster on the contrary is characterised by a shrinking heterogeneity and a negative functional and cognitive lock-in of the actors. **(← p. 608)** Regarding the cluster life cycle, the Mittelhessen cluster is positioned between the sustainment and decline stage.

Strong path dependencies in clusters due to spin-off activities and hence transferring of routines are in place. Nevertheless, individual firms always have the chance to break free of their inherited routines and develop their strategic direction further. This contingency of firm strategic decisions in combination with path dependently developed routines should be incorporated in future research to cluster evolution. Furthermore, technological differences and different market environments can impose different challenges on clusters

even within the same industry, which lead to different cluster evolutions and distinctive cyclical developments. The relationship between the exploitation of cluster heterogeneity via localized learning and the associated change of knowledge, as stated by Menzel and Fornahl (2010), could be confirmed. Due to interdependencies between the driving forces it appears not adequate to rate the effects of individual driving forces and separate more important from less important factors. Results from our research thus call for a thorough integration of driving forces in case studies to understand why and how clusters evolve. In this respect we demonstrated that the three levels of firm, relations between actors and the system are important differentiating levels for analyses of cluster evolution. Moreover, the empirical results reveal in which way the conceptually derived driving forces for cluster evolution are at work in concrete examples and thus become comprehensible.

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Endnotes:

(1) For a recent critique on the concept of lock-in see Martin, 2010; Martin and Sunley, 2010.

(2) An additional relational conceptual strand of literature focuses on networks and their evolution (e.g. ter Wal and Boschma, 2011; Li et al., 2012). However, applying this in a reliable way first of all would have required network analysis back in 1998 and secondly, some of the implied processes of network evolution (e.g. learning and cooperation) are captured by the driving forces of localized learning as well as rivalry and trust relationships.

(3) The scale ranges from 1 (innovation source very important) to 5 (innovation source not important).

(← p. 607)

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