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## **Triggers and Drivers of Cluster Development: the Case of Agritech in North-Western Germany**

**Dominik Santner**  
University of Bremen  
Centre for Regional and Innovation Economics  
dsantner@uni-bremen.de

### **Abstract**

University of Bremen, Centre for Regional and Innovation Economics

Year of enrolment: second

Expected final date: December 2014

Email: dsantner@uni-bremen.de

Recent concepts on cluster evolution assume that clusters develop individually depending on specific inputs of knowledge. These concepts are cleaved to a traditional simple local/global thinking. Recently several scholars introduced a multi-scalar perspective on the development of regional economies. External factors from multiple scales affect regional development in specific ways. The on-hand study follows this thinking developing a cluster specific multi-level model. In a case study on the agricultural engineering industry in North-Western Germany it is shown that knowledge dynamics originating from all scales affect the development of cluster agents with dynamics from R&D cooperation being more likely to come from the local level. Institutional factors show effects from multiple levels especially from the national one. Innovation and market related changes are triggered by factors from all scales.

# Triggers and drivers of cluster development: The case of agritech in North-Western Germany

Dominik Santner\*

December 14, 2013

**Abstract** Recent concepts on cluster evolution assume that clusters develop individually depending on specific inputs of knowledge. These concepts are cleaved to a traditional simple local/global thinking. Recently several scholars introduced a multi-scalar perspective on the development of regional economies. External factors from multiple scales affect regional development in specific ways. The on-hand study follows this thinking developing a cluster specific multi-level model. In a case study on the agricultural engineering industry in North-Western Germany it is shown that knowledge dynamics originating from all scales affect the development of cluster agents with dynamics from R&D cooperation being more likely to come from the local level. Institutional factors show effects from multiple levels especially from the national one. Innovation and market related changes are triggered by factors from all scales.

## 1 Introduction: Clusters and cluster change

Regions perform economically differently. Some regions are prosperous while others lack behind. In neo-classical approaches factors forcing change to an economy where traditionally seen as being of explicitly exogenous nature. Today scientists are increasingly aware that there should be region specific forces influencing regional economic development and causing spatial divergence.

An influential concept within this school of thinking are concepts of regional clusters (Porter, 1990; Porter, 2000), industrial districts (Sforzi, 1989; Amin and Robins, 1990) and innovative milieux (Crevoisier and Maillat, 1991; Ratti et al., 1997). Clusters are geographic concentrations of interconnected companies and organisations in a particular

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\*University of Bremen, Centre for Regional and Innovation Economics (CRIE), email: dsantner@uni-bremen.de

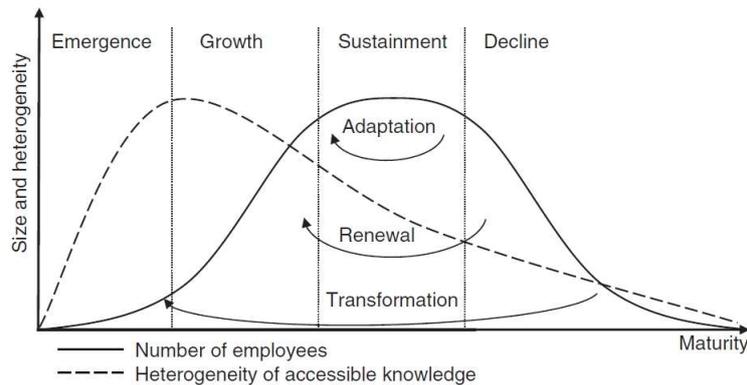


Figure 1: Cluster Life Cycle. Source: Menzel and Fornahl (2010, p. 218)

field (Porter, 1990). They are characterized by cluster specific dynamics that are the result of cluster-internal and cluster-external influences. Clusters show characteristics and dynamics that make them distinguishable from other regions with that specific industry (Menzel and Fornahl, 2010). Knowledge creation and innovation are seen to be largely results of this regional based interconnections. Menzel and Fornahl (2010) argue that the heterogeneity of accessible knowledge is the driving force of cluster development and innovation. The terms 'heterogeneity' and 'accessible' imply that the knowledge needs to be different to the knowledge base of the company to create something new. On the other hand, heterogeneity or variety must be related as too large cognitive distance between two knowledge bases would hamper adoption (Frenken et al., 2007). The outcomes of related variety (due to Jacobs externalities) are more radical innovations as different knowledge is recombined. Incremental innovations are the result of Marshall externalities.

This discussion shows that clusters are seen to be dependent on a very specific set of heterogeneity of knowledge to be innovative. Recent approaches assume that the availability of this knowledge and the capacity of companies in a cluster to use this knowledge is path dependently changing over time. Relational economic geography approaches understand economic development as an output of socio-economic interaction. Within regional contexts a 'buzz' of rumours, trust and shared cultural habits facilitates economic development (Storper and Venables, 2004). Knowledge spillovers are more likely to occur in a shared spatial context, especially within high-tech industries (Krugman, 1991). Tacit knowledge spillovers are most likely to occur in a shared cultural and regional context. Beyond the regional context different mechanisms of social interaction channel external knowledge into the regional context being the basis for radical innovation and change (Bathelt et al., 2004).

Early cluster theory remains static, not able to explain change systematically. Recently approaches from Evolutionary Economic Geography took the idea of path dependent into their agenda. In their cluster life cycle approach Menzel and Fornahl (2010) assume that the development of clusters follows a certain ideal life cycle clearly distinguishable from the global development of the respective sector. The model says that

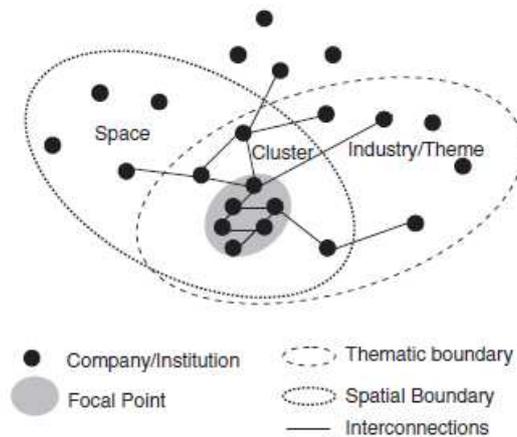


Figure 2: Elements of a cluster. Source: Menzel and Fornahl (2010, p. 214)

clusters follow different stages of development but can occasionally renew themselves at different points in their life cycle depending on the cluster specific context and history (figure 1). The driving force of growth and decline of clusters is the availability of heterogeneous knowledge. This availability depends on the absorptive capacity of the companies (Cohen and Levinthal, 1990). The concept follows the traditional local/global thinking very prominent in relational economic geography. Menzel and Fornahl (2010) follow the idea that a cluster is the overlapping and concentration of a specific spatial with a specific industrial context characterized by interconnectedness of companies and institutions (figure 2).

Menzel and Fornahl (2010) lack to explain the specific origin of technological and cognitive heterogeneity within the cluster. The identification of specific aspects explaining the origin of heterogeneity and related variety is an important research field that has to be investigated. Recently a discussion started about the question of scale in factors affecting regional development and the origin of these factors on different spatial scales and from different territorial contexts (Brenner, 2004; Asheim and Coenen, 2006; Peck and Theodore, 2007; Crevoisier and Jeannerat, 2009; Coenen et al., 2012). It goes beyond the classical local/global thinking. In the following section a picture of the heterogeneous approaches on multi-scalar influences is drawn. It shows that institutional settings (including political intervention) and knowledge dynamics have an impact on cluster development from different spatial scales.

## 2 Multi-scalar impacts on cluster development

### Institutional factors

Sectors in territorial units and their institutional environment co-evolve (Murmans, 2003; Malerba, 2006; Martin and Sunley, 2007; Schamp, 2009; Schamp, 2010; Strambach, 2010) along their specific trajectory. In general the quality and quantity of the eco-

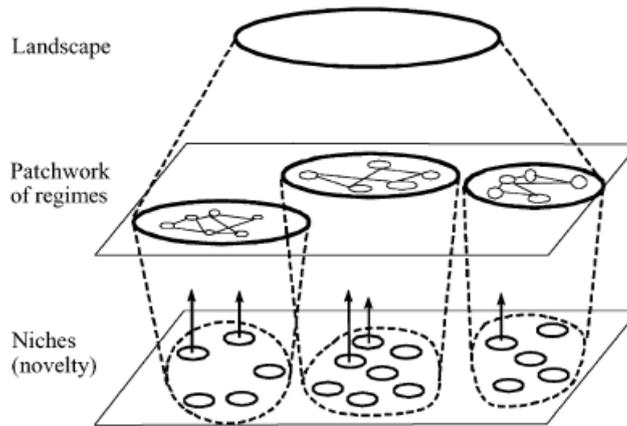


Figure 3: Multiple levels of a nested hierarchy. Source: Geels (2002, p. 1261)

conomic performance of agents and regions is a combination of different influences, like scientific knowledge, engineering practices, production processes, established user needs, regulatory requirements, institutions and infrastructures that form a relatively stable socio-technical regime (Rip and Kemp, 1998; Coenen et al., 2012).

Cluster development can be understood as a transition process, as 'system innovations' between distinctive socio-technical configurations within multiple spheres like technologies, corresponding changing markets, user practices, policy, cultural discourses and governing institutions (Geels et al., 2010; Coenen et al., 2012). This process is described within the frameworks on sustainability transition and is characterized by co-evolution and multiple changes in socio-technical systems, multi-actor interactions between social groups, radical changes in terms of scope and long-term processes over several decades (Geels and Schot, 2010).

Criticising the naïve conceptualisation of space in sustainability transition Coenen et al. (2012) argue for a geographical perspective for comparative transition analysis based on innovation dynamics. Innovation dynamics include a multi-level perspective (MLP) (Markard et al., 2012). A multi-level perspective is central for the analysis of the origin of different triggers and drivers of change in clusters. MLP is the stabilising influence of a socio-technical regime as a complex of scientific knowledge, engineering practices, production processes, established user needs, regulatory requirements, institutions and infrastructures that form a relatively stable socio-technical regime (Rip and Kemp, 1998; Coenen et al., 2012). Socio-technical regimes tend to be relatively stable and mostly resist system innovation (Coenen et al., 2012). Within such a regime 'niches' can emerge and act as spaces for incubation and innovation (Geels, 2002). The external sphere to the regime is the landscape. The concept is based on agency that emerges between the three levels (figure 3). Interventions of actors are the drivers of development and the condition for their agency is a main subject for investigation in transition analysis.

Geels' concept remains explicitly non-spatial (Coenen et al., 2012). Coenen et al.

(2012) argue in support of a more geographical perspective on transition studies. They criticise that the original approach is not sensitive to scale and that the 'global' is treated weakly as it is reduced to an external, unchallengeable force. Global production networks are however territorially bounded while local actors are able to influence them (Coenen et al., 2012). The consideration of scale is important because similar phenomena operating on different scales and representing the same underlying process can look very differently. Tacit knowledge spillovers can for example occur on the local level via face-to-face contact (Storper and Venables, 2004) while on the international scale 'epistemic community building processes' like conferences or journal communities (Haas, 1992) provide the needed cognitive proximity (Coenen et al., 2012). Coenen et al. (2012) argue that the benefits of a geographical perspective for comparative transition analysis lie in the explanatory power about these inter-scalar mechanisms and how they affect local development.

Coenen et al. (2012) draw upon the concepts of comparative institutional advantage and institutional thickness to explain spatial differences in innovation patterns. Certain institutional environments within specific territorial units have a positive influence on economic development and the technological direction of innovation in a certain industry. The concept of institutional thickness holds on at this observations of differently developing regions. It focusses on interaction within specific institutional settings and deals with the question why in certain territories governance bodies show a good performance in supporting the activities of external agents and channel them into intra-regional interaction patterns (Amin and Thrift, 1995). Coenen et al. (2012) see the two concepts of comparative institutional advantage and institutional thickness of being complementary. They combine a regional with a national perspective and are a fruitful contribution to a multi-scalar perspective on institutional development.

Concluding from these theoretical inputs Coenen et al. (2012) argue in support of a multi-level and multi-scalar sustainability transition based on three assumptions. Firstly, scale is a socio-spatial construction, an instrument of social actors to pursue their goals within spatial frameworks (Jonas, 2006). Secondly, economic activity is of relational character. The third assumption is that scales have no hierarchies (Brenner, 2001). Coenen et al. (2012) urge to resist the temptation to treat one scale as being more important than others. Scales matter because of the interaction of agents between different scales.

A specific aspect of institutional settings is the political environment economic agents are embedded. Within the concept of 'state spatial selectivity' (Brenner, 2004) a theoretical foundation to explain this coherence between the political and the economical is given. The concept is based on 'strategic-relational state theory' introduced by Jessop (1990). According to Jessop (1990) the specific form of the capitalist state is determined by its position associated to the capital circuit. State and capital remain separate spheres but are strongly interdependent and build up a functional entity. This specific set of the political sphere in the capitalist economy is call by Jessop the 'state form'. Because the state (or politics) has no direct access and power of decision over one of its major foundations, the capital, it shows a tendency to privilege persons and organisations that hold capital (Offe, 1984). According to Jessop (1990) the capitalist state shows two ways to reach this goal. The first are 'state projects'. The intention here is to change the

structure of the state directly. They are not conclusively associated with the capital. The second way are 'state strategies'. They are directly associated with capital and the privileging of its holders. Examples for state strategies are direct and indirect funding or changes in general economic policies. According to Jessop (1990) 'state form', 'state projects' and 'state strategies' form the three foundations of statehood in capitalism. All three of them depend on each others characteristics and development. Because state projects and state strategies have an impact on their basis, the state form, the concept has an explicitly dynamic and evolutionary perspective.

Brenner (2004) enhances this approach by a spatial perspective. According to Jessop's labelling Brenner's concept includes a 'state spatial form', 'state spatial projects' and 'state spatial strategies' as basic dimensions of spatial statehood in capitalism. The 'state spatial form' contains a world system of national states and their internal administrative subdivision on different scales. Based on the specific state spatial form 'state spatial projects' are applied to adjust this administrative setting including competences and power between different spatial entities and different spatial scales. Finally 'state spatial strategies' are applied to have a direct impact on the capital circuit and the holders of capital in a spatial perspective, including infrastructure investment as well as industry and labour market policies with specific impacts on certain spatial scales or in certain spatial entities. In this dynamic set of spatial statehood continuously new forms of spatial statehood emerge, that are based on earlier forms and thus form a trajectory of spatial statehood in capitalism.

In a comparative analysis of regional and urban development policies in Western-European welfare states Brenner (2004) shows that those European countries show all a similar development pattern of spatial statehood in these policy fields since the era of the Keynesian welfare-state in the early decades after World War II. State spatial projects increasingly lead to a decentralized set of power on different spatial scales and administratively more individual policies within different territorial entities. Cluster policies are one result of this development. Economic agents like companies are increasingly affected by policy intervention from different spatial scales additionally to the national level. Regions and municipalities develop increasingly own strategies to gain an economic advantage. These political strategies on the local and regional level together with national and European policies affect the development in European clusters.

These assumptions presented by Coenen et al. (2012) and Brenner (2004) show that institutional settings are increasingly of multi-scalar nature. The development of economic systems like clusters is an interplay of various factors like technology, institutions, cooperation and learning patterns as well as policy that come from different spatial scales and from different territorial entities. In the case of clusters the manifestation of this interplay is a specific localized development pattern that follows its trajectory and is occasionally affected by radical changes initiated by certain events. In the following section a closer look will be taken on the specific multi-level dynamics of knowledge dynamics.

## Knowledge dynamics

Knowledge flows are one of the best investigated possible drivers and triggers of cluster change. In line with the canonical thinking of spatiality between the local sphere and an opposite global sphere knowledge dynamics have been mostly observed from the view of proximity impacts in a global world. Different forms of proximity, for example geographic or cognitive proximity are seen as powerful catalysts for innovation and economic growth (Nooteboom, 2000; Boschma, 2005). In spatial terms everything that is not local is seen to be global regardless of the specific spatial and scalar context. Approaches and studies that follow this way of thinking belong to the rich and influential set of literature which is known as research on clusters (Porter, 1990; Porter, 2000), industrial districts (Sforzi, 1989; Amin and Robins, 1990), innovative milieux (Crevoisier and Maillat, 1991; Ratti et al., 1997). Knowledge exists in these studies in a close spatial context with specific localised dynamics, occasionally influenced by external inputs (Bathelt et al., 2004).

This bipartite way of thinking about the nature of knowledge and its dynamics does not fit with the reality of the modern economy. Crevoisier and Jeannerat (2009) remark that knowledge dynamics occur in a context beyond a simple local/global dichotomy. New transportation and communication technologies, the increase of education levels and research capacities and a growth of intangible activities within production and consumption compositions led within the last decades to a significant growth and multiplicity of knowledge that can be increasingly be mobilized over greater distances (Crevoisier and Jeannerat, 2009). Certain universal technologies like ICT were introduced in many industrial sectors. Finally, innovations are increasingly the result of socio-cultural dynamics. Knowledge is not a simple good that produces externalities but a social dynamic or collective activity that is characterised by being a sharing activity within territorial settings (Antonelli, 2006). Knowledge increasingly diffuses between people in different regions and at varying distances. The local level and local knowledge dynamics remain important and interact with other regional and scalar settings. Knowledge dynamics include joint R&D as well as client and supplier contacts. According to Nelson and Winter (1982) Crevoisier and Jeannerat (2009) point out that radical innovations are the result of external knowledge flows that lead to localised new technological trajectories creating incremental innovations. Other knowledge dynamics like human capital flows can introduce new knowledge to organisations and companies by integrating specifically skilled and diversified workers.

Building on this argumentation Crevoisier and Jeannerat (2009) develop their concepts of territorial knowledge dynamics and multi-location knowledge dynamics, combining the strength of proximity-based argumentation with the insight that knowledge becomes increasingly mobile over long distances. Economic performance is increasingly strongly dependent on agents' abilities to get access to and to use external knowledge from different thematic and spatial contexts (Crevoisier and Jeannerat, 2009). Crevoisier and Jeannerat (2009) develop a model answering the question of how knowledge dynamics in different regions with a different factor endowment and specific capabilities for knowledge creation and absorption function work. It is based on relational, circulatory as well as structuralist approaches. It highlights that learning is a territorialised multi-scalar

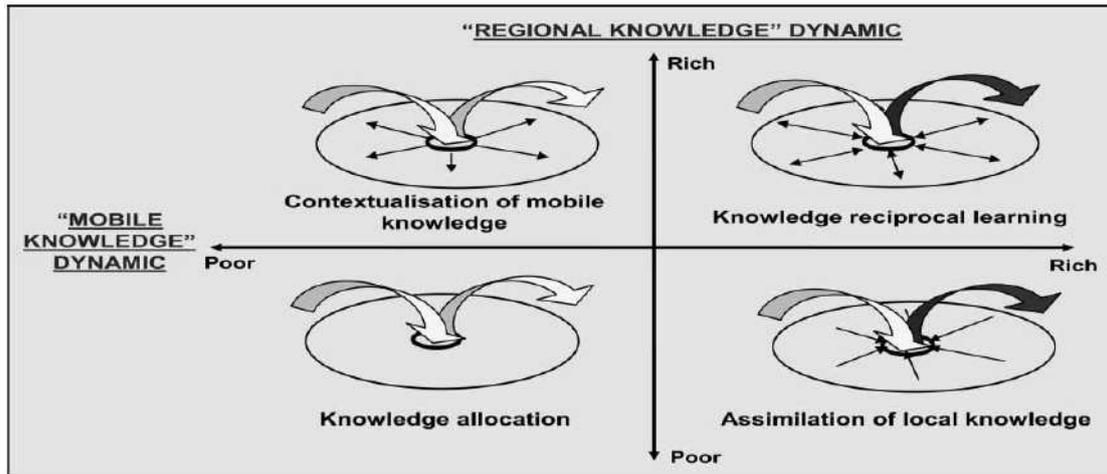


Figure 4: The mobility and anchoring of knowledge within the region. Source: Crevoisier and Jeannerat (2009, p. 1236)

and multi-locational dynamic. Different locations have different capacities to use these multi-scalar and multi-locational dynamics over distance as well as in proximity. The ability to use and absorb external knowledge is described by Crevoisier and Jeannerat (2009) with the term of anchoring. It is the immobile form of mobility. Mobility and anchoring are the two aspects of territorial knowledge dynamics. They highly depend on the ability of economic agents to understand new knowledge. Frenken et al. (2007) describe this issue in their concept of related variety. Cohen and Levinthal (1990) call this ability the absorptive capacity of the agent.

Anchoring possibly creates new knowledge by recombination of existing and introduced knowledge. Recombined knowledge is a possible source of new knowledge dynamics that can span different places and scales. External knowledge dynamics from different scalar and territorial sources possibly interact with local knowledge dynamics (figure 4). If mobile or regional knowledge dynamics are poor they can be possibly absorbed but are unable to absorb other knowledge on their own. If they are rich they can. A regional setting of agents that show rich regional knowledge dynamics will be able to absorb knowledge from external sources from different locations and scales. A set of interconnected territorial knowledge dynamics is characterized by rich proximity and distance interactions and form multi-location territorial knowledge dynamics.

### Multi-scalar perspectives on triggers and drivers of cluster development

As has been shown aspects affecting the development of regional economies including regional clusters are increasingly seen to be of multi-scalar origin and effect. The co-evolution of industries, their specific knowledge dynamics and their institutional and political environment probably shows a development towards interdependencies on multiple scales. The demand of economic agents to get access to knowledge from different spa-

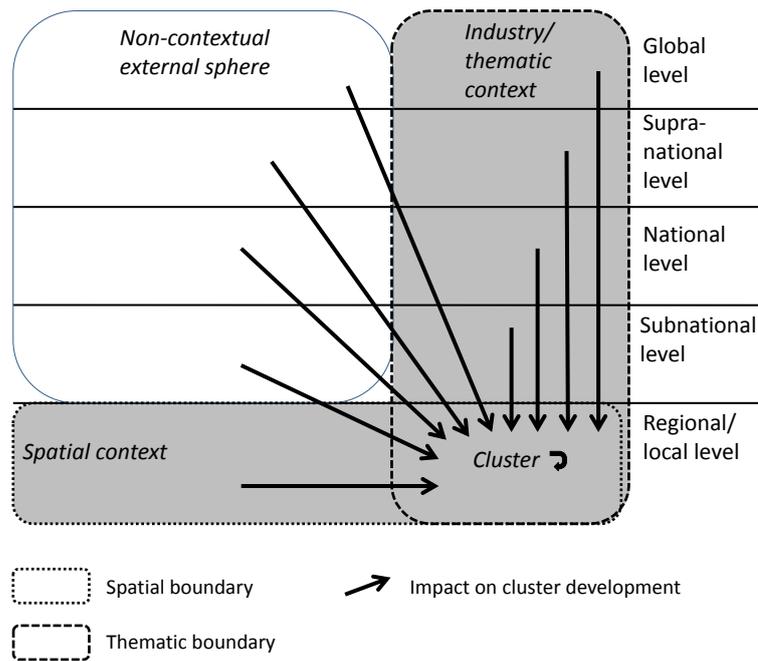


Figure 5: A multi-scalar pattern of impacts on cluster development. Source: own contribution

tial contexts leads to political strategies privileging companies in territorially and scalar multiple ways. The outcomes are not only regional specific strategies for economic development but also local political impacts from all scales. The general development of the cultural and institutional setting goes along this trend. The outcome is a self-enhancing dynamic of the co-evolution of industries, institutions and their political environment.

Because regions show different capacities to get access and to use external knowledge individual regional political strategies are likely to develop. According to Crevoisier and Jeannerat (2009) there should be different development patterns for different clusters according to their specific capacities. Cluster development is affected by impacts and mechanisms from inside and outside the cluster on multiple scales resulting in specific individual regional development patterns. A simplified model to illustrate this multi-scalar impacts on cluster development is shown in figure 5 being a step further towards a multi-scalar concept of regional economic development.

It is widely unknown where multi-scalar and multi-locational impacts of cluster development, the triggers and drivers of cluster change come from. The specific characteristics of drivers and triggers coming from different scales is unknown. In the on-hand study an investigation of these factors for a specific case study is applied. Concluding from the previous argumentation and according to this general goal three research questions emerge:

1. On which spatial scales and from which thematic context do which triggers and drivers of cluster agents development originate?
2. Which changes in cluster agent development are triggered and driven by which factors?
3. From which spatial scales and from which thematic context are these specific changes affected?

These questions are applied in the on-hand study on the case of the agricultural engineering industry of North-Western Germany. The argumentation follows the spatial and thematic categories shown in figure 5. The following sections introduce the study and the empirical results.

### **3 Data and methodology**

The on-hand study is based on the 'cluster life cycle' project funded by the European Science Foundation. The study included qualitative research on agricultural engineering in North-Western Germany. 30 semi-structured interviews with stakeholders from the cluster were held in 2012 and 2013. In total it encompasses 21 interviews with stakeholders from companies and eight with stakeholders from other organisations.

Interview partners were identified via different ways including a snowball-approach and the identification via literature on the cluster, company data banks and industry fair participation lists. The agricultural engineering industry is scattered over large parts of North-Western Germany (figure 6), covering parts of three German federal states: Lower Saxony, North Rhine-Westphalia and Bremen. The interviews were only held with stakeholders from Lower Saxony. The reason is that the core of the cluster with the highest concentration of companies is located in the districts of Osnabrück, Vechta and Cloppenburg, all part of Lower Saxony (Müller, 2012). Companies being situated in the same federal state share the same political and institutional environment. For reasons of comparability the study was limited to companies from the most important federal state in terms of agricultural engineering industry shares.

### **4 Agricultural engineering in Western Lower Saxony: An overview**

North-Western Germany (compare figure 6) shows one of the highest concentrations of the agricultural engineering sector worldwide. It is home to some of the most innovative and significant companies of this sector. Windhorst (2004) refers to it being the 'Silicon Valley of agricultural engineering'. The cluster consists of two sub-clusters, one based on animal house technology and one is based on agricultural vehicles, especially trailers. There are some links between the two industries including biogas plant manufacturing combining competences from both industries.

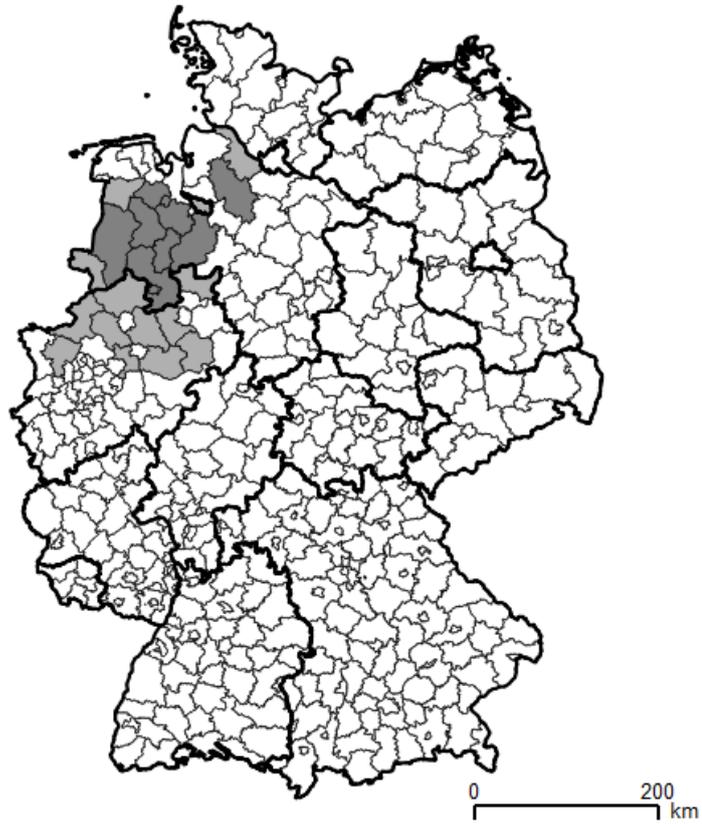


Figure 6: The agricultural engineering industry in North-Western Germany (Shaded areas are rural and urban districts that are according to Müller (2012) home to companies of the agricultural engineering sector in North-Western Germany. Darker shades indicate districts where interviewed stakeholders for the on-hand study are situated.) Source: own contribution.

A historical overview of the early development of the region is given by Windhorst (1975). The region developed after World War II to a prosperous industrialized area with the construction of a motorway in the 1960's and 1970's and general strong economic growth in post-war Germany. Alongside the industrialization of pig and chicken keeping as well as crop farming a strong and competitive animal house and field vehicle industry emerged. Many companies of the cluster showed a long-term growth until today. Some of them remained highly innovative introducing constantly new technologies to their production within their existing technological trajectories. More radical innovations occasionally were also introduced including biogas plant manufacturing triggered by federal laws (renewable energy act in 2000).

The region is characterised by certain cultural and institutional settings having strong impacts on the economic development and entrepreneurial habits. Local politics are dominated by conservative forces since decades. This political stability reduces uncertainty for entrepreneurial projects. People share a sense of togetherness and a common identity even between entrepreneurs and employees.

Since the 1980's the regional development of agriculture and agricultural engineering is increasingly accompanied by scientific institutes and universities (University of Applied Sciences Osnabrück, University of Vechta, etc.) resulting in an increasing interconnectedness of science with companies. Recently many companies from the cluster show a tendency to enter international markets being today strongly export oriented. Additionally the regional market remains important. Local farmers today often play the role of test users for new products. Challenges to cluster growth come from political intervention and society (animal protection, building laws, highway code, etc.) as well as from environmental effects (liquid manure, extensive groundwater use). Unlike agriculture most producers from the agricultural engineering sector use these challenges as chances for innovation and growth as farmers need to adapt new technology to fit the new requirements.

The following section deals with the results from the interview study. The following section consists of four parts. Firstly, general characteristics of the interviewed companies and organisations are depicted. Secondly, different triggers and drivers affecting agents' development are categorized by their thematic and spatial origin. Thirdly, the shift goes towards the effects and changes. It is analysed which triggers and drivers lead to which effects. The fourth subsection shows from which thematic and spatial context the factors affecting specific changes originate.

## **5 Results from the qualitative study**

### **Overview of the interviewed organisations**

The following interpretation of the respective interview results is based on 22 semi-structured qualitative interviews held in 2013. An overview of the data set is given in table 1. The analysed dataset includes 21 interviews with cluster companies and one interview with a non-company organisation that is directly involved in the innovation process of the industry. The original study includes additional eight interviews with

other industry experts. The results from those interviews are very helpful and relevant for the interpretation of the general development of the industry. As these additional experts and the organisations they belong to are not involved in the innovation process they are not included in the study.

Table 1: Overview of interviewed cluster companies and organisations

Organisations	Number	Organisations	Number
<i>Interviews:</i>		<i>Subsector*:</i>	
companies	21	lifestock related technology	12
other organisations (other experts**)	1 (8)	plant related technology	9
		biogas technology	4
<i>Stage of development:</i>		<i>Scale of market orientation:</i>	
emergence	2	regional	1
growth	18	national	6
sustainment	1	european	9
decline	1	global	6
<i>Number of employees:</i>		<i>Share of university degree employees:</i>	
1 to 9	2	0 to less than 10%	9
10 to 49	3	10 to less than 25%	5
50 to 499	13	25 to less than 50%	4
500 or more	4	50 to 100%	4

*\*multiple answers possible*

*\*\*not considered in descriptive analysis*

The 22 interviewed organisations can be classified along the three sub-sectors of the agricultural engineering industry. Because some companies are active in more than one field they can be classified in more than one. Organisations are included in a group if they have been active in the respective field within the last 15 years. Twelve organisations were active in livestock related technology industry including stable-designers and their suppliers. Nine interviewed organisations are active in the field of plant related technology mainly from agricultural trailer production including suppliers. Four organisations produced complete biogas plants or parts of it.

Most organisations have been mainly in a phase of growth during the last 15 years. Two just emerged in this time and one organisation was each in a sustainment and a decline phase. One can conclude that the whole cluster is likely to be in a growth phase. The cluster is looking back on a relatively long history. Many of the interviewed organisations at least twenty years old. The current growth phase is in line with many

periods of prosperity since the 1960's.

Many cluster companies follow an internationalisation strategy. While some do so since decades many other decided internationalise more recently. Within the last 15 years only one interviewed organisation remained a mainly regional and six a mainly national market orientation. Most interviewed organisations sell their products internationally with nine organisations oriented towards European (EU, EFTA) and six towards global markets (including Non-EU/EFTA Eastern Europe). Eastern European EU-members and non-EU members (Russia, Poland, etc.) became the most important growth markets for many interviewed organisations.

The interviewed organisations are mainly medium sized. Thirteen have between 50 and 499 employees. Only a few are smaller or larger. Four companies are groups with more than 500 employees. Almost all interviewed companies of all sizes are family enterprises. This structure is representative for the cluster and the region. The degree of knowledge intensiveness is quite heterogeneous. Nine organisations show just small shares of employees with university degree under 10 percent while four organisations show shares over 50 percent.

### **Triggers and drivers for change**

This study assumes that triggers and drivers for change have their origin on different spatial scales inside and outside of the thematic context of the respective industry (figure 5). In the following section the triggers and drivers are described according to the thematic and spatial context they originate from. The effect these triggers and drivers have had on the development of the organisation is discussed at a later point of this study.

Table 2 shows the factors that had an impact on firm development originating directly from the cluster mentioned by the interviewed organisations. Each count means that one organisation mentioned this type of factor to be relevant for the development of the company within the last 15 years. It shows that especially knowledge dynamics like R&D cooperations, the demand of customers from the same industrial context (industry and agricultural customers) within the cluster as well as other networking activities, that are not R&D cooperations are relevant factors. Different knowledge dynamics have been stated 34 times as been relevant factors from the cluster level. Communication and interaction in spatial and cognitive proximity seems to have a significant effect on the development of the investigated organisations. Other factors including institutional and market factors were mentioned much more less in respective to the cluster level.

Spatial proximity is often seen in cluster studies as promoting cluster development. Factors from the non-cluster regional level are depicted in table 3. Eight organisations mentioned that regional shortage of skilled labour affects their development. The region in western Lower Saxony is of rural type. The regional labour market has only small capacities to supply cluster companies with the needed skilled workers. The rural character of the region is not attractive for many potential employees from other regions. Many firms suffer from this aspect. Other relevant factors from the regional level are of institutional character, especially the shared regional culture and identity. Four organisations mentioned this to be a relevant factor determining their development. Societal

Table 2: Cluster level factors determining the development of the interviewed firms and organisations

Factors	times stated	Factors	times stated
<i>institutional factors:</i>		<i>market factors:</i>	
societal/political discourse	1	demand	2
		competitive pressure	1
<i>knowledge dynamics:</i>		<i>other factors:</i>	
R&D cooperations	17	coincidence	1
customer contact	11	firm/person specifics	1
general networking	6		

and political discourses are relevant for three organisations including mainly topics on environmental consequences resulting from intensified agriculture and biogas plants in the region.

Table 3: Regional level factors determining the development of the interviewed firms and organisations

Factors	times stated	Factors	times stated
<i>institutional factors:</i>		<i>market factors:</i>	
regional culture/identity	4	shortage of skilled labour	8
societal/political discourse	3		
<i>knowledge dynamics:</i>		<i>other factors:</i>	
R&D cooperations	2	–	–
general networking	1		

Political and other institutional factors are potentially heavily determined by the federal state level. German states have huge competences in several political fields including agriculture and environmental issues. All interviewed organisations are located within Lower Saxony being affected by this common context on the subnational level. Tables 4 and 5 show the factors from the level of Lower Saxony in terms of industry related and non-industry related contexts. Several laws from this level affect the development of the organisations mentioned eight times including animal protection and building laws. Political and societal discussions on agriculture had an effect on four companies' development. Knowledge dynamics from the shared industrial thematic context from the Lower Saxony level had an effect on the development of several organisations. Customer needs from this level are relevant for nine, R&D cooperation for eight and other networking activities for one organisation. Market and other factors from the Lower Saxony level are relevant only for a few organisations.

Table 4: Subnational level industry related factors determining the development of the interviewed firms and organisations

Factors	times stated	Factors	times stated
<i>institutional factors:</i>		<i>market factors:</i>	
–	–	competitive pressure	1
		demand	1
<i>knowledge dynamics:</i>		<i>other factors:</i>	
customer contacts	9	coincidence	1
R&D cooperations	6		
general networking	1		

Table 5: Subnational level not industry related factors determining the development of the interviewed firms and organisations

Factors	times stated	Factors	times stated
<i>institutional factors:</i>		<i>market factors:</i>	
societal/political discourse	4	–	–
animal protection laws	3		
building laws	2		
other environmental laws	2		
other laws	1		
<i>knowledge dynamics:</i>		<i>other factors:</i>	
R&D cooperations	2	–	–

Political power, media, markets, industry structures and institutions are still organised to a large degree nationally. Tables 6 and 7 show that thematically internally knowledge dynamics and thematically externally institutional factors are of relevance for many interviewed organisations. Ten organisations have R&D cooperations within and seven without the own thematic-industrial context with partners from Germany outside Lower Saxony. Similar to the cluster and subnational level customer needs have a direct effect on the development. Institutional factors from the national level are mainly laws. National laws on animal protection affect ten, the renewable energy act eight, building laws five and other laws and six organisations' development. These laws have different impacts. Even if especially laws on animal protection and the environment are hampering the economic development of farmers, producers of farm technology often profit from them as these laws generate new demands from farmers who need to adjust their production. The renewable energy act had a positive impact on the development of many firms during most of the observed period while the last amendment in 2012 slowed down the demand for biogas plants resulting decline for some organisations. In contrast to the regional and the subnational level general market factors that are not resulting in knowledge dynamics are relevant for some organisation. Six stated that general competitive pressure and demand structures had an effect on their development.

Table 6: National level industry related factors determining the development of the interviewed firms and organisations

Factors	times stated	Factors	times stated
<i>institutional factors:</i>		<i>market factors:</i>	
industrial standardisation	1	competitive pressure	6
societal/political discourse	1	demand	2
<i>knowledge dynamics:</i>		<i>other factors:</i>	
customer contacts	14	-	-
R&D cooperations	10		
general networking	2		

The European market and political integration are nowadays advanced. As stated earlier nine of the 22 investigated organisations show an orientation towards European markets. The supranational level has gained importance within the last decades. Tables 8 and 9 show that many companies from the cluster are affected by knowledge dynamics and market factors from the EU level. While demand structures and inputs from customers in terms of farmers are located in Western and in Eastern European countries in many instances, R&D cooperation partners from other European countries are mostly located in direct neighbouring Western European countries. European level institutional settings were only mentioned by a few organisations to be important. Four organisations mentioned animal protection laws and two mentioned other laws to be important for their development.

Table 7: National level not industry related factors determining the development of the interviewed firms and organisations

Factors	times stated	Factors	times stated
<i>institutional factors:</i>		<i>market factors:</i>	
animal protection laws	10	–	–
renewable energy act	8		
building laws	5		
societal/political discourse	4		
other environmental laws	3		
other laws	3		
industrial standardisation	1		
<i>knowledge dynamics:</i>		<i>other factors:</i>	
R&D cooperations	7	–	–

Table 8: Supranational (EU) level industry related factors determining the development of the interviewed firms and organisations

Factors	times stated	Factors	times stated
<i>institutional factors:</i>		<i>market factors:</i>	
industrial standardisation	1	demand	5
		competitive pressure	2
<i>knowledge dynamics:</i>		<i>other factors:</i>	
customer contacts	10	firm/person specifics	1
R&D cooperations	8		
general networking	1		

Table 9: Supranational (EU) level not industry related factors determining the development of the interviewed firms and organisations

Factors	times stated	Factors	times stated
<i>institutional factors:</i>		<i>market factors:</i>	
animal protection laws	4	price fluctuations	1
other laws	2		
<i>knowledge dynamics:</i>		<i>other factors:</i>	
R&D cooperations	1	–	–

Alongside with the cluster level the global level is in contrast to the other levels characterized by no political framework. Laws are not formulated and organised on the global level. Global factors can be expected to be mostly of somehow market-related nature. Tables 10 and 11 show that triggers and drivers from the global level are all of industry-related or market-related nature. Demand and competition structures are mentioned by seven respectively one organisation to have had affected their development. Direct contacts to costumers and their needs were mentioned by six agents. Industrial standards and indirect standards implemented by general technological developments within electronics are the only institutional factors that affect firm development mentioned by six respectively one agent.

Table 10: Global level industry related factors determining the development of the interviewed firms and organisations

Factors	times stated	Factors	times stated
<i>institutional factors:</i>		<i>market factors:</i>	
industrial standardisation	6	demand	7
		competitive pressure	1
<i>knowledge dynamics:</i>		<i>other factors:</i>	
customer contacts	6	–	–

Table 11: Global level not industry related factors determining the development of the interviewed firms and organisations

Factors	times stated	Factors	times stated
<i>institutional factors:</i>		<i>market factors:</i>	
general technological advance	1	price fluctuations	3
		competitive pressure	1
<i>knowledge dynamics:</i>		<i>other factors:</i>	
–	–	Great Recession	1

## Changing aspects within firms and their triggers and drivers

Change within the development of firms and organisations can be of various character. It can be of positive, negative, both or neutral kind. Agents can diversify into new product fields or within their existing technological setting or concentrate on their core business. Market strategies can change regarding the orientation towards certain markets. Tables 12 and 13 show how often agents stated that a certain trigger or driver led to a specific effect. Agents could state more than one trigger for a certain type of

change. Additionally sometimes a certain kind of change occurred more than once in the development of an agent. Thus the total number of statements in some cases exceeds 22.

One of the most radical changes for firm development is the decision of the organisation to diversify into a totally new field of products that are not directly related to the set of products the organisation developed before. However even in these instances the decision to diversify is based on previously existing knowledge within the company or organisation. In the on-hand case study the diversification was mostly one into biogas plant manufacturing. Biogas plants contain parts that are related to mechanisms that are used in agricultural engineering. For example screw-conveyors are used in biogas plants as well as in feeding mechanisms in animal houses. However the trigger for the diversification is mostly coming from external of the firm or organisation. Three agents stated that the renewable energy act triggered a diversification into biogas plant manufacturing. Other triggers are market related like competition and demand structures. In one case a random event triggered diversification into a new field.

More common than the diversification into a new field is innovation within the existing technological field. Agents can develop new products or refine existing products via incremental innovation. New products are mostly the result of knowledge dynamics. In 17 cases agents stated that R&D cooperations where the trigger for new products. In six cases the communication with customers and the response to their needs led to new products. Five times networking activities besides R&D cooperation led to that effect. Another important set of triggers and drivers are institutional factors. In ten cases different kind of laws forced agents to develop new products. The establishment of industrial standards was the reason in three cases to innovate.

Incremental innovation also mainly triggered and driven by knowledge dynamics and institutional factors. The most prominent trigger for incremental innovation is communication with customers outside of R&D cooperations. Mostly these customers are in this study farmers that apply the technology produced by the companies of the cluster. In twelve instances customer needs forced agents to refine their products. R&D cooperations are less significant for incremental innovation. Only in four cases they caused incremental innovation. Different kind of laws were in nine cases the reason for incremental innovation. Industry standards forced four times agents towards this. Laws and standards are therefore important triggers of incremental innovation.

Related to innovation is the general increase in an agents R&D quality. Firms and organisations might invest in their facilities to stay innovative. However, only in four cases this kind of change was stated, competitive pressure being mentioned twice being the trigger or driver of it. The concentration on their core business of agents is sometimes accompanied by the omission of a previously active product field. Four times this kind of change was mentioned being triggered by competition or firm specific aspects.

Market oriented changes include internationalisation strategies and the increase or the decrease of sales. Internationalisation was in most cases triggered by international demand structures. Nine times this trigger was mentioned. Thus internationalisation is mostly market driven. Other, less important triggers include firm/person specific aspects in two cases and the renewable energy act in one case. General sales increases are by contrast more triggered by institutional factors, including different laws as well

Table 12: Triggers and drivers for change

Impact	Trigger/Driver	times stated
entry new product field	renewable energy act	3
	competitive pressure	1
	demand	1
	coincidence	1
new products	R&D cooperations	17
	customer contacts	6
	general networking	5
	animal protection laws	4
	industrial standardisation	3
	renewable energy act	2
	other laws	2
	building laws	1
	other environmental laws	1
	competitive pressure	1
	firm/person specifics	1
	general technological advance	1
incremental innovation	customer contacts	12
	animal protection laws	4
	industrial standardisation	4
	R&D cooperations	4
	building laws	2
	other laws	2
	demand	1
	general technological advance	1
	price fluctuations	1
	other environmental laws	1
increase in R&D quality	competitive pressure	2
	firm/person specifics	1
	general networking	1
omission of product field	competitive pressure	2
	firm/person specifics	2

as political and societal discourses. Eight times institutional factors were mentioned to have triggered or driven sales increases. Only in two cases market factors were stated to have triggered major sales increases. The regional factor of scarcity of skilled labour is the most mentioned factor leading to sales slow-downs. Political and societal discourses on specific topics including environmental impacts of agriculture and animal protection concerns were the reason in five cases for slow-downs. Laws led in eight cases to slow downs. Institutional factors like laws and discourses were mentioned to cause uncertainty especially in farmers. Thus they are less likely to invest.

In some cases the interviewed companies and organisations were established within the investigated period of 15 years prior to the interview. The triggers of the founding are quite heterogeneous, including networking, general demand, person specific aspects and the renewable energy act.

The reduction of uncertainty for an agent is not really a change. However, less uncertainty affects the development of a firm significantly. The regional culture, characterised by stability, shared values and a sense of togetherness was mentioned four times to reduce uncertainty. In two cases general networking activities leading to trust were mentioned. Other changes including the relocation of the firm into the region, the modernisation of the production and the insolvency were mentioned only once each.

Concluding from this it can be seen that the mostly mentioned effects being triggered by various factors are innovations (radical as well as incremental) and market related changes including increases and decreases of sales as well as internationalisation strategies. Innovations are mostly the result of knowledge dynamics with R&D cooperations being most important for the development of new products and the contact to customers being the most important trigger for incremental innovation. Additionally to these knowledge dynamics institutional factors, especially laws play a major role in triggering innovation. Market related changes are not associated with knowledge dynamics. Market and institutional triggers play a role resulting in sales changes or internationalisation strategies. These observations do not yet tell us something about the scale of the triggers and drivers leading to which change. This aspect is shown in the next subsection.

## **Scalar and thematic origins of changes**

In the previous subsection it has been shown that the main changes of the development of the firms within the observed cluster are different kinds of innovations and market related changes including increases and decreases of sales and internationalisation. The following section takes a look on the origin of triggers and drivers in terms of their scalar and thematic context in respect to the changes they cause.

In tables 14 and 15 the changes are listed together with the origin of their triggers and drivers. These tables show that different changes are affected from different scales differently. New products are mainly triggered from the cluster, the thematic and the national levels. The cluster level includes knowledge dynamics (R&D cooperations and customer contacts) while the national level is associated by knowledge dynamics as well as federal laws of different kind. This observation is also true for incremental innovations while laws, and thus the national level are slightly less significant. Knowledge dynamics

Table 13: Triggers and drivers for change (proceeding)

Impact	Trigger/Driver	times stated
internationalisation	demand	9
	firm/person specifics	2
	renewable energy act	1
sales increase	renewable energy act	3
	animal protection laws	2
	societal/political discourse	2
	coincidence	1
	demand	1
	general networking	1
	other environmental laws	1
	price fluctuations	1
sales slow-down	shortage of skilled labour	8
	societal/political discourse	5
	building laws	4
	renewable energy act	2
	price fluctuations	2
	animal protection laws	1
	other laws	1
	firm/person specifics	1
	Great Recession	1
establishment of firm	general networking	2
	demand	1
	firm/person specifics	1
	renewable energy act	1
reduction of uncertainty	regional culture/identity	4
	general networking	2
relocation of firm into region	firm/person specifics	1
modernisation of production	competitive pressure	1
insolvency	firm/person specifics	1

are important in the thematic sphere on various scales, most prominent the cluster and the national level.

Internationalisation is, as has been shown mainly driven by demand structures on international markets. International demand for agricultural machinery is associated with the thematic context on the supranational and global level (table 14). Sales increases are as has been shown in the previous subsection mainly triggered by institutional factors (laws, discourses) that are mainly associated with the national level. Laws are mainly of non-thematic character (table 15). Sales-slow downs are caused by regional shortage of skilled labour and institutional factors like laws and discourses. They are originated mainly from the non thematic context as can be seen in the table. These institutional factors are in this case not only mainly from the national level. Subnational level factors play here also a mayor role. Building laws and animal protection laws as well as other environmental laws are partly defined at the level of the state of Lower Saxony. Recently political debates on future laws in the field of environment and animal protection within the government of Lower Saxony caused uncertainty among farmers causing slow-downs in sales for some producers of agricultural machinery.

## 6 Conclusion

Recent concepts within 'Evolutionary Economic Geography' including cluster life cycle approaches (Menzel and Fornahl, 2010) assume that the specific interplay of knowledge available to cluster agents, certain external knowledge sources and the capacity of cluster agents to use this knowledge is seen as being crucial for the development of the heterogeneity of accessible knowledge and the development of the cluster in total. According to Frenken et al. (2007) external knowledge needs to be related to the existing knowledge of agents to be assimilable.

Research on regional clusters and theories within the relational thinking framework has been traditionally based on a simple local/global thinking. Recently this simple duality has been criticised. Several concepts on multi-scalar mechanisms of institutional impacts (Coenen et al., 2012; Brenner, 2004) and knowledge dynamics (Crevoisier and Jeannerat, 2009) have been developed. These concepts assume that regional economies are increasingly affected by factors from multiple scales. Based on these arguments a concept of multi-scalar impacts on cluster development has been developed in the on-hand study. It assumes that cluster development is possibly affected by factors from various spatial scales within and without the same industrial-thematic context.

In a study on the agricultural engineering industry in North-Western Germany it has been shown that factors affecting the development of firms and organisation belonging to the same cluster are affected by impacts from multiple scales. The first research question deals with the origin of triggers and drivers. Especially knowledge dynamics originate from all investigated scales within the common thematic-industrial context. However the quality of these knowledge dynamics tends to be different on different scales. R&D cooperation is not relevant for the agents on the global level while the cluster and the national level remain most important. This might be a hint towards the necessity of

Table 14: Origin of not firm-specific triggers and drivers according to effects

Origin of trigger/driver	times stated	times stated
	<i>entry new product field:</i>	<i>new products:</i>
cluster	2	17
region (not thematic)	0	1
theme subnational	0	9
theme national	0	11
theme supranational	0	9
theme global	0	5
non-theme subnational	0	5
non-theme national	3	14
non-theme supranational	0	3
non-theme global	1	1
	<i>incremental innovation:</i>	<i>increase in R&amp;D quality:</i>
cluster	10	1
region (not thematic)	2	0
theme subnational	7	0
theme national	10	2
theme supranational	8	1
theme global	7	2
non-theme subnational	2	0
non-theme national	6	0
non-theme supranational	1	0
non-theme global	1	0
	<i>omission product field:</i>	<i>internationalisation:</i>
cluster	0	0
region (not thematic)	0	0
theme subnational	1	0
theme national	2	0
theme supranational	0	6
theme global	0	7
non-theme subnational	0	0
non-theme national	0	1
non-theme supranational	0	0
non-theme global	0	0

Table 15: Origin of not firm-specific triggers and drivers according to effects (proceeding)

Origin of trigger/driver	times stated	times stated
	<i>sales increase:</i>	<i>sales slow-down:</i>
cluster	1	1
region (not thematic)	0	9
theme subnational	1	0
theme national	1	0
theme supranational	0	0
theme global	0	0
non-theme subnational	1	6
non-theme national	6	7
non-theme supranational	2	2
non-theme global	1	2
	<i>establishment of firm:</i>	<i>reduction of uncertainty:</i>
cluster	1	1
region (not thematic)	0	4
theme subnational	0	0
theme national	2	0
theme supranational	0	0
theme global	0	0
non-theme subnational	0	0
non-theme national	1	0
non-theme supranational	0	0
non-theme global	0	0
	<i>modernisation of production:</i>	
cluster	0	
region (not thematic)	0	
theme subnational	0	
theme national	1	
theme supranational	1	
theme global	0	
non-theme subnational	0	
non-theme national	0	
non-theme supranational	0	
non-theme global	0	

cognitive and cultural proximity needed for successful R&D cooperation. On the other hand the contact to customers and the reaction to their needs are relevant on all spatial scales including the global level. Cognitive proximity seems to be sufficient within the shared thematic context to force agents to innovate.

The study shows that institutional factors affecting agents development mostly come from the subnational and especially the national level. This is a result of the fact that politics and opinion-forming institutions like media are still highly organised on these levels. On the regional level identity forming aspects, trust and a shared identity highly influence agents' development.

The second research question addresses the coherence between specific changes and their triggers. Innovation is in the on-hand study highly driven by knowledge dynamics. While R&D cooperation has been mostly stated to have caused the development of new products incremental innovation is mostly driven by contacts to customers. New products and incremental innovation are both also triggered by institutional factors, mainly laws. In contrast to the more common forms of innovation like the development of new products and incremental innovation the more radical form of innovation of the entry of an agent into a new product field is never been mentioned to be the result of knowledge dynamics, but by laws, competition, demand and coincidence.

The second large set of changes mentioned by most interviewed agents deals with market related changes including internationalisation and general increases and decreases of sales. Knowledge dynamics are not relevant for these changes for most agents. Market related factors and institutional factors, especially laws were mostly mentioned to cause these changes.

Finally the third research question asks for the origin of triggers in respect to specific changes. Innovation is mostly affected by factors originating from the same thematic context on different scales with the regional/cluster level and the national level being most important. Additionally laws from the non-thematic national level are important. Market related changes are affected differently. Internationalisation is triggered mainly by supranational and global factors within the same context while general sales increases and decreases are often triggered by factors from the non-thematic sphere on multiple scales, mainly laws and discourses but also the shortage of skilled labour in the case of sales slow-downs.

Concluding from these observations it can be said for the case of the observed agents from the agricultural engineering cluster that their development has been affected from multiple scales with some differences regarding innovation and general market related changes. The on-hand study still has some shortcomings. It offers no comparable analysis of other clusters and industries. Thus generalising statements on multi-scalar impacts on cluster development can not be given. However it offers a first insight into the topic and is a new piece in the mosaic of an emerging multi-scalar thinking of economic space. Future research should pay attention to the comparability of results including several clusters and industries.

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