Is ambidexterity crucial for cluster resilience? Conceptional consideration and empirical evidence

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Abstract

Purpose – This study, a conceptual paper, aims an answer the question, how significant cluster ambidexterity is for the resilience of individual clusters.

Design/methodology/approach – The authors draw up an abductive synopsis of empirical information and relevant theoretical sources. A case study is used to illustrate some of the findings.

Findings – The results of the analysis show that the ambidexterity of a cluster can contribute to its resilience when adverse external developments arise. Ambidexterity proves to be simultaneously a common strategy of key cluster actors and a mechanism for coping with critical situations and developments that can be activated by the cluster actors and may – eventually – lead to cluster resilience. While ambidexterity does not guarantee cluster survival, it can contribute significantly to their economic resilience under adverse conditions.

Research limitations/implications – The concept is developed on a limited empirical basis and would need to be tested and deepened by comparing a wide range of case studies from different clusters.

Practical implications – A better understanding of the importance of ambidexterity for the development of industrial clusters contributes to a better fine-tuning of cluster support policies.

Originality/value – Ambidexterity as a concept originating from business administration has so far only been rudimentarily tapped for empirical and theoretical cluster research. The paper identifies and develops a path how this could be accomplished to a greater extent in the future.

Keywords Cluster, Ambidexterity, Cluster resilience, Ambidextrous organisations, Contingency, Cluster evolution

Paper type Conceptual paper

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1. Introduction

This paper is motivated by the observation that industrial clusters, even if they are very similar in their basic structure (life cycle stage, sector, industry, technology), have been successful to very different extents in trying to respond to external challenges to their economic and technological development. Saxenian (1996) asks why two prominent American ICT clusters, Silicon Valley and the cluster around Route 128, met external challenges with different degrees of success in the mid-1980s. In the first case, the challenge arose from the emergence of successful Japanese semiconductor competitors, in the second, from the dissemination of PCs and work stations. Ferrary (2011) explores the reasons for the rather different success of the clusters around two major telecom equipment manufacturers, Lucent Technologies and Cisco Systems, in adapting to an extremely rapidly changing technological environment. The watch industry in the Swiss Jura managed to successfully adapt to the innovations of quartz and digital watches after initial major transitional difficulties, a success that the watch cluster in the neighbouring French Jura could not match (Bathelt and Glückler, 2018, p. 259; Maillat *et al.*, 2018). In a generalised analysis of cluster renewal processes, Trippl and Tödtling (2008) develop a broader framework for such diverse development patterns by displaying the wide range of such cluster-based renewal processes in old industrial regions.

Another starting point for this paper was the Ruhr Area Massive Steel Forging Cluster (MSFC) that serves as an illustrative example here in our analysis [1]. In this cluster, some companies made joint efforts to find ways out of an impending crisis by searching for alternative technological solutions and new ways to market their products in parallel to their ongoing, revenue-generating day-to-day business. They behaved ambidextrously to use a concept from business and organisational theory (Birkinshaw and Gibson, 2004; Gibson and Birkinshaw, 2004; O'Reilly and Tushman, 2004). The concept of ambidexterity has been applied in the organisational literature to entire companies or the full range of their sub-units (Birkinshaw and Gupta, 2013). In all cases, the aim of an ambidextrous strategy is to promote the economic survival chances in the face of serious challenges of the respective organisational unit due to changes in the competitive environment. To phrase it differently, the goal is to strengthen its resilience.

It is tempting to apply ambidexterity to clusters analogous to corporate contexts to better understand the resilience of clusters. Is the transfer of such a figure of thought methodologically justifiable? After all, industrial clusters are not organisations in the usual sense of the word. Clusters are open systems of interconnected organisations (firms, research organisations, etc.). However, clusters do not only consist of loose agglomerations of organisations, but are multi-organisational forms based on close inter-firm networking (Porter, 1998), they also develop characteristics that are typical of "normal" organisations such as in some cases, the public representation through joint cluster bodies that act as representatives of the interests of the cluster actors [2]. It is, therefore, not surprising that cluster researchers have occasionally taken up the cluster ambidexterity as an empirical research topic (Bocquet and Mothe, 2015; Ferrary, 2011; Mendes *et al.*, 2023; Wolf *et al.*, 2019). However, the conceptual foundations of cluster ambidexterity and its significance for cluster development have not yet been systematically scrutinised. This is exactly what this paper aims to do.

In the following, we understand "resilience" as the ability of a cluster to absorb threatening external influences or shocks in such a way that it returns to its previous or a modified growth path after necessary adjustments and restructuring. By "ambidexterity", we mean the ability of an organisation to combine exploitative and explorative activities to ensure the organisation's survival.

The paper focuses on three research questions:

RQ1. What does "ambidexterity" mean in the context of an industrial cluster?

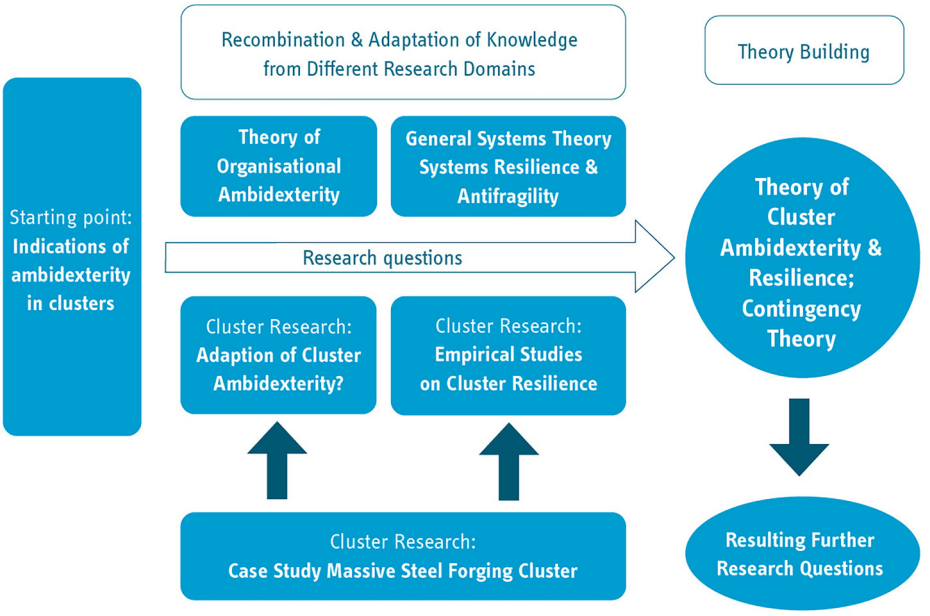
RQ2. What are possible determinants of cluster resilience?

RQ3. Can ambidexterity contribute to cluster resilience?

The structure of the paper is as follows: In Section 2, the methodological approach is sketched. Section 3 discusses the applicability of the organisational theory concept of ambidexterity to clusters (*RQ1*), introduces the concept of resilience and discusses the determinants on which cluster resilience depends (*RQ2*). Section 4 presents the illustrative cluster case. Against this background, Section 5 integrates the lines of argumentation of the preceding chapters and deals with the relationship between cluster ambidexterity and resilience (*RQ3*). Section 6 contains a summary and conclusions.

2. Methodological approach

This conceptual paper combines ideas from different research approaches with reference to an empirical issue to develop a new theoretical explanation of the issue. The process has been described, for example, by Gilson and Goldberg (2015). The logic of the underlying research process was somewhat different from the presentation logic of this paper. The basic methodological approach can be classified as *retroduction* or *abduction*, a procedure that is applicable beyond disciplinary boundaries, for example in economics (Lawson, 2005), economic geography (Gong and Hassink, 2020) and the theory of architectural design (Schön, 2021; Kretz, 2020). The substance of this procedure also corresponds to the concept of "appreciative theorizing" (Nelson and Winter, 1996, pp. 45 – 48). The development of our argument is based on a recursive process in which the diverse theoretical sources and the empirical information enter a dialogue based on repeated feedback loops.



Source: Own depiction

Figure 1.
Research task

Figure 1 illustrates the connection between the theoretical components from different disciplines, which are combined in the research process and adapted to the empirical situation to be analysed. Starting with the observation of an ambidextrous behaviour of cluster actors (case study MSFC), which aims to ensure the economic viability of their own company, and in this way, *nolens volens*, is suited in most cases to strengthen the viability of the entire cluster, the figure of thought of ambidexterity was taken up from organisational research. On this basis, the question arose to what extent the concept of ambidexterity had already been adopted by cluster research and what cluster researchers understood by the "ambidexterity" of a cluster. To analyse the relationship between ambidexterity and resilience, the relevant cluster literature was examined to see what cluster researchers understand by "resilience of a cluster" and what causes they hold responsible for the (non-) resilience of clusters under the onslaught of external challenges.

Our reference case, the MSFC, is suited as a single case to analyse the characteristics of the production and innovation system of an individual cluster and the relationship to cluster ambidexterity and resilience. This cluster is an important part of the automotive value-added chain and has been strongly affected by the ongoing transformation of the global automotive industry. Of the approximately 230 companies in this industry in Germany, around two-thirds are located in the cluster in the federal state of North Rhine-Westphalia [3]. These firms produce to a substantial degree (about 50% of turnover) for the automotive industry, but also have other customers, especially in the machinery sector, which accounts for about one-third of the turnover.

For analysing development patterns of the MSFC, a diverse case study approach is used to illuminate different possibilities of variation in the relationship between ambidexterity and resilience of a cluster (Seawright and Gerring, 2008). The information on which this discussion in our case is based essentially originates from a research project on technology transfer in massive lightweight forging, which was conducted between 2015 and 2018 [4]. Thus, our study focused on observing the actual developments in our case (the massive forging industry and the related parts of the innovation system and value chain; Yin, 2018). In that project, 33 expert interviews on the consequences of changing framework conditions for innovation processes and technology transfer were conducted with representatives from firms in all parts of the value chain (24) and representatives of universities and research institutes (nine) (RWI and ika – RWI and Leibniz-institut für Wirtschaftsforschung and Institut für Kraftfahrzeuge der RWTH Aachen University, 2018). These interviews, although not directly focused on ambidexterity and resilience, resulted in insights about the ambidexterity of individual firms and mechanisms that probably influence the degree of resilience of the cluster.

3. Cluster resilience through ambidexterity?

Key concepts and empirical studies.

3.1 Application of the ambidexterity concept to clusters

The concept of *"ambidexterity"* was developed in business organisation theory (Birkinshaw and Gupta, 2013). It refers to a behavioural orientation of an individual, an organisational subunit or the entire organisation (company). Ambidexterity means that the organisation is not limited to the implementation and development of established behavioural patterns but tries out and pursues alternative promising orientations in parallel. This combination of different behavioural patterns is meant to strengthen the company's long-term performance, i.e. to improve its resilience to structural and technological change.

Gibson/Birkinshaw define "organisational ambidexterity" as "*[. . .] the capacity to achieve alignment and adaptability at a business level*" (2004: 209). Ambidexterity, thus, combines proven, routine business behaviours and future-oriented behaviours that parallel routine

processes under the umbrella of one organisation. The term addresses mental "acts" and their physical consequences at the same time. Early work in this research tradition saw ambidexterity as being anchored primarily in the *structural ambidexterity* of a (business) organisation (Duncan, 1976, p. 167). In their meta-analysis of business ambidexterity research, Birkinshaw/Gupta (2013) show that the initially narrow understanding of the concept has evolved into a broad stream of different conceptualisations. "*Structural ambidexterity*" was replaced by "*contextual ambidexterity*" (Birkinshaw and Gupta, 2013; Gibson and Birkinshaw, 2004), under whose conceptual umbrella different possible forms of expression of the combination of present and future orientation can be combined. Common feature of all relevant conceptualisations is that ambidexterity is about tensions, ambivalences, contradictions inherent to the organisation, trade-offs in conflicting allocation decisions, whereby the arising tensions are resolved in balancing acts that find a middle way between the extreme positions (Datta, 2011; O'Reilly and Tushman, 2004; Tushman and O'Reilly, 1996). The dichotomy of *exploitation* and *exploration* (cf. original formulation in March, 1991) has been established as a constitutive pair of opposites that characterises ambidexterity. In operationalising this dichotomy, the authors choose very different paths and methods to measure the chosen operationalisation criteria.

At first glance, it seems difficult to justify why clusters, which are not hierarchically organised companies but networks of independent organisations, should develop the capacity for ambidexterity. Yet, there are good reasons to assume that clusters can be "ambidextrous". On the one hand, clusters, like industries, regions, diverse human communities, develop loose network-based cross-organisational governance structures and thus can be perceived from the outside as collectives pursuing the interests of their members. Here, the representation of interests can have different degrees of formalisation. Most works of the normative cluster research literature tacitly assume that cluster initiatives supported by the government could "act as" representatives of their clientele in a similar way to corporate managements. This is of course only true to a limited extent compared to companies.

On the other hand, an industrial cluster comprises multiple legally independent organisations, all of which in turn display intentionally controlled behaviour. A will of any kind of the – in the legal sense – fictitious entity cluster can therefore only be constituted through the voluntary cooperation of the cluster actors involved, whereby the intersection of common interests of the participating firms/other organisations to which this collective will can refer is always limited. Cluster policy measures that address the total of cluster actors inevitably imply the existence of a collective body of some kind that can speak for the cluster enterprises. There is also empirical evidence that cluster actors form alliances to pursue and articulate shared interests (Cainelli, 2008). In the economic theory of collective action, this phenomenon has been reflected at the theoretical level (Olson, 2004).

As in entrepreneurial decision-making processes, the cluster's origin of ambidextrous behaviour always lies in the decisions of individuals that determine the course of a cluster actor (company, research institute) in terms of the R&D, production and marketing orientations to be adopted. The decisions taken are reified in the services, products and organisational structures of the (sub-) organisation, but also in the further course of the routine corporate processes. Because of the interactions between the actors in the cluster network, individual company ambidexterity will inevitably influence the cluster's performance, function and orientation. The extent to which this can happen depends on the weight of the ambidextrous company or companies in the cluster and the focus of the ambidextrous activities. However, the ambidextrous activities of a cluster actor do not automatically mean that the cluster becomes (more) ambidextrous. A critical mass of activities focused on ambidexterity by cluster actors is

needed for the cluster itself to take on ambidextrous features. This also means that the cluster can exhibit a higher or lower degree of ambidexterity.

The above considerations lead us to the following pragmatic definition of the ambidexterity of clusters:

> A cluster is ambidextrous when an individual cluster actor or a group of actors which shape the face of the cluster activities, while maintaining their usual day-to-day business and following established business routines, devote a significant part of their activities and resources to exploring alternative technological solutions, opening new market connections, finding new ways of operating in a changing institutional environment.

Firm activities that focus on ambidexterity only contribute to cluster activities if they aim at the development of local firm activities. This is not the case if these activities only aim at the "general" survival of the firm, without a connection with local activities. Intermediate cluster organisations can contribute to cluster ambidexterity by fostering common explorative activities, but their existence or activities are not a necessary precondition for the ambidexterity of a cluster.

Ambidexterity has been taken up repeatedly in recent cluster research (Behrens *et al.*, 2020; Bocquet and Mothe, 2015; Ferrary, 2011; Mendes *et al.*, 2023; Wolf *et al.*, 2019). As in most of the publications in organisational theory, ambidexterity was associated primarily with exploring new technological solutions in parallel with the usual incremental improvements to established technology. Common to these works is, on the one hand, that the characteristic of ambidexterity is not only attributed to the individual cluster actors but is tacitly transferred to the cluster without addressing the conceptual problem behind this transfer. On the other hand, ambidexterity, if it maintains the above-mentioned balance between exploitative and explorative orientation, is associated with a positive valuation in the sense of increasing innovative capacity, economic performance and ultimately resilience.

3.2 Possible determinants of cluster resilience

In the second half of the 20th century and the early 21st century, the concept of resilience gained a firm foothold in numerous natural and social science disciplines (Meadows, 2008; Roth *et al.*, 2021). The broad reception of the concept in the related disciplines of economic geography, urban studies and spatial economics has given rise to many studies on two related topics: The resilience of local and regional economies (Boschma, 2015; Evenhuis, 2017; Kiese and Hundt, 2014; Martin and Sunley, 2015; Simmie and Martin, 2010) and – what is our topic – the conceptualisation, operationalisation and determinants of economic resilience of industrial clusters (Behrens *et al.*, 2020).

As far as the different types of spatial economic units are concerned, the basic conceptual and methodological challenges and research agendas associated with resilience are very similar in content. Many insights that refer to the economic resilience of regions can also be applied to clusters in a modified form. The literature on regional economic resilience provides a general conceptual framework for analysing spatial economic resilience. Cluster research has produced a rich and growing body of discoveries on cluster evolution (for a review, see Chu and Hassink, 2022), most of which are related to cluster resilience more broadly, even if it is not explicitly addressed as such. Examples of explicit analyses of the resilience of cluster firms and clusters are the contributions on the influence of sector-specific technological configurations on resilience to external shocks (Li *et al.*, 2022) and the influence of cluster membership on firm resilience (Behrens *et al.*, 2020).

Among the general approaches discussed by Martin and Sunley (2015, p. 4) and Evenhuis (2017: 6) for assessing the economic resilience of regions, the *evolutionary conception* is closest to reality and possesses the greatest analytical potential. This approach

emphasises the dynamic, open character of the reactions of regional economies to shocks and external influences of any kind and avoids the conceptual framing of equilibrium thinking. Both the more mechanical *engineering conception*, which corresponds to the comparative-static approach of neoclassical economics, and the *ecological conception*, which envisages the possibility of new trajectories, are less suitable for capturing the complexity and dynamics of adaptation processes.

Modifying the definition of regional economic resilience by Martin/Sunley (2015: 13) and taking into account the definitions of other authors (Boschma, 2015; Li *et al.*, 2022; Simmie and Martin, 2010), we define cluster resilience as follows:

> The economic resilience of an industrial cluster is understood to be its ability to counter the existential threats resulting from changes in the environment, whether they are of a technological, competitive, structural or regulatory nature, in such a way that it can continue to develop along its previous development path or on a new sustainable path, even if it has to accept temporary setbacks and losses and to take on challenging restructuring and reorientation processes.

Our understanding of resilience-testing threats includes both sudden, shocking external events and gradually escalating threatening challenges. The adaptation processes studied in the resilience literature (Evenhuis, 2017; Martin and Sunley, 2015) can take place over longer periods of time, encompass different phases and take very different forms.

In our context, all possible causes why economic-spatial units proved to be more or less resilient are of interest. This object of investigation confronts researchers with the elementary realities of an analytically elusive complexity of their objects of investigation. Explanatory models that explain the relevant causal relationships are always partial in nature, and they are suitable for studies on economic resilience to varying degrees, depending on the purpose of the research. The medium-range theories developed in economic geography to explain the impact of structural diversity, modularity, related variety, structural redundancy or diversified specialisation (Martin and Sunley, 2015, p. 28) on regional economic resilience thus always illuminate partial aspects of a complex entity, the fullness of which is initially impossible to grasp. In many cases, the different perspectives offered complement each other, but sometimes, they also point to trade-offs anchored in reality or resulting from faulty conceptualisations.

A central feature of the existing literature (Boschma, 2015; Martin and Sunley, 2015) is that structural factors of all kinds – economic sectors, business population, forward and backward linkages, labour force potential, presence of research institutions, credit institutions – are given a high weighting compared to issues related to governance, agency and decision-making by human actors. This, of course, has to do with disciplinary specialisations, as the interest in governance, agency and decision-making processes is more likely to be found in institutional economics and management research. The availability of "hard facts" is also likely to play a role in the structural factors.

As cluster ambidexterity is part of the field of decision-making and strategy development, it belongs to the subject area of agency and governance. By scrutinising ambidexterity, we are moving on the "soft" side of resilience research. Regarding ambidexterity, the following elements gain importance:

- intentional acts of individual people and their organisations;
- an environment and sphere of action of the people and organisations involved, which are characterised by contingency and uncertainty;
- individual idiosyncratic features of the cluster actors and the cluster itself (spatial economic environment, internal structure, modes of the interplay of individual firms, research institutions and higher educational institutions); and

- the role of individuals who develop new ideas and decide about the allocation of resources towards different purposes.

In view of what has been said about complexity, monocausal explanations of economic resilience will mostly fail as soon as more complex contexts are at issue. It would therefore be wrong to see ambidexterity as an exclusive key to the causal explanation of the resilience of industrial clusters, but it is one (partial) line of explanation that can help us to gain a better understanding of the whole phenomenon.

4. The case of the Ruhr Area Massive Steel Forging Cluster

In the following, we use our case of the MSFC to look at three aspects: the nature of the *challenges* faced by the cluster firms, the *reactions* of the firms and the cluster to these challenges and conclusions to be drawn from the observations.

4.1 Challenges for the cluster and individual cluster companies

The MSFC was confronted with substantial external challenges, which have accumulated over a longer period of time, commencing around the year 2010. Previously, the cluster itself and also the part of the automotive value chain in which these firms were located enjoyed stable conditions. Massive forging firms produced multiple parts that were used in automobile production. Some companies practised R&D themselves on a continuous basis, other (mostly smaller) firms also produced supplier parts based on engineering drawings from their customers. Some of the OEMs also had own massive forging departments that produced some of the parts. Innovation activities were mainly oriented towards cost savings (e.g. material savings due to improved product design), while customers gradually increased the cost pressure over time. At the same time, efforts were made to tap into new markets. The steel for massive forging was sourced from specialised steel manufacturers.

Multiple developments led to substantial and possibly life-threatening challenges for the cluster, but even more for individual companies (Table 1). In the course of time, competition from China became stronger, with Chinese companies supplying parts at lower prices. More recently, the increasing importance of e-mobility was associated with a totally new design of the automobile. The powertrain in which many massive forging parts are used is substantially smaller in electric cars than in cars with a combustion engine. At the same time, technical progress made better steel materials available and new possible markets for massive forging parts developed (e.g. in windmills). The combination of e-mobility and new competitors led to substantial threats to the most important existing markets for the forging industry and therefore also to the related cluster. The requirements to react to the impending external threats are quite different at the level of individual firms and the cluster. At the level of the individual firms, this would mean that the firms would be able to encounter the combination of new competitors, changes in the value-added chain and new technological possibilities by a combination of different possible responses in parallel to their routine business: developing new markets, developing new products and product variants and – related to these efforts – enhancing their research networks with suppliers, customers and universities/research institutes.

On the level of the individual firms, three steps had to be taken. Firstly, the decision-makers had to decide that different paths should be taken and take steps to implement this change. This took place in varying degrees in different firms, depending on the individual situation and characteristics of the responsible managers. In the second step, flexibility of the internal firm organisation was necessary to shift production to new materials. The interviews showed that this second step could be associated with substantial difficulties and resistance. In the third step, the network relations to the customers had to be rearranged. In

Aspect	Observation
Changes in configurations of the cluster	
Regulatory framework	Society/policy
Technology	– *Before*: Few influences of changing framework conditions – Environmental regulations Technology – *Before*: New steels mainly used in coatings – Possibility of new steels also in massive steel applications
Production and innovation regime	Markets – *Before*: Tendencies: Outsourcing at the side of the OEMs and systems suppliers; substantial cost pressure – *New tendencies:* E-mobility, new markets (wind turbines), competition from China Collaboration – *Before*: Rather low degree of cooperation – Increased cooperation (industrial collective research as framework)
Observations regarding ambidexterity and resilience	
Ambidexterity	Firm level – From the beginning different degrees of ambidexterity – R&D intensive firms, others working just based on engineering drawings – Some firms already developed into new markets Cluster level – Lock-in in the automotive value chain; modest role of new markets – Low degree of cooperation; exception: industrial collective research
Resilience	Individual firm: low degree of resilience – Before: Mostly low potential resilience because of fixed position in the value chain (exception: few mostly large firms) – No way to influence the changing car design; alternative markets are small Cluster – As with firms: Stable position over a long period of time, but no resilience to potential outside shocks – Changing situation: Only partly possibility to open up new markets – Ambidexterity can only partly (for some firms) ensure resilience because of shrinking market size for massive forging products

Sources: Own depiction, based on expert interviews with forging firms, firms in other parts of the value chain and representatives from research organisations

Table 1.
The MSFC – basic features, ambidexterity and resilience

the original situation, the exchange between the massive forging firms and their customers took place between the sales department and the buying department. On this level, however, no information about the advantages and disadvantages of new materials and product designs could be exchanged. The buying departments of the OEMs and systems suppliers were only interested in the costs of new parts and not in their material characteristics like weight, which could contribute to fuel savings. Therefore, new network relations between the R&D departments had to be developed.

4.2 Cluster actors' responses

There were multiple reactions of the single companies to the external threats. Larger firms adapted their research activities in particular to try to open up new markets (such as wind turbines) and also to experiment with new production methods. However, as these activities are part of the competitive core strategies and some of the activities had started years before our project started, it was not possible to understand all activities that were going on.

Common activities of the firms involved commenced in 2013 and continued until 2018, [5] while the adaptions of firm strategies and activities are still going on in 2023. Many of the firms with no own R&D department did not react in any apparent way.

In addition, an intermediate organisation – the *Industrieverband Massivumformung* (Industrial Association for Massive Forming) that has already existed for a long time – supported the cluster firms (and also firms outside the cluster as the *Industrieverband* is organised nationwide) in dealing with this structural change. Organised by the Association, several industry projects were initiated to gain information on the possibilities of using new materials and help in re-arranging the networks along the value chain. The projects were financed partly by the member firms, partly by a publicly funded programme for industrial collaborative research (*Industrielle Gemeinschaftsforschung*). These projects focused on lightweight forging (technical realisation with the use of new steel materials) and on estimating the potential weight loss that could be realised with a lightweight design. The OEMs and system suppliers did not actively initiate research activities but took part in network meetings. Their focus was on the consequences of e-mobility for the company as a unit.

The *preparedness* for the challenges and the related threats to competitiveness can be displayed in different dimensions. At the firm level, the degree of preparedness among the companies was substantially different. There were few rather innovative firms that looked for new markets from the beginning. Other firms were reluctant to substantially change their strategy. The internal units of the firms involved (production and testing departments) often approached the new situation very sluggishly. The existing network relationships were not adapted to the new situation from the beginning, because they focused mainly on the sales departments of the massive forging companies and the purchasing departments of the OEMs or system suppliers. To develop and sell new product designs, new network relations between R&D departments had to be developed.

The *Industrieverband* proved to be an important actor that supported ambidexterity. The *Industrieverband* also in the past had monitored new developments and taken care of the development of the relationship with universities and research organisations to gain knowledge about the potential of new materials. There was not much direct contact to firms that were not active in the *Industrieverband*, but it seems fair to assume that most of them did not have the necessary contact to universities and research organisations to attain the new skills. Overall, the industry was for the most part rather closely integrated into the inflexible structure of the value chain that made it difficult to develop into new markets. However, the industry-wide structure constituted a network that helped the firms out of the dilemma, while some more innovative firms were able to develop their own solutions apart from the common activities.

4.3 Ambidexterity and resilience: the case study perspective

When looking at the development that took place and is still going on in the MSFC, it becomes clear that ambidexterity is a feature that cannot be developed at once but has to be built over a long-time span. Ambidexterity of a cluster does not require each single firm to be ambidextrous, but rather that the cluster structure and ongoing processes lead to the development of options for action that can function in emergency situations as mechanisms to withstand critical external challenges.

When assessing our case, we cannot speak explicitly of an ambidextrous cluster. Rather, we can see that ambidexterity presents itself as a point on a continuum that ranges from pure routine orientation to an all-dominant future orientation that neglects the present business. The dominant ideas, actions and organisational structures of the cluster and

the companies/research institutes operating in it can be characterised by contradictions. The R&D department might be rather innovative, but if the internal structures of a firm are rather sluggish, this could pose a problem for the whole process. At the same time, intermediate organisations (like cluster organisations or the *Industrieverband* that in this case took a similar position as cluster organisations in other cases) could play an important role for cluster ambidexterity. They can identify new trends and subsequently support research activities and the necessary adaption of cluster networks.

Whether and to what extent the developments described in the MSFC will lead to cluster resilience in the medium and long term is not yet clear as the developments outlined here are still going on. However, possible success or failure is not only linked to ambidexterity. Being innovative in developing new massive forging parts could partly offset the cost pressure from external competitors. E-mobility will substantially shrink the market for massive forging parts. New markets that are developing probably are likely to be substantially smaller than the shrinking market in the automobile industry. This shows that while ambidexterity can contribute to economic resilience of the cluster, it cannot guarantee it on its own.

5. What are the relationships between cluster ambidexterity and resilience?

5.1 Towards an evolutionary theory of cluster ambidexterity

In this section, we generalise the insights gained. Resuming the thread of discussion on cluster resilience and ambidexterity and of our illustrative case, we place ambidexterity in the context of cluster evolution and describe its possible role in times of turbulences caused by challenging external circumstances.

5.1.1 Contingency as a challenge. Industrial clusters operate in an economic, social and political environment that is characterised by contingency (Bathelt and Glückler, 2018, p. 46f.), i.e. the principal possibility of unforeseeable events and developments in their environment and regarding the future development opportunities of their own entity. Different short-, medium- and long-term development trends overlap, counteract or reinforce each other, while clusters as well as economic regions and agents are also constantly adapting (Martin and Sunley, 2015).

Essential ideas of the business contingency theory (Donaldson, 2001; Ebers, 2004) can be transferred to cluster development as they attempt to analytically capture adaptation processes of the business organisation to internal and external contingencies of any kind (such as external shocks). These prove to be necessary when business performance declines to achieve a new fit of the business organisation to the changed external and internal parameters through reorganisation processes. This analytical approach originally based on comparative-static models recently gives room to evolutionary approaches (Donaldson, 2001, p. 245ff.).

On the cluster level, the contingencies of external influences can relate to a wide variety of issues, such as the development of the industrial sector dominating the cluster, disruptive changes in technology evolution, significant changes of the knowledge and resource basis available in the cluster region, developments among suppliers at the upstream stages of the value-added chain, ups and downs in the development of product-specific or overall economic demand. Forward-looking action in parallel with normal business operations may, if necessary, create the conditions for defence potential to be available when latent threats manifest themselves. Of course, attempts to break new ground can lead to failure (as, e.g. in the case of Lucent Technologies; cf. Ferrary, 2011) and thus to a waste of valuable resources. One factor to be emphasised here is the extremely pronounced heterogeneity of cluster constellations in terms of industry, life cycle stage, company population and size structure, production and knowledge networks, embedding in regional and interregional

networks, regional economic and social environment, regulatory framework, presence of other accompanying institutions such as research and educational institutions, credit institutions, VC providers and many other parameters.

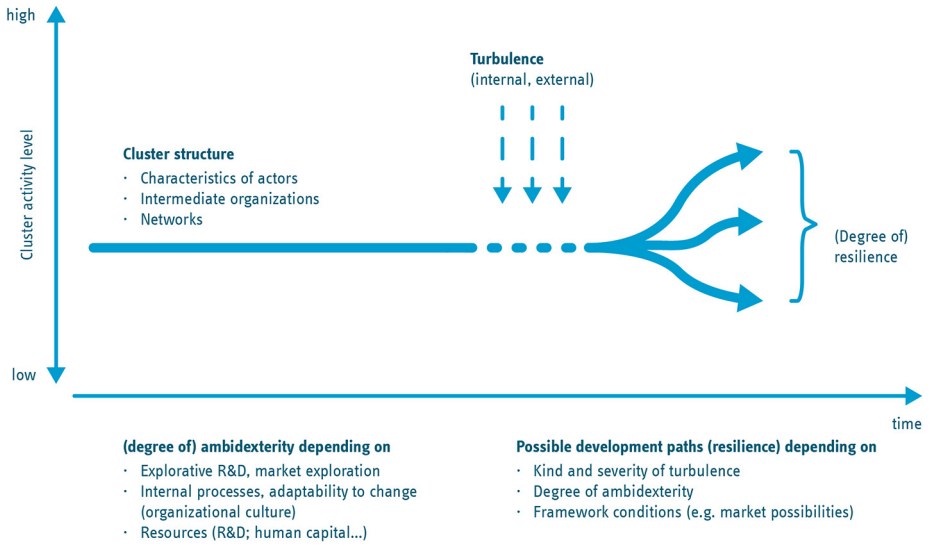
Cluster actors can respond to the challenges of contingency in a variety of ways. Frequently observed rather destructive general human behavioural patterns – that decision-makers in companies display just like other people – are ignoring, suppressing or denying imminent dangers (for an impressive example from general history, cf. Festl, 2019). The positive counterpart to this is proactive behaviour. In the case of cluster actors, this includes attempts to anticipate possible disruptions and changes in technological and market development and to take precautions so that one's own company can withstand the impending burdens. Whether and when one or the other response is chosen depends on many factors, including structural factors that condition path dependencies and idiosyncratic factors that determine the cluster actors' reaction. The broad spectrum of influences that might determine the reaction to external influences ranges from personal dispositions of decision-making individuals to macroeconomic conditions.

5.1.2 Cluster ambidexterity, contingency and structure. Ambidexterity, practised in R&D and innovation, in the design and continuous development of sourcing and supply relationships, in the maintenance and expansion of vital relationship networks, can be seen as an attempt by cluster companies to make suitable preparations at an early stage for a later fit of their own organisational arrangements to future changed constellations. It is the result of strategic orientations of the cluster actors, which contains elements of both calculated and spontaneously grown intuitive strategies (Mintzberg, 1995, p. 415). Ambidexterity can become an important feature of the companies during environmental turbulence. If there is a critical mass of corresponding ambidextrous features and activities in the cluster, we can speak of cluster ambidexterity, which was only partially the case in our illustrative case study.

The characteristic of ambidexterity or the strategy aimed at bringing it about is not merely the result of decisions that were at the discretion of the responsible individuals. The voluntaristic component, which is inevitably inherent in many human decisions, is subject to narrow limits, which in the case of clusters are determined by structural factors associated with path dependencies as well as idiosyncratic contextual circumstances.

As soon as external challenges arise, the question arises as to whether the cluster actors succeed in countering them with the previously exploratively developed solution models, provided that the cluster actors have taken precautions in the relevant area. Figure 2 depicts possible effects of cluster ambidexterity on cluster resilience. In principle, in the course of the due adjustment and restructuring process, it is conceivable that there will be a shift to the previous development path (middle position on the right), an upward development or – in case of failure – an economic decline.

It should be taken into account that the individual firms located in a cluster benefit or suffer very differently from adaptation and development processes of any kind (McCann and Folta, 2011). The degree of resilience of a cluster can only be shaped actively within limits. A multitude of highly specific constellations of structures and contextualities is conceivable, under which, on the one hand, ambidexterity emerges in a specific way and, on the other hand, in each individual case – whatever the concrete constellation – ambidexterity has the possibility of positively influencing adjustment processes to external change. Grabher (1993) uses the example of the Ruhr region to analyse the implications of lock-ins in old industrialised regions for their structural renewal, which amount to very limited possibilities of renewal processes prepared by ambidexterity. Other authors paint a more



Source: Own depiction

Figure 2.
Cluster development, ambidexterity and cluster resilience

optimistic picture of the possibilities of undermining the formative influences of path dependencies (Boschma, 2015; Martin, 2009).

Among the key factors that determine the economic resilience of clusters are, among a large number of possible influencing factors, in particular:

- the stage in the cluster life cycle at which the challenged cluster is located (Bergman, 2008; Fornahl and Hassink, 2017; Menzel and Fornahl, 2010);
- the industrial sector that dominates the cluster;
- the scope and sectoral as well as size composition of the cluster's business population;
- the knowledge base of the region, including the presence of business-related research institutions and educational institutions;
- the characteristics of the technology field in which the cluster firms operate such as the relevant innovation cycle (Li *et al.*, 2022);
- the degree of industrial diversity in the cluster (Brown and Greenbaum, 2017);
- the presence of efficient accompanying institutions associated with the cluster's industrial complex, such as lending institutions and VC providers; and
- the resource base (actual and potential labour force pool, infrastructure facilities, logistical integration into the wider economy) of the cluster region.

5.1.3 Ambidexterity in the context of economic resilience. Given these inevitable limits to the possible influence of ambidexterity, conceivable constellations of results of the effect of ambidexterity on resilience are shown in Figure 3. Under the impact of external threats, ambidexterity can, in the best case (Quadrant I), lead to the disruptions being successfully overcome and the cluster returning to the old or a modified path of sustained prosperity.

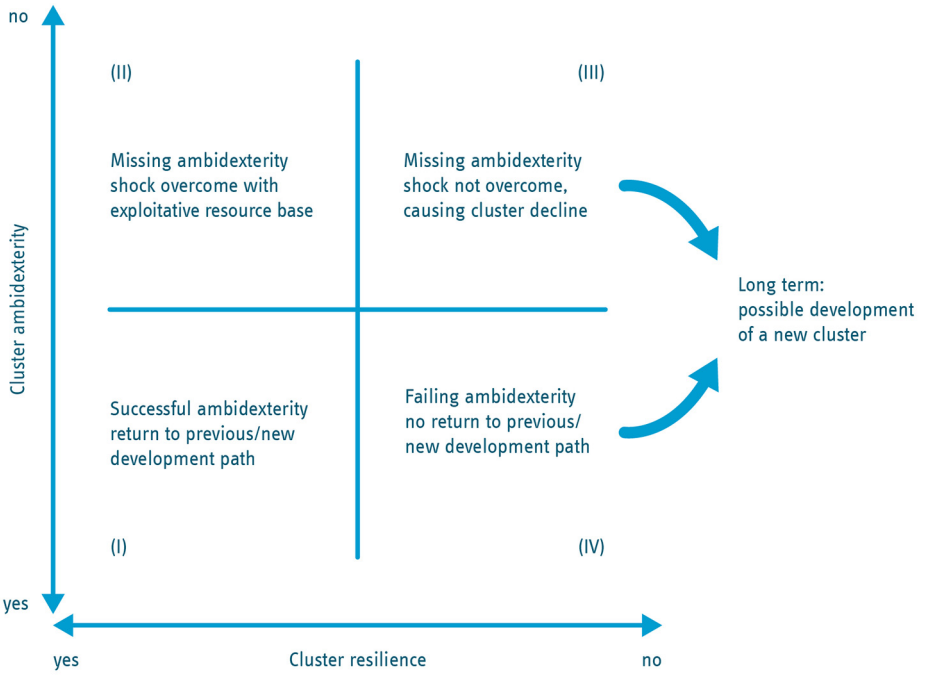


Figure 3.
Ambidexterity and resilience at the cluster level: possible constellations

Source: Own depiction

A long-term stable development could also result from a "strategy" of full mobilisation of the proven (exploitative) resource base in turbulent times without the previous development of new alternatives (Quadrant II). In this – probably less likely – case, the cluster proves to be resilient from an ex-post perspective without being ambidextrous. However, failing ambidexterity (Quadrant IV) can lead to an impasse of low economic resilience like its absence (Quadrant III). In the long term, the situations (III) and (IV) open up the possibility for a cluster region to develop a completely new cluster based on a new activity field, a case described by Fornahl *et al.* (2012).

Whether one or the other outcome variant occurs is, of course, always strongly dependent on the structural and contextual conditions. These will differ substantially in many cases, even when it comes to clusters of the same industrial sector. Thus, contingency leads to a situation of uncertainty in which it is not predictable ex ante, whether ambidexterity leads to cluster resilience (Quadrant I) or whether the efforts are not successful (Quadrant IV). Lastly, the quality of the exploratory effort arrangements expressed in ambidexterity plays a role. Qualitative aspects encompass the technological solutions that are chosen as well as the type and volume of resources devoted towards new paths.

5.1.4 Possible contribution of cluster ambidexterity to an evolutionary theory of cluster development. To understand the role of ambidexterity in cluster evolution, it is useful to refer to a central insight of the theory of evolution of complex adaptive systems (Holland, 2010; Kauffman, 1996; Krakauer, 2019), which has been taken up by evolutionary economics (Arthur, 2015; Foster, 2000; Nelson, 2000; Nelson and Winter, 1996): new variants of existing technologies, market solutions, organisational forms, etc. emerge through human

experimentation. Those variants that compete successfully displace the previously dominant or less successful competitors: Against this background, ambidexterity turns out to be an essential mechanism for coping with the contingencies arising from the permanent change of a dynamic cluster environment. Ambidexterity of a cluster (or any organisation) is the attempt to make provisions for future challenges resulting from the constant change of its own environment in parallel to the routine-determined standard business that dominates the cluster activities in times with no turbulences. Ambidexterity is always associated with opportunity costs, which are offset by the hoped-for but uncertain benefits from a greater ability of the cluster actors to assert themselves against adverse events and developments in the future. It offers no guarantee of economic survival, but it can be a useful means of increasing the cluster's resilience to challenges from outside.

6. Summary and conclusions

This paper uses the concept of ambidexterity, a research approach developed in business organisation theory (Birkinshaw and Gupta, 2013), to examine the influence of proactive strategic behaviour of cluster actors on economic resilience. We apply the concept of ambidexterity to regional clusters and discuss the possible role of ambidexterity as determinant of cluster resilience. The MSFC is used as an illustrative case for our argument.

Firstly, we look at ambidexterity in the context of an industrial cluster (*RQ1)*. The analysis shows that ambidexterity of individual cluster actors can lead to a situation where, as soon as a critical threshold is exceeded, the cluster takes on ambidextrous features, i.e. is characterised by a combination of exploitative and explorative activities that varies in the respective strength of both sides. Cluster ambidexterity can come about in very different ways. As a result of independent activities of individual cluster actors, through the close networking of ambidextrous cluster actors, or through the action of a common cluster organisation charged with explorative activities.

When looking on the determinants of the cluster's economic resilience (*RQ2)*, we find an extremely complex constellation of various influencing factors in a constantly changing complex adaptive system (Boschma, 2015; Martin and Sunley, 2015). The relevant determinants can be categorised into three large groups – other classifications would also be possible – structural and contextual factors as well as factors connected with people's intentional actions, which can be summarised under the headings of agency and governance. Ambidexterity belongs to the latter group.

We find that cluster ambidexterity can, under favourable circumstances, prove to be a driver of renewal for an economically challenged cluster (*RQ3)*. In this respect, it contributes to the economic resilience of the cluster. However, it would be wrong to see ambidexterity as a panacea for solving the problems of clusters in crisis. Explorative activities do not necessarily lead to favourable outcomes in attempts to adapt to external threats. A multitude of structural, contextual and intentional factors influence the (degree of) resilience of a cluster; only their complex interaction can bring about resilience. The ambidexterity concept is suitable as a building block for an evolutionary theory of cluster development. From an evolutionary perspective, the ambidexterity of clusters can be considered as a mechanism for coping with environmental contingency, which can involve both sudden shocks or the gradual questioning of the familiar technological and economic foundations on which the cluster's economic prosperity is based.

Four conclusions concerning the future research agenda and cluster policy can be derived from our analysis. Firstly, cluster ambidexterity is a fertile field for empirical studies of cluster resilience. For example, comparative case studies of the reactions of distressed clusters with the same sectoral profile and similar threatening constellations of environmental changes would be

useful. Also of interest would be the emergence of ambidextrous behaviour of a single cluster actor and the extent to and transmission channels by which ambidexterity of individual cluster players or a group of cluster actors shapes the orientation of the entire cluster.

Secondly, in the more theoretically oriented research on the evolution of industrial clusters, research approaches that emphasise structural factors (sector, cluster population, resource potential) have naturally carried more weight so far because they are generally more accessible to empirical research. Therein lies the risk that deterministic views of cluster development in the form of supposedly inescapable path dependencies (Martin, 2009) or cycles of development are given too much weight. By contrast, many idiosyncratic and contextual factors are possibly not regarded enough. This concerns all factors that relate to the intentional actions of the individuals working in the cluster, i.e. in the broader sense of the agency of the cluster events. The integration of agency and governance into a theory of cluster evolution could make a useful contribution to a more thorough theoretical illumination of the role of individuals' decisions and actions as well as idiosyncratic factors in cluster development.

Thirdly, ambidexterity is important for the strategic management of common activities of actors within the cluster, provided that there is a cluster organisation or there are common activities of cluster actors focused on cluster ambidexterity. Balancing the evolutionary and constructive forces of the cluster (Sölvell, 2008) is a challenge that is amenable to learning processes. Cluster managers could, for example, learn from each other by exchanging knowledge with other cluster managers through sharing their own experiences of successes and failures.

Fourthly, a central result of cluster research on cluster policy is the realisation that cluster policy concepts based on the motto "one size fits all" are misguided in view of the enormous diversity and context sensitivity of the cluster scene (Grashof, 2021; Tödtling and Trippl, 2005). A closer look at ambidexterity leads to a stronger focus on the specific, idiosyncratic features of cluster activities and their accompanying circumstances. It is likely to enhance the sensitivity to the contextuality of the development of the clusters to be promoted and of the actions of the cluster actors and can thus support solutions, which are tailored to the individual situation of the clusters concerned.

Notes

1. The MSFC developed in the context of the Ruhr iron-steel complex and emerged through decades of market processes. It was neither triggered by cluster policy nor was it a special object of cluster policy measures.
2. In this paper, we use the term "cluster actors" to refer to firms, research and other organisations that are part of the cluster. If occasionally the role of individuals active in these organisations is addressed, this should be clear from the context.
3. Based on data from the Federal Statistical Office of Germany for 2020. Source: www.massivumformung.de/branche/branchenstruktur (accessed on 07/22/2022), RWI/ika 2018.
4. In this research project, participation took the form of an accompanying analysis of the technology transfer process, with the task of identifying barriers to knowledge exchange.
5. www.massiverleichtbau.de/startseite/ (last accessed on 14 September 23).

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