

## Everywhere the same? Competitiveness of two regional vegetable production clusters in Southern Germany

### RESEARCH ARTICLE

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### Abstract

German vegetable production is characterized by its pronounced variety of cultivated vegetable crops. There are also large differences among distinct production regions in terms of climate conditions, farm structures and marketing infrastructure. Two of the most important vegetable production regions in Southern Germany are the so-called ‘Knoblauchland’ (Garlic Country) in Middle Franconia and the open-field production region in Lower Bavaria. Although these two vegetable production regions are geographically not far apart, they show distinct differences in size of the region, their historical development, and different scope of production. This paper analyzes the competitiveness of the two vegetable production regions following Porter’s definition of industry clusters and his Diamond model. Applying this approach, competitiveness is specified by four bundles of determinants, namely factor conditions, local demand conditions, available supporting industries, and type of rivalry and strategies. The cluster concept emphasizes the importance of the interplay of the different determinant bundles and, in addition to the existing networks and competitiveness, it also helps identify possible options for improvements of the framework conditions. Thus, practical implications have been derived on how cluster stakeholders can mitigate weaknesses such as unfavorable conditions, and further combine their strengths to increase competitiveness in the long term.

**Keywords:** cluster, competitiveness, Diamond model, Porter, vegetable production

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## 1. Introduction

The German vegetable production is a relevant part of the national agricultural sector and characterized by a strong diversity among federal states (e.g. Bavaria) as well as among individual production regions in terms of market concentration, vegetable crops grown, and general production and marketing structures. At the same time, the potential for future development of individual production regions also varies, especially in the face of increased competition, in large parts from foreign imports. If one looks at specific production regions as separate production clusters, the competitiveness of these clusters can be evaluated based on different determinants, depending on the characteristics of each region.

In agriculture, a continuous trend toward the formation of regional production clusters can be observed worldwide. (Li *et al.*, 2022). In this line, research into these developments and effects on the actors involved have also attracted the attention of scholars and academics (Sporleder, 2009). Of course, literature does not focus exclusively on agriculture. On the contrary, it predominantly refers to other economic sectors and industrial clusters. Cluster theory determines industrial clusters in any kind of economic sector as a geographic concentration of interacting enterprises and institutions (Galvez-Nogales, 2010; Porter, 1996). In a broader perspective, Porter defines clusters as ‘geographically proximate groups of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities’ (Porter, 1998: 78). Within this comprehensive definition, the geographic divisions can be composed of single cities or regions up to an individual country or even several neighboring countries. Porter assumes that a country’s competitive industries are not evenly distributed across that country. Rather, they are connected in groups of industries that are connected to one another in various ways that result in networks (Porter, 1998). These industrial clusters constitute a spatial concentration of companies, in which specialized suppliers, customers, service providers, and further influential institutions are connected to the respective industry directly or indirectly. The spatial territories can be grouped together at national or even international level, and they can also include metropolitan areas or regions. However, the markets of the clusters usually extend far beyond the territory (Bathelt and Glückler, 2011).

Industrial clusters have long been an important component of economic geography research. A large body of literature deploys cluster concepts to analyze and elaborate strategic tools for improving competitive advantage, improving production conditions, organizing networks within clusters, and implementing technological innovations (Gordon and McCann, 2013; Guiliani, 2008; Li *et al.*, 2022). With his theory of ‘the competitive advantage of nations’ (Porter, 1990), Porter made a highly regarded, referred, reviewed, but also criticized contribution to analysis of the (international) competitiveness of industrial countries in the 1990s (e.g. Davies and Ellis, 2000; Grant, 1991; Sölvell, 2015; Yetton *et al.*, 1992). This concept, known as the Diamond model, is not limited to the consideration of countries as clusters. Smaller geographic areas such as regions and regional industrial sectors can also be considered. Since its establishment, the concept has been widely used, e.g. in the study of industrial sectors at the regional level (Delgado *et al.*, 2014; Kowalewski, 2013; Resbeut and Gugler, 2016), in some cases in focused studies of the agriculture and food industry (Aguilar and Vlosky, 2007; Giuliani and Bell, 2005; Huo *et al.*, 2019; Serikow, 2017; Tavoletti and Te Velde, 2008). Often, the cluster model is used when investigating industries or regions in emerging markets and developing countries (e.g. Bhattacharya *et al.*, 2012; Poku *et al.*, 2018) to identify comparative advantages or constraints to competitive growth. The applications of the Diamond model range from studies of regions with multinational corporations (Lahti, 2013; Younes, 2012) to industry sectors dominated by small and medium-sized enterprises (Kharub and Sharma, 2016).

However, existing literature pays only limited attention to competitiveness of clusters in the agricultural sector which goes beyond the purely economic consideration of competitiveness indices (Dirksmeyer and Fluck, 2013; Mizik, 2021). Complicating matters further, these studies rarely distinguish between agricultural and manufacturing clusters, which means that the differences between agriculture and manufacturing in terms of cluster formation and development are often disregarded (Guiliani, 2008). In this context, agriculture is different from other industries because of its own underlying conditions, such as soil, climate, ecosystems,

and the handling of 'live' plants or animals. In addition, agricultural production stands out from other business sectors regarding many key elements of cluster formation such as the stakeholders involved, the multi-layered nature of commercialization of agricultural products, and the local roots of farmers as the central cluster actors. As family farms constitute most regions, characteristics such as business management, social constellations, and rural communities need to be considered (Li *et al.*, 2022). Another characteristic of agricultural clusters is the hierarchical imbalance between the production level and other actors in the multi-stakeholder value chains (Stringer and Heron, 2008). Here, the interdependencies and power differential between the stages of the chain in favor of the downstream segments (processing, distribution) are often greater than in other industrial clusters (Deconinck, 2021).

Regarding individual agricultural specialty crops such as vegetable, fruits and wine production, the scope of substantive cluster research is even more limited. Many of these sectoral studies refer to individual regions and address only narrow sectoral policy of these regions and are difficult to generalize. Yue and Cao (2021) analyzed competitiveness of the lemon industry in a Chinese district to explore strategies for high-quality development of this industry. In doing so, the authors identified shortcomings of coordination, of skilled workers, and of political support as distinctive peculiarities of this production cluster. A qualitative case study examined two emerging wine production cluster in different regions of the world (Giuliana, 2008). For both regions in Chile and Italy, it was found that the existing internal knowledge of the production companies and the external openness of the cluster participants are crucial drivers for the development of innovation and competitiveness (even more than a distinct intra-cluster network linking). Another study in the area of wine production focused on the measurement and analysis of the competitive performance of the wine industry of South Africa (Van Rooyen *et al.*, 2011). In this study, a qualitative survey and evaluation of the determinants of the Diamond model at two data collection points in time also showed the dynamics of developments in the competitiveness of this industry. Tavoletti and Te Velde (2008) applied the model to investigate both competitive determinants of an internationally successful regional Dutch flower production cluster, and concluded that competitiveness can be maintained despite disadvantages compared to developing countries (e.g. higher wages, less favorable climate conditions). The region under study compensates competitive disadvantages, among other things, with a high level of technology, extensive logistics system and existing human skills, to gain a competitive advantage over other global growing regions. In the field of vegetable marketing, Ekelund and Tjærnemo (2009) used the model to analyze the competitiveness of the vegetable retail sector in southern Sweden, in particular the role of specific actors in local food supply chains. They identified central chain strategies employed by retailers as well as local demand and an entrepreneurial innovation spirit as important factors in the development of local food clusters.

Existing literature is very limited in scope and quality to provide a comprehensive systematic overview of the competitiveness of regional agricultural clusters in industrial countries and, in particular, of European vegetable production. The present study analyses the competitiveness of two contiguous vegetable production regions in central Europe, for the first-time. A comparison of geographically defined production regions using determinants that describe the development of these food industry clusters provides valuable information for scholars, industry stakeholders and policy makers beyond the two regions under consideration. The use of the Porter's Diamond model to analyze and compare the competitiveness of the two regions follows Porter's definition of industry clusters. Information on the determinants of the model is empirically collected and evaluated through qualitative interviews with relevant cluster stakeholders in both clusters. The applied methodological approach can also be used to transfer it to other regions in Europe, to be able to compare developments in competitiveness of vegetable production clusters.

## **2. Vegetable production in Germany and study regions**

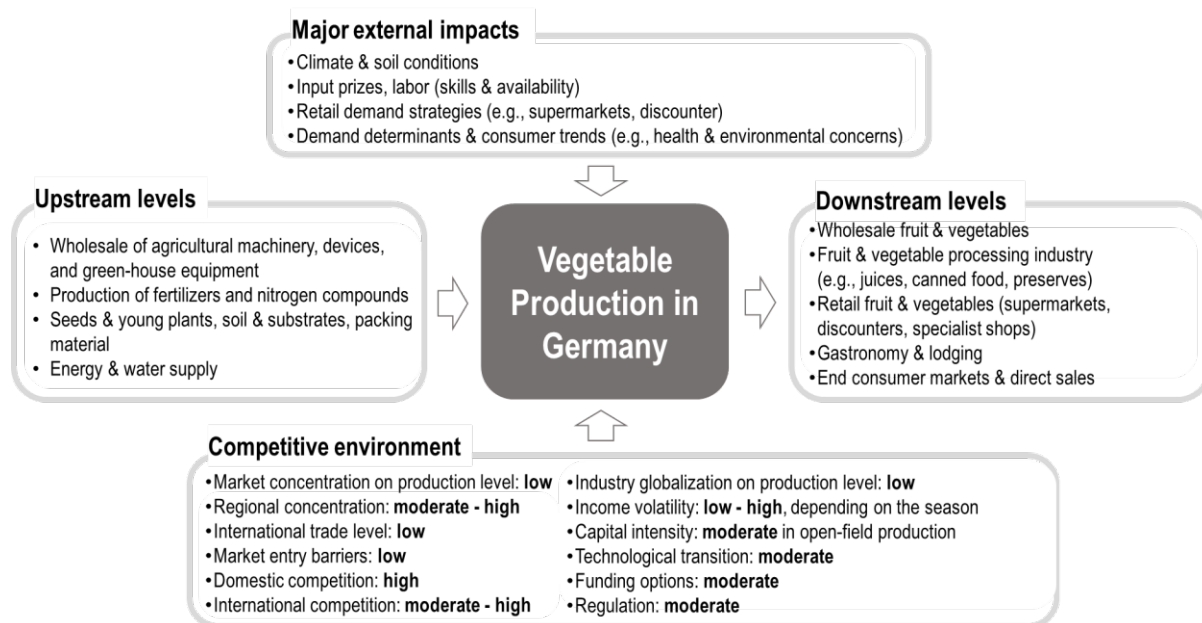
Germany's competitive strength on international food markets is characterized by a relatively high export share of food products among all EU member states (Juchniewicz and Łukiewska, 2021). However, this applies mainly to the export of meat, dairy products and cereals and only to a limited extent to vegetable products. The importance of vegetable production, as well as the structures that support it and their level of

development differ greatly in the individual federal states and regions of Germany (Strohm *et al.*, 2016). The two production regions analyzed in this paper are generally considered to be two outstanding vegetable production clusters in southern Germany. An introductory overview of the vegetable sector is necessary to understand the specific characteristics of the two regions analyzed and to evaluate the situation of both regions.

### 2.1 Overall situation of vegetable production in Germany and federal state of Bavaria

The production of vegetables has the highest gross value added of all branches of the German horticultural sector in contrast to the production branches of fruit, ornamental plants, and nursery products (Dirksmeyer and Fluck, 2013). The 2017 agricultural statistics for Germany showed a total of 6,500 companies with their main business focus in vegetable production and a total land area used by these companies for vegetable production of about 130,000 hectares. The production area includes 1,700 hectares under protective cover, such as greenhouses and foil tunnels (Destatis, 2018). The most important vegetable crops in open-field production in Germany in 2017 were asparagus (28,500 ha), carrots (13,000 ha), onions (11,500 ha), and a variety of cabbages (12,000 ha) (Behr, 2019; Destatis, 2018). With a total production area of 2,200 ha, pickling gherkins are not that widely cultivated, but still represent an important vegetable. Mainly fruit vegetables, such as tomatoes and cucumbers, and various lettuce varieties are grown in protected cultivation.

Depending on the crop domestic supply varies between less than 10% (e.g. bell pepper) to up to more than 80% (e.g. carrots, asparagus). The overall domestic supply has remained at a relatively stable level of between 35% and 40% in the last 15 years (Behr, 2019 and earlier issues). Slight annual variations between 1 and 2% can be largely attributed to weather-related yield fluctuations. Meanwhile, domestic per capita consumption has increased in recent decades from around 64 kg in 1980 to around 97 kg in 2018 (Behr, 2019). While these two trends seem to indicate a significant expansion of vegetable production in Germany, the highly competitive environment and volatile and seasonal impacts continue to shape developments in vegetable production and connected industries (Figure 1).



**Figure 1.** Market and competitive situation of the vegetable production sector in Germany (based on Anonymous, 2021).

In the vegetable sector, businesses at the production level are generally participants in value chains with several other actors at both upstream and downstream levels. Upstream levels include producers and suppliers of farm inputs such as machinery, seeds, fertilizers, and pesticides, as well as energy and water suppliers. The downstream level can be divided into two sublevels: Direct customers in both, wholesale organizations and the vegetable processing industry constitute one sublevel. The other sublevel consists of food retail chains, which supply end consumers, and bulk buyers, such as catering and accommodation businesses. Primary producers in the vegetable production sector in Germany are known to use a wide variety of distribution channels. In addition to marketing to actors at the wholesale level, producers also sell directly to the retail level (mainly supermarkets and discounters) and to end consumers (direct farm sales, weekly markets, etc.). This diversity is explained by a low market actor concentration at the production level with many small self-marketers and a low number of cooperative marketing organizations. Approximately 28% of the sales volume at the wholesale level is allocated to producer cooperatives (Strohm *et al.*, 2016). Along with this weak concentration, entry barriers are low at the production level. However, the number of companies, particularly small ones, has steadily declined in recent decades.

A significant share of vegetable produce is passed on to the food processing industry. Companies involved in vegetable processing dry, cook and preserve vegetables, which are either used in other food-producing sectors and gastronomy, or distributed to the retail level. In contrast to the other industries associated with vegetable production, wholesale trade has continuously lost importance in recent years. In order to reduce costs, more and more food retailers and restaurants buy their products directly from vegetable farmers and cooperatives, and thus, eliminate the need for intermediary wholesale trade.

The total market consumption of fresh and processed vegetable products in Germany over the past ten years has ranged between 7 and 7.5 million tons (Behr, 2011, 2019). During that same period, the German retail market has been characterized by imports of fresh and processed vegetable products. Depending on the type of vegetable crop, German producers experience moderate to high international competition in the domestic retail market. For most vegetables, EU-28 countries accounted for over 90% of total imports (UN, 2019). Especially for fruiting vegetables (e.g. tomatoes, cucumbers, gherkins, and peppers), Germany's main supplier countries are the Netherlands and Spain. Export amounts of fresh vegetables are comparatively low, so that, in contrast to processed vegetable products, the degree of globalization of domestic actors at the production level is also low.

Due to the distribution of distinct production areas in cluster regions all across Germany, companies face an increase in competition at the regional level. A large proportion of fresh and processed vegetables reach end consumers through food retailers (estimate of 70%; Behr, 2019). This leads to severe price and quality pressures on both producers and wholesalers, and thus, to fierce competition. In addition to seasonal uncertainties in production yields, price negotiations and daily trading also have an impact on the volatile income situation of producers. Many vegetable growers are, therefore, forced to find ways to reduce expenses (e.g. by producing abroad), to look for niches, such as organic production, or to develop innovative products or strategies (e.g. extending supply periods).

Strohm *et al.* (2016) provided an overview of the regional distribution of important vegetable production clusters in Germany. The authors see geo-climatic conditions, historical developments, proximity to potential markets, existing transport infrastructure, and regional water availability as key factors for the different characteristics of individual production regions. Individual entrepreneurial decisions (e.g. choice of location of processing companies) can also promote cluster formation and change specialization within a region. On the whole, German vegetable production is characterized by its diversity in terms of both vegetable crops cultivated, and scope of production. The two vegetable production regions considered in this paper demonstrate major differences with regard to company structures, production scopes, and established distribution channels.

## 2.2 Basic features of two vegetable production regions in Bavaria

Bavaria, situated in the south of Germany and the largest in terms of area and second most populated German federal state, yet with a relatively low population density, has a long tradition in commercial vegetable production. Following North Rhine-Westphalia, Rhineland-Palatinate and Lower Saxony, Bavaria has the fourth largest share of the total commercial vegetable production (14%) in Germany (Destatis, 2021). Since the mid-1990s considerable increases in the yield of almost all types of vegetables have been observed in Bavaria, making these types of horticultural products more competitive (Sutor *et al.*, 2019). Similar to other agricultural production sectors in Germany, structural change can be observed in cultivation and marketing of vegetables in Bavaria. For decades, there has been a continuous trend towards fewer but larger farm units and an increasing share of the marketing of vegetables through food retail chains. Currently, Bavaria has the second largest share of protected vegetable crops in Germany and 19% of the total greenhouse area in commercial horticulture in Germany (Sutor *et al.*, 2019). The main distribution channels for vegetables from Bavaria are interregional marketed industrial vegetables (e.g. pickled vegetables) and the sale of fresh vegetables via either food retailer chains or through large marketing cooperatives. Two of the most important regional vegetable production regions in Bavaria are the area known as ‘Knoblauchland’ (Garlic Country) in Middle Franconia and a highly concentrated area of open-field vegetable cultivation operations in Lower Bavaria. Garlic Country has a long tradition of agricultural production with currently about 130 farms cultivating vegetables. Geographically located between the cities Nuremberg, Erlangen and Fuerth, Garlic Country covers around 1,900 ha of agricultural production (Moninger and Schmidtell, 2017), about 900 ha of which are used for vegetable production (Bavarian State Statistical Office, 2018). A large part of the production is cultivated on open fields, but the proportion of land under protected cultivation is increasing (mainly fruit vegetables such as tomatoes, cucumbers, peppers). The vegetable farms in Garlic Country are mainly family-run and employ up to 150 seasonal workers, depending on the type of production.

In addition to its central location in the middle of the metropolitan region of Nuremberg, the region’s advantageous interregional infrastructure and transport connections, as well as an established well-functioning irrigation concept with its own water association, can be seen as the region’s advantages (Moninger and Schmidtell, 2017). Another characteristic of vegetable production in this specific region is a high level of specialization. Organic vegetable production also plays an increasingly important role in the region. A closer look at the social farm structures in Garlic Country shows it to be a compact and socially cohesive territory with a new generation of highly motivated producers who continually strive to comply with market standards and diversify their production to adapt to changing consumer demands. As a consequence, Garlic Country has reached a production level that exceeds local demand. Currently, vegetables produced in Garlic Country are marketed both regionally and in markets beyond the region. However, land scarcity and market requirements have posed challenges in open-field production. The proximity of Garlic Country to larger towns in a metropolitan region creates opportunities for the further development of both organic production and regional marketing. Due to the resultant increase in sales, however, competition for production land has intensified even more, and with it land values. Greenhouse construction for a continuous and sufficient production of vegetables in the limited production area is one strategy to keep the region competitive.

The second vegetable region analyzed, Lower Bavaria, is an official district of the federal state of Bavaria. A regional section of this district, which stretches over parts of three subdistricts, is a contiguous region of vegetable production. To simplify, this production region is named ‘Lower Bavaria’ in the following. Lower Bavaria has developed into one of the most important growing and marketing regions in Germany for open-field vegetables. Around 45% of the open-field area of Bavarian vegetable production (about 5,600 ha) is located in this region. Lower Bavaria contains the largest contiguous cultivation area for pickling gherkins in Europe, and the largest production area for onions in Germany. The cultivation area used to produce these two types of vegetables, combined with that used for extensive asparagus production, constitutes more than half of the total vegetable production area in the region (Bavarian State Statistical Office, 2018). Besides, a wide variety of other vegetables are grown, with different regional and interregional distribution strategies.

Farm sizes range from small family farms to partnership companies with 40 or more permanent employees. A considerable part of the cultivation is done on leased land. In gherkin production, however, there are also individual actors who, in addition to their own production areas of up to 150 hectares, process a significant part of their harvest on an industrial scale. In recent decades, open-field vegetable production in Lower Bavaria has undergone substantial development, and producers currently benefit from established structures that facilitate both production and marketing. Although the further development of vegetable production might face challenges due to climate change, available land with good soil quality still seems to offer opportunities for increased production. Adverse weather conditions have so far not caused as drastic effects on yields in Lower Bavarian vegetable production as in other production regions in Europe. Meanwhile, the consequences of climate change and a limitation of irrigation options are becoming an important issue in this region as well. Regarding marketing, many of the established production and processing companies in the region rely on long-standing and stable relationships with the retail sector. The reliability of supply and the high quality of pickled vegetables from Lower Bavaria is well known in other European countries (e.g. Netherlands, UK, Czech Republic) thus, demand is consistently high. As production requires a relatively high number of seasonal workers, labor costs are also high relative to other areas of vegetable production. The quantity and price of vegetables produced in Lower Bavaria specifically for processing into pickled vegetables are mainly contractually arranged. Marketing of these processed products is carried out mainly by the local processing industry (i.e. producers of pickled gherkins and sour canned food); and occurs beyond, with a large part of the goods being destined for export. Vegetables produced in Lower Bavaria that are intended for sale as fresh product are sold almost exclusively to regional food retailers.

Although the two vegetable production regions studied are only about 150 kilometers apart, they show pronounced differences. In addition to the size of the regions, basic differences are, e.g. their historical development and their scope of production. Thus, both regions are clearly distinct from other contiguous vegetable production regions in Bavaria and Germany. An analysis of the competitive situation of a spatially limited region ('production cluster') must therefore include all related external and internal factors, and associated protagonists.

### 3. Porter's diamond model

The two production regions considered in this article include the entire value chain from the production to the marketing of vegetables. Thus, both regions can be considered as distinct and geographic concentrations (clusters) of companies and institutions operating in the field of vegetable production. The integrated concept of the Diamond model considers the complexity and interdependencies of various determinants, which are represented in the framework (Figure 2). Interregional or international competitiveness of a specific regional cluster results from local industries successfully competing against other regional and interregional competitors (Maaß and Khanzadeh, 2004).

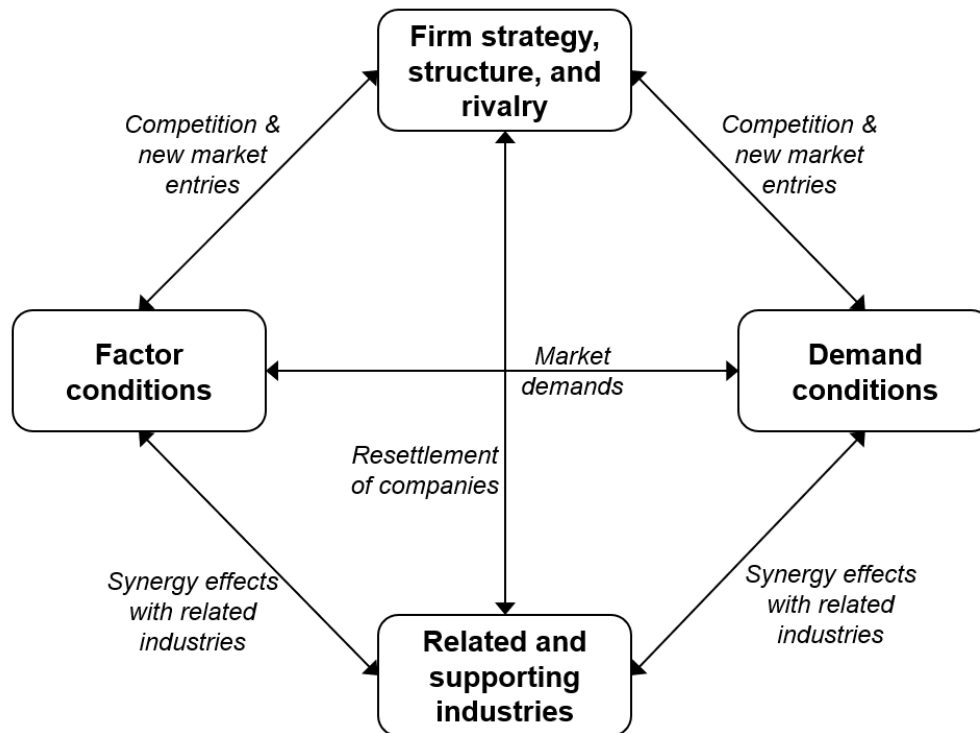
Porter identified four main components or bundles of determinants that shape the environment, in which the cluster actors compete and that influence the competitiveness of companies involved:

#### 1. Factor conditions

This first bundle encompasses determinants of quality and quantity of various production factor endowments, such as workforce and infrastructure, which are necessary for a regional cluster to be competitive in a specific industry, including:

- basic factors (e.g. natural resources, unskilled and semi-skilled workers);
- advanced factors (e.g. tangible and intangible infrastructure; highly skilled workforce);
- specialized factors (e.g. sector-specific banking, specialized research).

Depending on the level of development of a production cluster, the requirements can change. The mere existence of the factors is not sufficient to achieve a competitive advantage. Productive use of the determinants and



**Figure 2.** Diamond model framework – bundles of determinants and self-reinforcing effects (based on Hartmann, 2013; Porter, 1990).

the creation of determinant-forming processes are also required. Finally, some factors' disadvantages may have a positive effect if they trigger innovation and modernization processes (e.g. increased mechanization in the absence of adequate labor supply).

### 2. Demand conditions

Porter highlighted the presence and nature of local customers as having an effect on sector growth and competitiveness. Regional demand has a decisive influence on how concrete advantages can be transferred to international markets. Domestic demand has three characteristics, the nature of consumer needs, the scale of the growth pattern and the mechanisms by which the benefits are transmitted. A cluster has advantages if domestic demand provides a clear picture of consumer needs (Porter, 1990). Thus, domestic consumption can also have an effect on the export competitiveness of an economic sector in that it provides motivation for innovation by cluster actors in order to continuously meet changing customer requirements (Huo *et al.*, 2019). The analysis of the demand for products and services and the resulting quality pressure pushes producers to develop and implement innovations (Porter, 1990).

### 3. Related and supporting industries

If local suppliers and related or associated industries are also (internationally) competitive, they provide cost, scale, coordination, and networking advantages (economies of scales) that can lead to competitive advantages for the cluster. Close relationships between producers, suppliers, and customers can support innovation processes. Availability of successful and competitive suppliers and customers within the same cluster is also a potential driver for the job market of specific industries (Kowalewski, 2013).



#### 4. Firm structure, strategy and rivalry

A common feature of production clusters following the definition of Porter is that there is competition between the companies involved. Porter considered this competition to be more beneficial than that with foreign companies due to its regional nature. He attributes this benefit, for example, innovation is more easily triggered by the exchange of information and communication among neighbors. Thus, this type of competition drives constant innovation and leads to a higher degree of quality and competitiveness. The replacement of static locational advantages with more dynamic advantages has positive effects on the overall production cluster (Porter, 1991). Thus, the existence of regional sectoral clusters has a major impact on the strategic position of associated firms (Schiele, 2008).

In the cluster framework, the exchange of knowledge amongst cluster players leads to joint learning processes. This results in improved solutions and innovations within the cluster and helps to raise competitive chances of both, the participating actors, and the regional economy through increased productivity. Production clusters thus develop because they increase the productivity of companies in competition. Higher productivity can be triggered by: (a) improved factor conditions through the close proximity of several companies (e.g. specialized labor market, domestic demand); and (b) a higher probability of developing necessary specialized infrastructure and faster establishment of new actors (e.g. spin-offs, start-ups).

Porter's Diamond model can be an effective instrument for identifying ways to improve the economic and social conditions in a geographic unit, e.g. to secure jobs and improve living standards in the region. At the economic level, productivity and competitiveness are primarily determined by the innovation potential of a cluster, and by the exploitation of competitive advantages that arise from within the cluster.

In addition to the characteristics of the four determinant bundles, their dynamic interactions also provide indications of the innovative capacity and competitiveness of a cluster (Porter, 1990). Market entry barriers and their impact on the establishment of new suppliers and related industries as well as the fulfilment of market needs can be derived when the Diamond concept is applied on a specific production cluster. For example, the impact of rising domestic demand results in increased pressure on firms to improve factor conditions. Favorable factor conditions and high (local) demand, in turn, lead to intensified local competition and higher barriers to entry in a production cluster.

Porter (1990) himself extended his model by two independent additional concept components 'chance' and 'government', either of which can directly influence each of the four basic bundles of determinants of the Diamond concept. Governmental intervention can have a supportive effect on a sector, and the competitiveness of companies. For example, companies benefit, above all, from a stable governmental system, an effective healthcare system, and professional education and research facilities. Porter emphasized the governmental factor and its intervening potential, and highlighted access to public goods, public contracts, market entry barriers, antitrust law, and the level of market liberalization as important elements. However, representatives of regions decide on the amount of public support depending on the competitiveness of the existing industrial clusters (Stejskal and Hajek, 2012). All of these elements can have an impact, e.g. on improving the inventory of factors while encouraging companies to actively increase their competitive advantage. Since both regions analyzed in this paper are operating in the same economic sector (vegetable production) and due to the spatial proximity of the two clusters, no considerable differences in impacts by government are to be expected, and therefore not considered further. Furthermore, events by chance, such as national economic downturns, sudden availability of disruptive technologies, and pandemics are largely unpredictable. A serious assessment of the impacts of such changes on competitiveness is hypothetical and does not address the main objective of comparing the situation of the two clusters. Thus, 'chance' as independent external determinant of the concept is also not considered in the analysis of the two vegetable cluster regions presented in this paper.

The Diamond concept is also subject to considerable criticism. One limitation is that while the use of productivity as a central parameter is suitable in developing production clusters, the same is debatable for

mature industry sectors (Davies and Ellis, 2000; Yetton *et al.*, 1992). Nevertheless, mature and traditional industries such as agriculture production and food industry can also increase productivity and achieve greater competitiveness through the implementation of improved processes (e.g. mechanization, measures to ensure more environmentally friendly methods of field production), innovations (e.g. climatically adapted vegetable varieties), and more generally, by increasing knowledge (Porter, 1990). Oftentimes, the question arises whether the model is suitable for application in every economic sector, especially in the agri-food sector, with the specifics of plant production and food processing. Actually, some literature has already shown that this concept is applicable to diverse agricultural sectors in different geographical contexts (e.g. Dannenberg, 2007; Giuliani and Bell, 2005; Huo *et al.*, 2019). Therefore, the concept is used to assess and compare the competitiveness of both two specific vegetable production clusters in Southern Germany.

#### 4. Methods

In a first step, an extensive literature search was conducted to collect data and background information on the German vegetable sector at a whole and the two production regions. An overview of the vegetable market and competitive situation is helpful to understand the characteristics of the two cluster regions Garlic Country and Lower Bavaria. Official statistics and relevant data collections were used.

A qualitative research approach using expert interviews was deemed suitable to analyze the current situation in the two production clusters. Interviewees were selected based on suggestions from the Office of Nutrition, Agriculture and Forestry of Bavaria, a vegetable producer association in Garlic Country, and other project partners. The initial contact with the interviewees was established via telephone and email (Table 1).

The interviews were conducted from January to July 2018 face-to-face on farms, by telephone and at a trade fair for organic food in Nuremberg. Based on background data from existing studies and statistical sources condensed in the first step, an initial semi-structured interview guide was prepared for the interviews in both regions. The initial interview guide was subsequently adapted to fit the specific area of expertise of each interviewee (e.g. organic or conventional cultivation, vegetable marketing, vegetable processing, producer cooperative, associations, public administration, and advisory services). The length of the interviews was between 30 and 90 minutes. The interviews conducted in Garlic Country took place in two rounds. In the first round of interviews general questions relating to all aspects of vegetable production and marketing were asked, while the second-round interviews were focused rather on the production level. Each of the 23 interviews conducted was audio-recorded for subsequent analysis. Afterwards, the interviews were transcribed, and their contents were aggregated and categorized into thematic fields, based on inductive analysis. Each of these thematic fields identified in the previous step was assigned to one of the determinants within of the four bundles of the Diamond model and individually evaluated according to their positive or negative

**Table 1.** Number and type of interviewees and location of interviews in the two regions analyzed.

Protected vegetable production Garlic Country		Open-field production Lower Bavaria
Interviews round 1: interviews on site, at a regional trade fair, by telephone	Interviews round 2: interviews on site, by telephone	All interviews on site
Representative of producer support institution (1)	Producers – conventional (3) Producers – organic (3)	Producers – conventional (3) Vegetable processor (1)
Representatives of state extension centers and private organic associations (5)	Trade representative (1) Vegetable production consultant (1)	Representatives of vegetable producer cooperative (2) Representatives of state extension centers and private associations (2)
Representative of the city administration of Nuremberg (1)		

effect on the respective determinant. Each of the specific determinants that combine to form the four bundles were evaluated qualitatively based on the analysis of the interviews in both regions, and quantified with an estimated value on a five-point scale, ranging from 'very satisfactory' (+2) to 'very restricted' (-2). The unweighted combination of all determinants within each bundle built the overall assessment of that bundle for each of the two regions analyzed. The overall assessments were then classified into five levels ('very satisfactory', 'satisfactory', 'neutral', 'restricted', 'very restricted') to determine their contribution to the competitiveness of each cluster region. The assessment scheme used makes it possible to take into account different and contradictory statements by different actors on individual topics. If there are different views within the cluster actors (e.g. farmers vs retailers), a determinant cannot be defined as 'very satisfactory' or 'very restricted'.

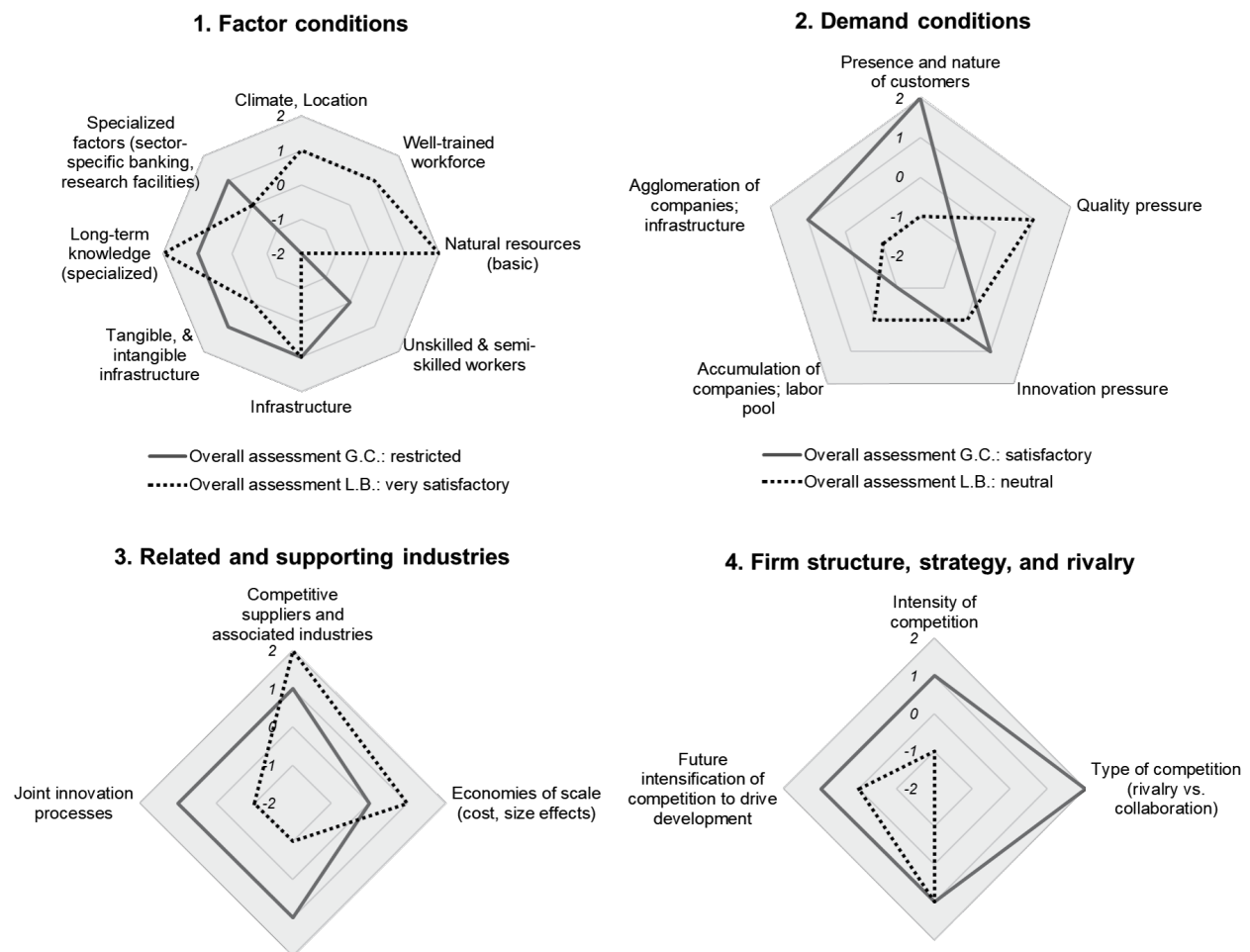
Use of the cluster approach is often criticized, primarily in terms of the reliability of measured data for the identification of the determinants (Maaß and Khanzadeh, 2004) or the lack of data precision (Grant, 1991). For the present study, the characteristics of individual determinants were assessed by qualitative analysis of interview transcripts, so that deficits due to data gaps and inconsistent measurement are mitigated. Another advantage over quantitative methods of data collection is that all information is available at the same level of observation and at a consistent level of detail. Consequently, an assessment of the overall model is possible on an equal level of information.

## 5. Results

### 5.1 Competitiveness of the two vegetable clusters

The specific situation and relative competitiveness of each of the two clusters is assessed and compared based on the four bundles of determinants in the Diamond concept (Figure 3). Detailed descriptions of the specific determinants are presented in Supplementary Table S1. The overall assessments of each of the four bundles of determinants of the two clusters studied can be classified into five levels: 'very satisfactory', 'satisfactory', 'neutral', and 'restricted', and 'very restricted'. For all four bundles, distinct differences between the two production clusters under consideration can already be seen visually, with the advantages and disadvantages of individual determinants being pronounced differently. The factor conditions in Garlic Country combine to result in a 'restricted' evaluation for this bundle of determinants. This is mainly due to relatively limited local conditions, such as strong competition for land, and a shortage of water, but also, to the fact that the industry, as a whole, lacks highly skilled workers. Location advantages such as good access to capital, intense ties to R&D industry, and the region's good technical infrastructure do not outweigh this negative overall assessment of factor conditions. In contrast, the combined evaluation of the factor conditions in Lower Bavaria result in an overall rating of 'very satisfactory'. The outstanding advantages of the region's location in vegetable production and processing are also shown by the fact that some of the larger actors had developed production sites abroad (e.g. Romania, Bulgaria), but gave them up for a return to the region. This turnaround is mainly due to poor infrastructure and additional costs of production and logistics abroad.

Porter's model assumes that strong domestic demand has a positive effect on interregional and intraregional markets, and also promotes the innovation potential of a cluster. Garlic Country benefits from a long tradition of commercial vegetable production and identification of the region with vegetables. There is a strong identification of the regional population with vegetable production. The high image of local markets has extended to interregional awareness through emerging food retail structures, but also competes with international suppliers. This competition and the high-quality demands of retailers increase the pressure for product innovation and process optimization among producers in the region. The situation in Lower Bavaria is quite different. Due to the dominance of production to supply vegetables for further processing by local companies, and the associated interregional orientation, local sales play only a minor role. The determinant 'innovation pressure' is a good example of an ambiguous assessment by the stakeholders surveyed in this region. While, for example, retailers see a high demand for innovation from consumers in the fresh vegetable sector, producers and food processors do not rate the pressure as high. Innovation is also hampered by the fact



**Figure 3.** Assessment of determinants of production clusters Garlic Country (G.C.; grey) and open-field production in Lower Bavaria (L.B.; dotted black) on a five-point scale from (-2 = 'very restricted' to +2 = 'very satisfactory').

that EU legislation does not yet require labels of origin for raw materials in processed vegetables, which is a hindrance in the development of a competitive advantage of vegetables produced in the region over brands.

The third bundle of determinants includes the existence of (internationally) competitive industries and suppliers in a region and their ability to take advantage of associated cost and coordination effects. The overall assessment for both regions is 'satisfactory', although the specific determinants have different focuses. In Garlic Country, the large presence of related and supporting industries contributes to a high evaluation for this bundle. Agglomeration advantages in a cluster not only come into play within one industry, but through the composition of several successful industries in the geographical unit (Kowalewski, 2013). However, a high level of specialization and product diversification is not perceived as an advantage for all actors in the region and is thus rated only 'neutral'. On production level, in particular, it is seen as more difficult to benefit from interactions with other industrial sectors. Garlic Country is particularly well embedded in the Nuremberg metropolitan region, and benefits from a highly attractive commercial environment. Vegetable production benefits, for example, from a variety of large customers such as canteens and the accommodation industry, but also from cross-sector support services such as tax consulting, marketing agencies and logistics companies. For example, in order to access international markets, know-how and possibilities of staff training in the field of food product logistics are decisive within a cluster (Fischer, 2004). The region Lower Bavaria, of course, benefits from a very strong position of the local processing industry and international sales markets.

But the interviewed actors from Lower Bavaria also expressed strong concerns about the challenges imposed by strong legal regulations, for example, in the organization of seasonal work. Producers would like to see more political commitment with regard to regulations that govern the employment of the large number of seasonal workers required, and to enhance the public image of vegetable production in general. This is a much bigger issue in Lower Bavaria than in Garlic Country, where there is less reliance on seasonal labor. Increasingly restrictive plant protection regulations cause additional problems for producers in this region. Noticeable disadvantages of German vegetable producers in terms of both crop management and national implementation of EU production guidelines is perceived as a distorting factor that inhibits international competitiveness. The close relationship with the processing industry in Lower Bavaria provides benefits to the producers in this region. The actors in the region were able to establish reliable and incorporated distribution infrastructures abroad. However, the very solidity of these structures may prevent the development of new cooperative structures, the entry of new companies, and limit general and cooperative innovation processes. Producers also criticize the decline in support and advisory services from the government at the production level.

The overall assessment of the two cluster regions in relation to the fourth bundle (firm structure, strategy, and rivalry) is very contrasting. According to Porter's assertion that intense local competition increases motivation and innovativeness, Garlic Country can be rated higher than the region of Lower Bavaria with its established markets and fairly fixed sales structures. While the interviewees in Garlic Country emphasized the healthy rivalry and the collegial way, in which the various production sectors interact and cooperate with one another, a more distanced relationship between the individual producers must be noted for Lower Bavaria. There are rather loose links in the form of information meetings between farms with different production scales and scopes. In both cluster regions there is sufficient entrepreneurial drive, either because of the recent entry of a new generation of technology-savvy production managers in the Garlic Country cluster, or because of the high number of large and highly entrepreneurial producers in Lower Bavaria. Both are prerequisites for a positive impact on competitiveness of the respective production regions. The overall assessment of this important bundle of determinants shows 'very satisfactory' conditions especially for Garlic Country, while it is assessed only as 'restricted' in the case of Lower Bavaria.

## 6. Discussion

The use of Porter's Diamond model turned out to be suitable for identifying main determinants of competitiveness in each of the two cluster regions analyzed. The qualitative analysis of the expert interviews conducted in both regions showed that the state of the components of the four bundles within the concept could be addressed and determined. Major differences between the two clusters in their determinants of competitiveness as well as the effects of the bundles' interactions with each other became apparent. A general advantage of the model is that rather than considering a cluster in terms of either a specific initial starting point or an optimal final situation, it focuses on the processes that result in a cluster moving from one phase to another – for better or for worse (Neven and Dröge, 2001). Porter (1990) points out that given cluster framework conditions of a country or region are not necessarily inherited by nature (e.g. in the context of low-wage countries, agricultural states, etc.), but rather, they continually develop and change. Thus, in both regions analyzed, significant changes in vegetable production and distribution structures have occurred in recent decades, completely changing the face of both production clusters.

In Garlic Country, an increasing competition for land and the changes in retail towards assortment retail outlets, enforced the professionalization of farms in vegetable production. Traditional agricultural production with mixed farm types and part-time managed operations is hardly found in this region anymore. In addition, technological transition has taken place more rapidly than in other vegetable growing regions in Germany due to decreasing limitation of land availability. High conversion rates from open-field vegetables to greenhouse production led to capital intensity, which is significantly higher than in average vegetable production in Germany.

Compared to the vegetable production as a whole in Germany, both clusters analyzed here show high market concentration at the production level and thus higher market entry barriers for new entrants. Although the factor conditions and firm structures are quite different, both regions show potentials in national and international competitiveness. Lower Bavaria is already established in international markets with specific vegetables (e.g. pickles, asparagus, cabbage, and potatoes) and the associated canning industry. The vegetable production itself benefits from relatively moderate land prices, good soils, and its widely recognized production know-how, which has also been shown in other studies to be an important determinant for the successful development of production clusters (Giuliana, 2008; Tavoletti and Te Velde, 2008). In Lower Bavaria, the intense development of the vegetable processing industry, and the internationalization of markets have also changed the landscape of vegetable production. In this respect, this region is comparable to other high-growth open-field production regions in Germany. Vegetable production in Rhineland-Palatinate, for example, is climatically favorable and also looks back on a long cultivation tradition, but benefits from the focus on cultivated crops such as lettuces and radishes, which allow multiple harvests per year on the same acreage (Stroh *et al.*, 2016). In contrast to Germany's largest production region in North Rhine-Westphalia, Lower Bavaria does not benefit from its proximity to western German metropolitan areas. In the marketing of pickled gherkins, Lower Bavaria has to compete against the 'Spreewaldgurke' from the east of Germany, which has already carried the protected geographical indication quality label under EU law for more than 20 years (Stroh *et al.*, 2016). All these disadvantages partly explain the strong position of the local processing industry and the increasing (inter) national distribution of products from Lower Bavaria.

The customer reach of Garlic Country products has also expanded regionally and nationally in the last two decades. The professionalization of the farms and marketing concepts increased sales beyond the metropolitan region. Over the past 20 years, vegetables from Garlic Country have increased in their importance in German food retail even more than vegetables imported from main import countries the Netherlands and Spain. A growing demand of German consumers for fresh and regionally produced vegetables will likely continue to have a positive impact on companies in this region. Results for this cluster are in line with a study of the food manufacturing sector in New York that conclude that the clustering of similar firms have positive economic effects on firms' revenues, also positively influenced by high levels of local urbanization (Schmit and Hall, 2013).

Government as independent concept component was not explicitly addressed in the framework used. However, some specific social and regulatory elements have been given consideration in both vegetable cluster regions analyzed (e.g. water regulations, cooperation with city councils). Specific conditions of production clusters can be positively influenced, for example, by political initiatives (Yue and Cao, 2021), technical progress (Tavoletti and Te Velde, 2008), and the presence of entrepreneurial spirit (Ekelund and Tjörnemo, 2009). The latter can also be encouraged by the state through professional training and support as well as by reducing bureaucracy and simplified regulations (Li *et al.*, 2022). Findings in this study support the viewpoints of other literature that restrictions in these areas limit competitiveness and industry development. Because industrial development is a continuous process, a cluster faces different environmental conditions at different stages. In some cases, local industrial policies are of higher relevance than national regulations in strengthening clusters and remaining sensitive to information about participants and potential market developments (Zhao *et al.*, 2021).

## 7. Conclusions and practical implications

The two cluster regions studied, geographically only 150 kilometers apart, both show potential for increasing their international competitiveness, despite their very different preconditions. For each of the two vegetable production clusters, the Diamond model identified points of strength, weakness, threats, and opportunities, relevant for national and international competitiveness. Each of the two regions analyzed have followed substantially different but rapid development paths over the last two decades. Favorable conditions in relation to infrastructure, innovativeness, market demand, cooperation and product competitiveness exist in both regions that helped ensure future potential in both national and international markets. Nevertheless, each

production cluster faces specific challenges and threats that need to be addressed in ways that allow actors to maintain the tradition and uniqueness of each of the respective production clusters.

The Model's determinants are characterized by mutual dependence and reinforcing processes based on interactions (Brosnan *et al.*, 2016). The dynamic interplay of the four bundles of determinates within the Diamond model allows for conclusions to be drawn for cluster actors and policy-makers about the innovative potential and, thus the competitiveness, of a regional industry cluster. The analysis showed that the characteristics of the four bundles for each of the two cluster regions are clearly distinct in nature. Garlic Country benefits from an advantageous business environment, a favorable rivalry situation, and high identification of the region with vegetable production, but suffers from diverse restricting factor conditions (e.g. land competition, water scarcity). The production cluster in Lower Bavaria has very good factor conditions (e.g. soils, production infrastructure, land prices) and an excellent environment of related and supporting industries. However, it is slowed down by neutral-level local demand conditions, a low diversity of different corporate structures (which limits effective cooperation processes), and the absence of pro-competitive rivalry.

Thus, satisfactory factor conditions in Lower Bavaria can potentially have a positive influence on regional demand, if these positive determinants can be communicated to promising customers (e.g. via a manufacturer's brand or protected raw material specifications). Conversely, strong demand conditions, such as those that exist in Garlic Country, can increase the pressure on producers to improve factor conditions to satisfy regional and interregional market needs. This is already noticeable in the continual increase in the production area under cover in this region in order to mitigate the natural disadvantages of the location (land competition, soils with low water storage capacity). Factor conditions are also affected by firm structure, strategy, and type of rivalry within a cluster. If a significant (uncooperative) rivalry exists, each of the players involved will be forced to invest to improve their respective production factors. A favorable situation of specific production factors on the other side, as is the case in Lower Bavaria, leads to an increase in rivalry in a region since the barriers to market entry are also lowered. An advantageous environment of related and supporting industries, as is the case in both of the cluster regions considered, has a positive effect on factor conditions. Producers in Garlic Country can benefit from better opportunities in the technological development of production sectors. Farm managers in Lower Bavaria involved in cooperatively organized vegetable processing, get options for outsourcing sub-processes and gaining flexibility in product marketing.

The assessment of cluster determinants also reveals existing barriers and drawbacks. A specific challenge of Garlic Country is the strong competition for land in the metropolitan region of Nuremberg and the associated increase in the share of production areas under glass, which has also triggered a public discussion about changes to the landscape due to increasing urbanization. The fact that land conflict is becoming even more intensified can be seen in protests by farmers against the increase of built-up areas and the expansion of the Nuremberg airport, but also current protests by citizens against the expansion of protected areas in vegetable cultivation. Nevertheless, it is expected that the concentration of individual larger and more professionalized farms on limited land areas will continue, further increasing efficiency and profitability per hectare. There are already producers in Garlic Country applying innovative space concepts such as multi-level greenhouse units and LED lighting for faster plant growth and crop rotation intervals.

Engaging interest groups outside the clusters is a necessary process to maintain agricultural structures that have been established over time. Compromises on scarce resources, such as water and land (Garlic Country) or lower-skilled workforce (Lower Bavaria) need to be found at round tables with community interest groups such as real-estate developers, environmentalists, residents, municipalities, employment agencies and producers in other agricultural sectors. The preservation of the well-known and appreciated vegetable production in both regions is of importance for many external stakeholders, e.g. in terms of the region's image, provision of local healthy food, prosperity and quality of life, jobs, and ecosystem services such as maintaining biodiversity, landscape and soil conservation. Politicians would do well to improve the framework conditions for cluster actors. Be it in legislation and bureaucratic processes in national and EU-wide regulations (e.g. adaptations of seasonal labor regulations, adjusting pesticide restrictions to other

international production regions, improving labelling of origin and brand protection), or at the local area (e.g. in easing building regulations, water usability and support for the local and regional marketing of vegetable products).

However, the cluster actors themselves also bear the responsibility to reduce cluster weaknesses and to make further use of their strengths in order to ensure long-term competitiveness. An important step that has already been taken in the last 20 years is the professionalization of the entire cluster and the establishment of a competitive infrastructure. Both regions have seen a recent change of generations, which has stimulated entrepreneurship, strategic focus on product quality and sales, and innovativeness. Thus, the vegetable industry in Garlic Country needs to keep a close watch on changing markets and consumer demand, and constantly adapt the product range according to consumer trends (e.g. production of mini gherkins). Producers and food processors can also influence the sales markets themselves, e.g. through innovative concepts such as extending the season through production of a broad range of vegetable crops, adoption of technological innovations, and optimized production control. In the open-field vegetable production in Lower Bavaria, it is beneficial for companies to expand cooperation structures within the region, to further stimulate the collegial exchange of knowledge, and benefit from joint strategies of marketing and public relation efforts. Closer cooperation and knowledge exchange could also mitigate the current deficit in extension services that is claimed by cluster stakeholders.

Major expectations of both clusters stakeholders from policy, however, are of an overarching nature and do not concern local conditions. In both regions, the main complaints are about the decline in extension services, or the national disadvantages compared to other countries in the availability of seasonal labor and stricter pesticide regulations. Despite existing drawbacks, both regions show potential to increase interregional competitiveness by building on their healthy local demand situation. Managerial philosophies and strategic decision must be tailored to the specific cluster's products and services considering cost and quality factors (Kennedy *et al.*, 1997). Depending on the type of products and the target customers, companies could use opportunities to strategically expand in terms of either cost leadership (Lower Bavaria) or product differentiation (Garlic Country). To investigate and potentially pursue these opportunities more closely, other well-known concepts introduced by Porter in the context of corporate management will be useful. These issues will not be further discussed at this point but should be considered in future research. However, application of the Diamond concept to the two vegetable production clusters was useful in deriving policy recommendations for supporting the competitiveness of both regions.

## Supplementary material

Supplementary material can be found online at <https://doi.org/10.22434/IFAMR2021.0119>

**Table S1.** Detailed overview: assessment of determinants of production clusters Garlic Country and open-field production Lower Bavaria.

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