

Benz, Lena; Block, Jörn; Johann, Matthias

Article

Hidden champions as a determinant of regional development: An analysis of German districts

ZFW - Advances in Economic Geography

Provided in Cooperation with:

De Gruyter Brill

Suggested Citation: Benz, Lena; Block, Jörn; Johann, Matthias (2024) : Hidden champions as a determinant of regional development: An analysis of German districts, ZFW - Advances in Economic Geography, ISSN 2748-1964, De Gruyter, Berlin, Vol. 68, Iss. 1, pp. 9-39, <https://doi.org/10.1515/zfw-2020-0043>

This Version is available at:

<https://hdl.handle.net/10419/333183>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



<https://creativecommons.org/licenses/by/4.0/>

Lena Benz*, Jörn H. Block, Matthias S. Johann

Hidden champions as a determinant of regional development: An analysis of german districts

<https://doi.org/10.1515/zfw-2020-0043>

Received December 2, 2020; accepted August 20, 2021

published online September 8, 2021

Abstract: Hidden Champions (HCs) are defined as market leaders in niche markets. They represent the success of the German *Mittelstand* like no other group of firms. However, little is known on how HCs contribute to regional development. Given their export strength, regional embeddedness, and strong vertical integration we expect HCs to have a profound effect on regional development. Using a German dataset of 1,645 HCs located in 401 German districts, we analyze the effect of HCs on a variety of regional development dimensions. Our results show that HCs are not equally distributed across regions and influence regional development. Regions with a higher number of HCs show strong regional economic performance in terms of median income. Moreover, HC intensity affects regional unemployment and trainee rates as well as regional innovation in terms of patents. Surprisingly, we did not find an effect of regional HC intensity on regional R&D levels and GDP. We can further conclude that the effect of HCs is not limited to the particular region in which they are located but that sizable spillover effects exist. Besides its contribution to the regional development literature, our study adds to a better understanding of the HC-phenomenon. Implications for regional policy makers are discussed.

Keywords: Germany; hidden champions; innovation; *Mittelstand*; regional development; regional performance

1 Introduction

Defined as (world) market leaders in a niche market, hidden champions (HCs) are a successful subgroup of the German *Mittelstand*. Discovered as a phenomenon in the 1990s by Hermann Simon, the concept of the HC is now widespread. Though HCs partly overlap with the German *Mittelstand*, comprising many family businesses, the hidden (world) market leaders clearly stand out as they possess distinct characteristics. Their formula for success includes, among other things, the combination of a niche market focus and intense internationalization as well as superior technological capabilities and a specialized workforce (e.g. Audretsch et al. 2018; Rammer/Spielkamp 2015, 2019; Simon 2012).

HCs and the German *Mittelstand* in general make considerable contributions to the performance of the German economy and its status as a dominant export nation. In a country comparison study, Audretsch et al. (2020) identify Germany as the nation with the largest number of world market leaders per capita, which might be one reason for the success of the German economy. In addition to their importance at the national level, the impact of HCs on the regional economy is undeniable. Indeed, regional studies have examined related firm types such as family firms or members of the German *Mittelstand* in general and have found evidence of an impact on different regional development dimensions (e.g. Stough et al. 2015). For instance, previous studies analyzed the impact of these firm types on regional innovativeness (Berleemann/Jahn 2016; Block/Spiegel 2013), regional economic growth (Memili et al. 2015) and regional resources such as human resources (Basco 2015).

Although the three groups partly overlap, considerable differences exist, which are crucial for a separate analysis of HCs at the regional level. HCs are, for example, defined by market leadership in a niche market (Simon 2012) and not by firm ownership as family firms. An analysis of the regional impact of HCs provides the opportunity to gain deeper insights into the HC phenomenon, which is especially interesting from a policy perspective at the regional level. HCs make considerable contributions to the performance of the German economy (e.g. Lehmann et al. 2019) and they represent major employers (e.g. Pahnke/

*Corresponding author: Lena Benz, University of Trier, Universitätsring 15, 54296 Trier, Germany, E-Mail: benz@uni-trier.de, ORCID 0000-0002-0952-130X

Jörn H. Block, University of Trier, Universitätsring 15, 54296 Trier, Germany, Witten Institute for Family Business, Alfred-Herrhausen-Straße 50, 58455 Witten, Germany, Erasmus School of Economics, Burgemeester Oudlaan 50, 3062 PA Rotterdam, the Netherlands, E-Mail: block@uni-trier.de, ORCID 0000-0003-4564-0346

Matthias S. Johann, University of Trier, Universitätsring 15, 54296 Trier, Germany, E-Mail: johann@uni-trier.de, ORCID 0000-0001-5436-4246

Welter 2019). Also, HCs are regionally connected and not only located in agglomerated but also peripheral areas (e.g. Audretsch et al. 2008; Lang et al. 2019). Due to the different characteristics of HCs, it is important to learn about their influence at the district level and uncover how they affect regional development dimensions such as performance or employment. Accordingly, HCs can attract the attention of policy makers and thus receive more support for the further development of the regions in which they are located. These considerations lead to the following research question: What impact does regional HC intensity have on regional development?

To answer this research question, we combine a dataset covering 1,645 German HCs with a dataset covering the 401 German districts. The former serves as the basis for our independent variable *HC intensity*. The latter consists of data on regional development dimensions and regional-level control variables. After combining both datasets, the final dataset with 401 observations emerges, representing the 401 German districts. Conducting linear regression analyses, we examine the influence of HC intensity on a wide range of regional development dimensions, i.e., regional economic performance, employment, and innovation, to obtain comprehensive insights into how regional HC intensity affects regional development.

The findings show that HC intensity significantly influences each of the regional development dimensions examined in our study. We find only partial support for the anticipated effects on the dimensions of regional economic performance and regional innovation, showing that HC intensity significantly affects these two dimensions only to a limited extent. In terms of regional employment, we find a significant influence of HC intensity on both variables capturing this regional development dimension, fully supporting the expected relationships. These results have to be considered in light of potential reverse causality which is a common limitation of geographic studies that are unable to use historical data. In our case, we lack past information on the HC dataset.

Consequently, our study contributes to the small and emerging stream of HC literature, which has been rather scant so far, with few scientifically published academic studies (e.g. Audretsch et al. 2018, 2020; Johann et al. 2021; Lehmann et al. 2019). Our findings contribute to a better understanding of HC functionality by looking at how these firms affect several regional development dimensions. Hence, we uncover the impact of HCs on economic performance, employment, and innovation at the regional level, highlighting the key role of this group of firms in the districts in which they are located. By examining HCs on a regional level, we also contribute to the literature on determinants

of regional development (e.g. Block/Spiegel 2013; Fritsch/Müller 2008; Vonnahme/Lang 2019), showing that HCs are an influential group of actors in the regional economy. Subsequently, these findings also have practical implications, especially for policy makers at the regional level.

This article is structured as follows: Section 2 provides deeper insights into the phenomenon of HCs, followed by an overview of the literature on the determinants and dimensions of regional development. Section 3 contains the derivation of hypotheses on the impact of HC intensity on selected regional development dimensions. The data and methodology of the study are explained in section 4, further introducing the variables included in our examinations. Section 5 presents the descriptive and multivariate analyses conducted, as well as a series of robustness checks and post hoc analyses. Finally, we discuss our findings in section 6, reveal the implications and limitations of the study, and highlight arising avenues for future research.

2 Literature review

2.1 The hidden champions phenomenon

HCs represent a particularly successful subgroup of medium-sized firms. Simon first discovered the HC phenomenon in the 1990s. The following conceptual understandings of HCs therefore originate from Simon (1996, 2012, 2013), who defines HCs according to three criteria. *First*, HCs are among the top three market-leading firms in the global market or are number one in their domestic continent. *Second*, HCs earn revenues below five billion euros, and *third*, they are relatively unknown to the public. While market share and revenue are quantitative and regularly utilized criteria for identifying HCs, academic studies typically do not operationalize the qualitative criterion of public awareness (e.g. Rammer/Spielkamp 2015, 2019). As the definition indicates, HCs primarily pursue the two synergistic goals of market leadership and growth. On the one hand, HCs strive for market leadership in quantitative terms in the form of market share, as well as in qualitative terms in the form of leadership over market participants by setting standards or being pioneers. On the other hand, HCs strive for continuous growth. Numerous examples of former HCs that became major international enterprises listed on the stock exchange (e.g. SAP and Fresenius Medical Care) demonstrate this. To achieve their goals, HCs follow a strategy that combines two paradigms that initially appear to be contradictory. HCs strictly focus on

niche markets where they serve selected customers with high-quality products. Nevertheless, while their focus on a selected niche makes their market small, international expansion gives them the necessary size to operate profitably. Therefore, HCs sell specialized products on a global scale (e. g. Audretsch et al. 2018; Voudouris et al. 2000).

Consequently, the HC phenomenon relates to the strategy literature. According to Porter (1980), firms strive for competitive advantages through the pursuit of one of three generic competitive strategies: cost leadership, product differentiation, or focus. While the achievement of competitive advantages through cost leadership refers to product standardization, mass-market service, and the reduction of fixed costs, product differentiation attempts to achieve a competitive advantage by offering high-quality products and exploiting customers' increased willingness to pay for such products. The focus strategy represents a variation on product differentiation, as it aims to offer high-quality products specifically tailored to the needs of selected customers in a defined market segment. Hence, firms pursuing a focus strategy operate in niche markets (e. g. Audretsch et al. 2018; Toften/Hammervoll 2009, 2010a, 2010b). In general, a niche market is a narrowly defined market that typically consists of only one customer or a comparatively small group of customers with similar needs (Dalgic/Leeuw 1994). Accordingly, a niche market strategy describes a firm's concentration on certain customer needs, product segments, or geographically or demographically defined markets (Teplensky et al. 1993; Toften/Hammervoll 2010a, 2010b). Firms following a niche market strategy position themselves in small, profitable, and homogeneous market segments that are not occupied by competitors (Dalgic/Leeuw 1994).

Reviewing prior research, Toften & Hammervoll (2009, 2010b) identify seven interrelated characteristics of firms operating in niche markets. These characteristics contribute to the successful implementation of a niche market strategy and thus correspond to the HC strategy. *First*, niche firms think and act small (Hamermesh et al. 1978) as they offer, for example, comparatively small production volumes, concentrate only on selected customers, and deliberately choose markets in which few competitors operate (Hezar et al. 2006). Although HCs operate in narrowly defined markets and produce small volumes for their national customers, their production volumes grow due to their international expansion. *Second*, niche firms consciously select markets based on their own strengths and competencies (Hamermesh et al. 1978), entering into only those niches where they are able to contribute valuable products due to specific skills and in-depth knowledge. Consistent with this strategy, HCs are specialists

within their industries. To maintain a market-leading position, they manufacture technologically advanced products and position themselves as quality leaders. Consequently, HCs require profound expertise, which they have acquired mainly due to their qualified workforce and extensive innovation activities (e. g. Lehmann et al. 2019; Rammer/Spielkamp 2015, 2019; Schenkenhofer 2020). *Third*, niche firms stand out by applying specialization and differentiation, typically with reference to products and customers (e. g. Audretsch et al. 2018, 2020; Dalgic/Leeuw 1994; Kotler 1997). In line with this, HCs focus on the individual demands of a limited customer base for whom they provide a correspondingly defined product segment. Moreover, they not only manufacture quality products but also offer a deep range of services within narrowly defined markets. To provide depth in value creation, HCs typically have their own production facilities and innovation labs (Rammer/Spielkamp 2015, 2019). *Fourth*, they are subsequently able to cover several stages of their customers' value chain, directly aligning their specialized competencies and resources with their customers' needs. Hence, HCs tailor their products precisely to customer-specific demands and set a strong focus on customer needs (Dalgic/Leeuw 1994). *Fifth*, niche firms attach great importance to their reputation and use word-of-mouth references to expand (Dalgic/Leeuw 1994). Since HCs typically operate in B2B markets, they are little known to end-product consumers. Because HCs avoid extensive marketing activities, a strong reputation functions as a prerequisite for successful business relations. Apart from this, HCs practice a strong value system based on conservative principles such as trust and loyalty, guiding both their internal and external relationships. *Sixth*, HCs consequently build strong long-term relationships with relevant stakeholders (Dalgic/Leeuw 1994; Voudouris et al. 2000). In addition to close relationships with employees, HCs maintain tight customer relations (e. g. Audretsch et al. 2018). Customer proximity forms their greatest strength and is, due to international expansion, actively practiced across national borders. Because complex, customized products require regular customer contact, HCs enter foreign markets at an early stage, rely on direct sales, and establish their own subsidiaries abroad. Furthermore, HCs carry out innovation activities in close consultation with their customers, and even top management maintains regular contact with customers (e. g. Rammer/Spielkamp 2015, 2019). *Seventh*, niche firms charge a price premium, as they are able to offer superior customer value (e. g. Dalgic/Leeuw 1994; Kotler 1997). Since HCs provide highly specialized products with state-of-the-art technology, they do not compete on the price of their products.

Therefore, prices are typically above the market average, which in combination with their international expansion significantly contributes to niche market profitability. Analyzing a sample of 4,677 German manufacturing firms over a period of ten years, Johann et al. (2021) for example show that HCs have a significantly higher profitability with regard to return on assets than non-HCs.

2.2 Determinants and dimensions of regional development

Regional development represents a multifaceted construct that links both different determinants and different dimensions at the regional level, as the processes and resources available to a region determine its development along several dimensions (Stimson et al. 2006). With regard to the determinants of regional development, prior research has investigated, among other things, whether the presence of certain firm types affects regional development. For example, scholars have examined the role of family businesses (e. g. Basco 2015; Block/Spiegel 2013; Stough et al. 2015). Starting with the specific characteristics of family businesses, Basco (2015) systematically links the family business and regional development literatures to analyze whether family businesses affect the factors, processes, and proximity dimensions of regional development. Similarly, Stough et al. (2015) investigate whether and how family businesses contribute to regional economic growth and development. Moreover, Block & Spiegel (2013) study the impact of family firm density on regional innovation output. Furthermore, scholars have analyzed the influence of new business formation on regional development (e. g. Fritsch 2008; Stuetzer et al. 2014). For example, Fritsch & Müller (2004) examine the relationship between new business formation and regional development over time, identifying time lags as well as both positive and negative effects of new business formation on regional employment changes. As a follow-up, Fritsch & Schroeter (2011) investigate the effect of start-up activity on employment growth at the regional level, finding an inverse U-shaped relationship. However, while prior research has frequently examined the impact of specific types of firms, such as family businesses or start-ups, on regional development, research analyzing HCs as a determinant of regional development is rather scarce. Lang and colleagues (2019) as well as Vonnahme & Lang (2019) examine the role of HCs in small towns and peripheral regions. Analyzing five economic indicators, Lang and colleagues (2019) show that small towns with HCs, in peripheral as well as non-peripheral regions, are in a better economic situation than small

towns without HCs. Also, qualitative research on HCs as a determinant of regional development exists in form of case studies (e. g. Kirchner 2019). Taking a quantitative approach, Vonnahme & Lang (2019) examine innovation activities based on a survey of 129 HCs. Since no homogeneous picture for the innovation behavior of HCs can be drawn, a cluster analysis divides the firms into groups that differ, for instance, with regard to the geographic focus of innovation activities. As the extent to which HCs contribute to progress and prosperity at the regional level remains mainly unclear, this paper aims to empirically investigate the effect of HCs on several dimensions of regional development.

Concerning the dimensions of regional development, prior research has offered a diverse set of thematic priorities, including economic (e. g. Porter 2003), institutional (e. g. Rodriguez-Pose 2013) and social (e. g. Iyer et al. 2005) dimensions. Focusing on the economic dimensions of regional development, scholars have investigated regional innovativeness (e. g. Broekel/Brenner 2011). In this context, Fritsch & Slavtchev (2011) emphasize the role of regional innovation systems, empirically analyzing factors that account for differences in the efficiency of regional innovation systems. Moreover, various studies have investigated the innovation output of regions as measured by the number of successful patent applications (e. g. Berlemann/Jahn 2016; Block/Spiegel 2013). In addition to analyzing dimensions related to knowledge creation at the regional level, others have considered employment-related dimensions (e. g. Fritsch/Müller 2008). Relating start-up rates to regional employment changes over time, Fritsch & Müller (2008), for example, find significant differences across regions in Germany; the effects of new business formation on regional employment changes are higher in agglomerations and regions with a high level of labor productivity than in rural areas and regions with a low level of labor productivity. For this study, we select three different dimensions of regional development in order to offer a broad picture on how HCs influence regional development.

3 Hypotheses

Since prior research has not sufficiently addressed the role of HCs as a determinant of regional development, the present study empirically investigates the effect of HCs on the following three dimensions of regional development: (1) regional economic performance, (2) regional employment, and (3) regional innovation. These three dimensions of regional development and the refer-

ring variables only partially capture the role of HCs as a determinant of regional development. In the following sections, we present each dimension and address their operationalization and the corresponding hypotheses. *Figure 1* provides an overview of the seven hypotheses and the expected influence of HC intensity on these regional development dimensions. In our study, we focus on the HCs' headquarters¹. Even though HCs organize their work on average with ten different locations (Vonnahme/Lang 2019), prior research shows that the headquarters of multinational and multibusiness firms play a significant role in an entrepreneurial as well as administrative sense (e. g. Ambos/Mahnke 2010; Chandler 1991; Landau/Bock 2013). Therefore, we would like to put an emphasis on the HCs' headquarters and their impact on regional development.

3.1 Regional economic performance

The economic performance of a nation is closely linked to that of its individual regions, which can vary considerably. Therefore, many of the essential determinants of economic performance reside within individual regions rather than nations (e. g. Porter 2003; Kitson et al. 2004). One of the most commonly used measures of economic performance is gross domestic product (GDP). GDP represents the total value of all goods, including products and services, generated in one year within the national borders of an economy. When transformed into GDP per capita for a defined area, conclusions about the development and performance of a region are possible. GDP is primarily generated by the production of goods. Although HCs operate in niche markets with small production volumes, operating on an international scale offers the potential to expand their production volumes. Since they manufacture on their own, HCs possess large production facilities, often located in rural areas. By producing large quantities locally (e. g. Lehmann et al. 2019), HCs significantly contribute to the GDP of their native regions. Consequently, we expect districts with a high intensity of HC headquarters to exhibit a higher GDP per capita.

Hypothesis 1a: Regional HC intensity is positively associated with regional GDP.

In addition to GDP, which captures the productive strength of a region, income levels are a fundamental measure of economic performance, as they reflect the standard of living of the regional workforce (Porter 2003). As previously mentioned, HCs generate huge profits by

selling specialized goods on a global scale. Since HCs are deeply rooted in their home region, a large portion of their profits flows into the firm and its employees. Moreover, HCs are stable employers who view their workforce as an important factor in their success (e. g. Lehmann et al. 2019; Voudouris et al. 2000). Hence, monetary incentives play an important role in keeping employees over the long term. Profitably operating within global niche markets, HCs typically possess sufficient economic strength to offer monetary incentives and pay adequate salaries. Consequently, we expect districts with a high intensity of HC headquarters to have a higher median income.

Hypothesis 1b: Regional HC intensity is positively associated with regional labor income.

In addition to GDP and labor income, business taxes represent another appropriate indicator of regional economic performance, adding a tax perspective to the presented measures. Business taxes are levied on the earnings generated by a domestic business. Thus, the amount of business tax to be paid directly depends on the amount of profits made. Therefore, business taxes are the most important source of revenue for a district's municipalities. For the same reasons as those already presented for hypotheses 1a and 1b, HCs significantly contribute to the business tax revenue of the municipality in which they are located (Lang et al. 2019; Röhl 2008). Because HCs successfully operate within global niche markets, they achieve comparatively high profits, thus leading to high business tax payments. Also, since HCs act independently and concentrate most of their activities and employees in their selected locations (e. g. local production facilities), business tax payments flow almost entirely into their native municipalities (e. g. Becker/Fuest 2010). As a result, municipalities that are home to HCs have higher business tax revenues. Wealthy municipalities in turn form the basis for the financial strength and economic prosperity of entire districts. Consequently, we expect districts with a high intensity of HC headquarters to have higher business tax revenues.

Hypothesis 1c: Regional HC intensity is positively associated with regional business tax revenues.

3.2 Regional employment

In addition to performance indicators, human resource-related figures reflect regional development. Regional employment refers to the proportion of working-age people employed within a given region. Due to regional differences in population density, the unemployment rate serves as an accepted indicator of employment levels,

¹ If the global headquarter is located outside of Germany, we include the national German headquarter of the HC.

making regions more comparable. Because HCs serve global niche markets, they need to handle relatively large production quantities. Nonetheless, HCs avoid outsourcing or strategic alliances and rely on maximum independence as well as control in production (Simon 2013). Consequently, they require a large workforce. Their strong growth further fuels the continuous demand for qualified employees. As a result, HCs try to manage the recruitment and long-term retention of employees by offering attractive jobs and familial corporate cultures (e.g. Lehmann et al. 2019; Voudouris et al. 2000). Accordingly, HCs make larger investments in human resource management practices (Rammer/Spielkamp 2019), acting as reliable long-term employers within mostly rural regions (Lang et al. 2019; Lehmann et al. 2019; Pahnke/Welter 2019). HCs permanently attract new employees and thus significantly contribute to regional employment. As a result, we expect districts with a high intensity of HC headquarters to exhibit lower unemployment rates.

Hypothesis 2a: Regional HC intensity is negatively associated with the regional unemployment rate.

The manufacture of advanced products also requires specific expertise and technical knowledge (e.g. Lehmann et al. 2019; Rammer/Spielkamp 2015, 2019). Hence, HCs need specially trained workers and invest not only in the training and development of employees but also in the education of the trainees themselves. In particular, the dual apprentice system in Germany, which specifically combines theoretical and practical teaching content, is an important pillar of the HC employment strategy (Audretsch et al. 2020; Jahn 2018; Lehmann et al. 2019; Schenkenhofer/Wilhelm 2020). It systematically ensures the technical competence of the workforce that is necessary to provide high-quality products. Jahn (2018) also verifies a significantly positive relationship between the relative importance of medium-sized firms and apprenticeship training at the regional level. Consequently, we expect districts with a high intensity of HC headquarters to have higher numbers of trainees.

Hypothesis 2b: Regional HC intensity is positively associated with the regional trainee rate.

3.3 Regional innovation

The relevance of regional innovation as well as its possible determinants have received great attention in recent research (e.g. Block et al. 2021; Fritsch/Slavtchev 2011; Makkonen/van der Have 2013). For example, Broekel & Brenner (2011) examine how twelve selected regional factors, including the number of R&D employees, the

presence of universities and technical colleges, and public research institutions, among others, affect the innovativeness of a region. Similar to various other studies (e.g. Block/Spiegel 2013; Fritsch/Slavtchev 2011; Fritsch/Wyrwich 2021; Thomi/Werner 2001), they relate these factors to the concept of regional innovation systems. A regional innovation system describes the components and processes of innovation on a regional level, forming an institutional setting within a region in which firms and other organizations interact and learn from each other (Cooke 2001; Cooke et al. 1998). This system provides targeted support for innovation activities at the regional level by creating an innovation-friendly climate that stimulates research cooperation, knowledge creation, and spillovers. Ultimately, this leads to increased regional innovation activities, both with regard to innovation input, for example, in terms of R&D expenditures, and innovation output, for example, indicated by the number of patent applications and new product developments. R&D expenditures and granted patents only represent a fraction of local innovation activities and allow limited statements on the innovation dynamics of a region as they focus almost exclusively on technological innovation (Block et al. 2021); however, they are established indicators in this context (e.g. Fritsch/Slavtchev 2011).

Niche firms play a particularly important role within regional innovation systems, as they require substantial expertise and profound knowledge to provide customers with specialized products (e.g. Dalgic/Leeuw 1994). Thus, to meet individual requirements and offer technological enhancements, HCs maintain large innovation capacities (e.g. Rammer/Spielkamp 2015, 2019). With regard to innovation input, HCs are associated with high levels of R&D investments (e.g. Audretsch et al. 2018; Schlepphorst et al. 2016; Zucchella/Palamara 2006). In a survey of 129 German HCs, Vonnahme & Lang (2019) find that more than 80 percent conduct in-house R&D. In addition to their own R&D activities, HCs often maintain regional relationships with universities and research institutions for innovation development, thus fostering the creation and exchange of knowledge (Rammer/Spielkamp 2015). Also, the majority of HCs assigns R&D contracts to third parties (Vonnahme/Lang 2019). Further, Fritsch & Slavtchev (2011) show that knowledge spillovers enhance private sector innovation activity, positively influencing regional innovation system efficiency. Therefore, by continuously investing in innovation (e.g. Rammer/Spielkamp 2015, 2019), HCs contribute to technological progress and substantially promote regional innovation. Consequently, we expect districts with a high intensity of HC headquarters to exhibit higher R&D expenditures.

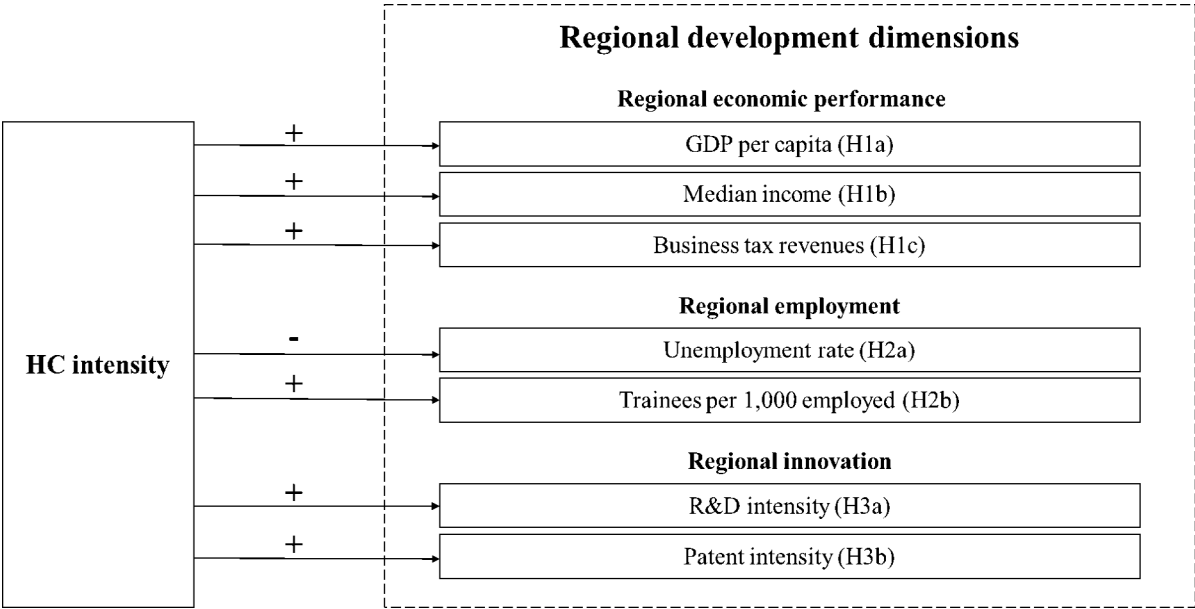


Figure 1: Influence of HC intensity on regional development dimensions.
Source: Own representation.

Hypothesis 3a: Regional HC intensity is positively associated with regional R&D intensity.

Furthermore, the innovation activities of HCs are also visible with regard to innovation output. As HCs claim to be quality and technology leaders within global niches, they actively shape their markets by setting standards and taking on a pioneering role in the introduction of market novelties. Typically, HCs conquer their niche markets with radical innovations and subsequently defend their market-leading position through incremental improvements (e.g. Audretsch et al. 2020; Rammer/Spielkamp 2015, 2019; Voudouris et al. 2000). The innovation rate of HCs considerably exceeds the average rate for the German economy (Vonnahme/Lang 2019). As a result, the protection of intellectual property plays an important role, particularly with regard to product innovations. In addition to lead-time advantages, HCs heavily rely on patents as an effective protection mechanism. Typically, HCs possess significantly more patents than large firms do (e.g. Rammer/Spielkamp 2019). Thus, their leading role in knowledge creation and innovation development results in higher innovation output at the regional level, which is partly reflected by patent indicators. Consequently, we expect districts with a high intensity of HC headquarters to have a higher number of granted patents.

Hypothesis 3b: Regional HC intensity is positively associated with regional patent intensity.

4 Data and method

4.1 Data sources and sample

The sample in our study consists of 401 observations, representing the 401 German districts listed in *table A1*. These refer to the NUTS 3-level (Nomenclature des unités territoriales statistiques), the official classification of the European Union for regional statistics, including all German districts and independent cities (European Union, 2018). Data at the district level stem from various sources: (1) the INKAR online database of the Federal Office for Building and Regional Planning (BBSR), (2) the European Patent Office (EPO), (3) the Regional Database of the Statistical Offices of the Federal Republic of Germany and the Federal States, (4) the Donors' Association for Science Statistics, and (5) the Communal Education Database of the Statistical Offices of the Federal Republic of Germany and the Federal States. *Section 4.2* provides more details on the data source for each variable. The independent variable HC intensity is an exception, as we first collect data for this variable at the firm level via the Bureau van Dijk database Orbis and the Electronic Federal Gazette (Bundesanzeiger) and then convert it into a district-level variable (see *section 4.2.2*). Additionally, we accessed data on the C-DAX stocks from the webpage of the Deutsche Börse AG, and venture capital (VC) investment data stem from the business-matching platform Spotfolio.

4.2 Variables

In the following, we describe the variables included in our analyses in detail. Additionally, *table A2* provides a summary of the variables, including variable names, short descriptions of the variables, the data sources, and variable categories.

4.2.1 Dependent variables

Seven dependent variables are included in our study, referring to the three regional development dimensions identified in *section 3*. Regional economic performance is captured by *GDP per capita* in euros per district in 2016; *median income*, measured as the monthly salaries of full-time employees subject to social insurance contributions in euros per district in 2017; and *business tax revenues* in euros per inhabitant per district in 2017. Data for all three variables are retrieved from the INKAR online database.

The *unemployment rate* is the first indicator for the second dimension, regional employment. It is measured as the share of unemployed individuals in the civilian labor force in percent per district in 2017. A further indicator for this dimension is the variable *trainees per 1,000 employees* as the number of trainees per 1,000 employees subject to social insurance contributions per district in 2017. Data for both variables are obtained from INKAR.

Regional innovation activity is the third dimension which is partly covered by two established indicators (e. g. Fritsch/Slavtchev 2011). A measure for the innovation input is *R&D intensity*. The initial data for this variable stem from the Donors' Association for Science Statistics, providing total corporate internal R&D expenditures, including personnel expenses in thousands of euros, for 377 districts in 2015. For privacy reasons, the values for the remaining 24 districts are included in the total of another district. Therefore, we divide this total value by the number of districts it comprises and use the result to replace the missing data for this variable in the dataset, thus keeping overall R&D expenditures constant. Finally, we calculate R&D expenditures per 100,000 inhabitants, giving the total corporate internal R&D expenditures in thousands of euros per 100,000 inhabitants per district in 2015. Another variable belonging to this dimension and referring to the innovation output is *patent intensity*, which is the number of patents granted per 100,000 inhabitants per district between 2011 and 2015. The total number of patents per district between 2011 and 2015 for 402 districts is taken from the EPO. Since November 2016, only 401 districts have existed due to Osterode and Göttingen

being combined into a single district, Göttingen; hence, we utilize the mean value of the patents from the two former districts as the value for the combined district. Additionally, we obtain the number of inhabitants in each district from INKAR, which we then divide by 100,000. Finally, the total number of patents is divided by this value to obtain the number of patents granted per 100,000 inhabitants per district.

4.2.2 Independent variable

The starting point for our independent variable is the construction of a sample consisting of 1,645 German HCs. A list-based search was conducted in order to identify the HCs. As a foundation, the HC lists of WirtschaftsWoche (2020) Langenscheidt and Venohr (2014) and Simon (2012) were combined. In addition, we checked other firm lists such as the list of German family enterprises by Seibold et al. (2019) and the lists of innovative (Mittelstand) firms published in Yogeshwar (2019) and Frankfurter Allgemeine Zeitung (2019) for potential HCs. Information on market leadership was additionally selected from the firm websites of the respective firms. Furthermore, we set Google alerts for the terms *Weltmarktführer* and *Hidden Champion* in order to identify additional HCs for our sample.

The 1,645 firms identified fulfill five criteria. *First*, they are among the top three market leaders worldwide or are number one on a continent. *Second*, their revenues for 2019, 2018, or 2017 must lie between ten million and five billion euros. Depending on availability, the revenue data are taken from the Bureau van Dijk database Orbis or the electronic Federal Gazette. *Third*, all firms must be older than ten years and employ more than 50 people. Information on founding years and employee numbers stems from Orbis or the firm websites. *Fourth*, all firms must be located in Germany. *Fifth*, subsidiaries of foreign firms are only included if they operate independently of the mother firm. As the typical HC criterion *unknown to the public* is difficult to measure, we do not include it in our study.

After constructing our sample of 1,645 German HCs, we obtain data on the NUTS 3 level of these firms via Orbis and the firm websites. Thus, we are able to calculate the total number of HCs for each of the 401 German districts. Additionally, we divide the number of inhabitants in each district by 100,000. Finally, the total number of HCs is divided by this value to create our independent variable *HC intensity*: the number of HCs per 100,000 inhabitants per district.

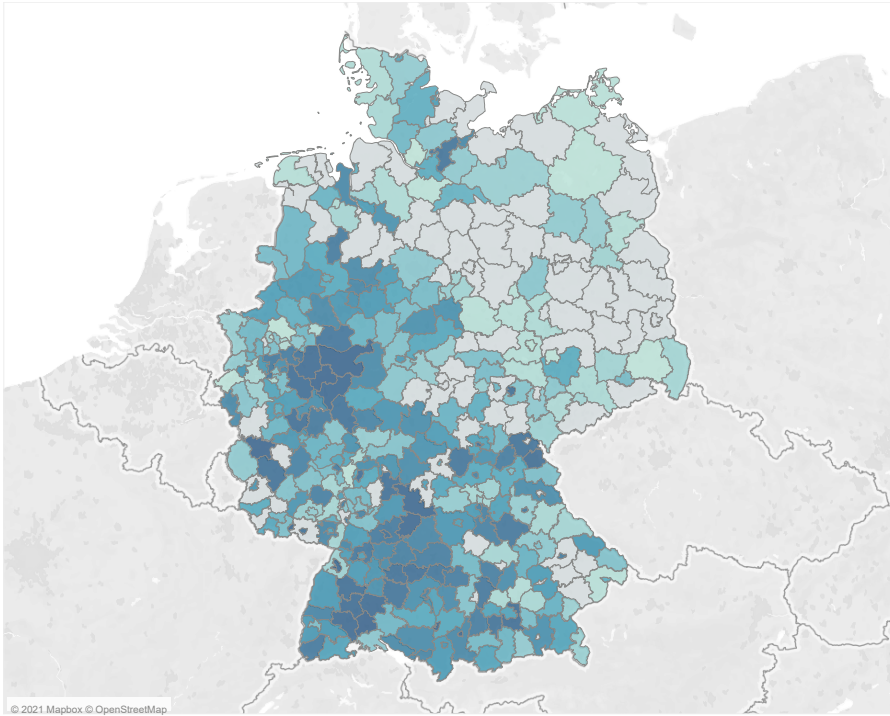


Figure 2: Regional distribution of HC intensity in Germany.

Notes: Distribution of the number of HCs per 100,000 inhabitants per district; darker colors represent an increasing HC intensity; grey colored districts possess a HC intensity of zero.

Source: Own representation, created via Tableau.

4.2.3 Control variables

We include several control variables in our study. First, *population density*, calculated as the number of inhabitants per km² per county 2017, indicates the rurality of a district. To gain information about the population, we utilized the *population average age* in years per district in 2017. Both variables are obtained from INKAR. To analyze the business structure of the districts, we utilize *firm intensity* as the number of firms per 100,000 inhabitants per district in 2017, sourced from the Regional Database of the Statistical Offices of the Federal Republic of Germany and the Federal States. Furthermore, we calculate *university intensity* as the number of public and private universities per 100,000 inhabitants per district in 2018. Data on the total number of universities at the district level originate from the Communal Education Database of the Statistical Offices of the Federal Republic of Germany and the Federal States. Moreover, we calculate *C-DAX intensity* as the number of firms listed in the C-DAX per 100,000 inhabitants per district. Therefore, we accessed a list of the 414 C-DAX stocks from the Deutsche Börse AG on 17 June 2020 and eliminated 16 stocks to avoid double counting, as the associated firms were listed with more than one stock, and

eliminated another seven stocks because the corresponding firms have not been active since 2016. The remaining 391 stocks and respective firms serve as the basis for our control variable. In addition, we access the number of newly established businesses per 1,000 inhabitants in 2017 from INKAR and replace the missing values for the districts of Bremen and Bremerhaven with the mean from the 399 available districts. We then multiply the numbers by 100 to achieve the number of newly established businesses per 100,000 inhabitants per district in 2017 as our variable *new business formation intensity*.

5 Results

5.1 Descriptive results

In advance of the multivariate analysis, we present a series of descriptive results, starting with an illustration of where the HCs are located in Germany. *Figure 2* presents a map of Germany including the district boundaries and the distribution of the number of HCs per 100,000 inhabitants per district. The color of the district indicates the HC intensity;

gray districts possess an HC intensity of zero, and darkly colored districts indicate an increasing HC intensity. The city of Memmingen possesses the highest HC intensity, with 13.69 HC per 100,000 inhabitants, followed by the districts of Kaufbeuren city (HC intensity = 13.67), Tuttlingen (HC intensity = 12.13), Olpe (HC intensity = 10.39), and Vulkaneifel (HC intensity = 9.90). A full list of the 401 German districts ranked according to HC intensity is provided in the appendix (*table A1*), which additionally includes the absolute number of HCs per district. Utilizing these values, we calculate a coefficient of concentration, stating that approximately 50 percent of the HCs are located in 55 of the 401 districts and that the six districts with the highest number of HCs account for more than 10 percent of the total number of HCs (1,645). Additionally, *figure A1* presents a map of the distribution of the absolute number of HCs per district, again with darkly colored districts indicating an increasing number of HCs. Ranking the districts according to their absolute number of HCs, the city of Hamburg has the highest number of HCs (35), followed by the city of Munich (33), the city of Berlin (30), Märkischer Kreis (28), and Esslingen (27). Several cartographic representations of HCs in Germany already exist. In order to verify our sample and the distribution of HCs, we compared our map to the representations of Langenscheidt and Venohr (2014), Simon (2012), and Ermann et al. (2011) which is based on the dataset of the Weissman Institute for Family Business. Our map shows a high visual similarity to the reference maps. Thus, it can be assumed that our sample and the distribution of HCs in Germany are in line with previous research. In addition, we calculated the number of world market leaders per district based on the WirtschaftsWoche (2020) sample and correlated it with the number of HCs per district of our sample. We find a correlation of 0.67, indicating a considerable overlap between the geographical distributions of the two samples.

Table 1 presents the descriptive statistics of and correlations among the variables included in the regression model. We detect a greater correlation between median income and GDP per capita (0.72) as well as between median income and population average age (-0.70), neither of which are problematic for the regression analysis. Regarding multicollinearity, the variance inflation factors (VIFs) of the independent and control variables are relatively low and thus unobjectionable. The independent variable HC intensity has a mean of 2.02, which indicates that a district possesses on average two HCs per 100,000 inhabitants, with a minimum of zero and a maximum of 13.69 HCs per 100,000 inhabitants per district. In terms of economic performance, the average district had a GDP per capita of approximately 36 thousand euros in 2016 and

a median income of approximately three thousand euros in 2017. Concerning regional employment, the districts possessed a mean unemployment rate of 5.36 percent and 43 trainees per 1,000 employees in 2017. The mean R&D intensity of 65,432.23 thousand euros per 100,000 inhabitants in 2015 and the mean patent intensity of 69.11 granted patents between 2011 and 2015 provide an overview of the regional innovation activities. Regarding regional exports, the average district possessed an export intensity of 1,060,115 thousand euros per 100,000 inhabitants in 2017.

5.2 Multivariate results

5.2.1 Sample assessment

Before testing our hypotheses, we assess the quality of our HC sample as relates to the market leadership criterion. Continental market leadership or being one of the top three firms worldwide is strongly connected with a high degree of internationalization, which can be measured by, i. e., the export performance of a firm (e. g. Sullivan 1994). Since HCs strive for market leadership in global niche markets, they are characterized by above-average export rates (Fryges 2006; Johann et al. 2021). Therefore, we test whether regional HC intensity is associated with regional export performance, captured by the variable *export intensity*. The Regional Database of the Statistical Offices of the Federal Republic of Germany and the Federal States offers data on the export revenues of firms in the manufacturing sector in 2017. Twenty-one missing observations are replaced with the mean of the 380 districts with available data. We report the final variable as export revenues in thousands of euros per 100,000 inhabitants per district in 2017. The linear regression analysis in the last column of *table 2* indicates a positive effect of HC intensity on export intensity ($\beta = 69,595.63$, $p < 0.05$). The international orientation and export strength of HCs make a decisive contribution to the export performance of the region in which they are located. Hence, districts with higher HC intensity also have higher export intensity, supporting our selection of HCs.

5.2.2 Hypothesis tests

We test our hypotheses and examine the influence of HC intensity on various regional development dimensions by conducting a linear regression analysis for each dependent variable (see *table 2*). Thus, we expect the number of HCs per 100,000 inhabitants per district to influence the

Table 2: Linear regression analyses.

Dependent variables	Regional economic performance			Regional education			Regional innovation		
	GDP per capita (H1a)	Median income (H1b)	Business tax revenues (H1c)	Unemployment rate (H2a)	Trainees per 1,000 employed (H2b)	R&D intensity (H3a)	Patent intensity (H3b)	Export intensity	
	Coeff (SE)	Coeff (SE)	Coeff (SE)	Coeff (SE)	Coeff (SE)	Coeff (SE)	Coeff (SE)	Coeff (SE)	
Independent variable									
HC intensity	369.23 (310.59)	38.15 (7.41)***	15.41 (5.28)***	-0.09 (0.04)**	1.10 (0.18)***	-417.56 (2,982.62)	7.42 (2.36)***	69,595.63 (28,890.29)**	
Control variables									
Population density	6.81 (1.08)***	0.12 (0.03)***	0.11 (0.02)***	0.00 (0.00)***	-0.00 (0.00)***	23.78 (10.37)**	0.05 (0.01)***	100.31 (100.43)	
Population average age	-2,605.62 (412.99)***	-116.89 (9.85)***	-42.61 (7.02)***	0.71 (0.05)***	-2.01 (0.24)***	-17,831.01 (3,966.01)***	-14.43 (3.14)***	-109,406.3 (38,415.53)***	
Firm intensity	4.12 (1.05)***	-0.05 (0.03)**	0.12 (0.02)***	-0.00 (0.00)***	-0.00 (0.00)	-14.43 (10.09)	0.01 (0.01)	-62.25 (97.70)	
University intensity	4,913.38 (1,942.39)**	-97.29 (46.34)**	-21.53 (33.01)	0.98 (0.25)***	-3.98 (1.13)***	-3,416.91 (18,653.02)	-27.23 (14.76)*	115,586.5 (180,676.9)	
C-DAX intensity	4,302.30 (1,014.13)***	112.02 (24.19)***	68.71 (17.24)***	-0.01 (0.13)	-2.23 (0.59)***	22,399.95 (9,738.79)**	41.72 (7.71)***	92,858.25 (94,331.89)	
New business formation intensity	-18.86 (5.87)***	0.25 (0.14)*	-0.12 (0.10)	0.00 (0.00)***	0.01 (0.00)	-108.83 (56.41)*	-0.17 (0.04)***	-212.39 (546.41)	
Constant	138,664.3 (20,164.6)***	8,185.89 (481.05)***	1,878.90 (342.74)***	-23.05 (2.57)***	131.26 (11.69)***	971,637.3 (193,643.5)***	709.48 (153.28)***	6,097,761 (1,875,670)***	
R ²	0.41	0.58	0.47	0.59	0.35	0.12	0.30	0.08	
F	39.33***	79.02***	50.43***	79.53***	29.85***	7.64***	24.26***	4.84***	

</

$n = 401$ districts; two-sided tests: * = $p \leq 0.10$, ** = $p \leq 0.05$, *** = $p \leq 0.01$; Coeff = coefficients, H = hypothesis; SE = standard error

regional development dimensions. Starting with regional economic performance, we find only partial support for our first hypothesis. HC intensity does not affect a district's GDP per capita, whereas it positively influences median income ($\beta = 38.15$, $p < 0.01$) and business tax revenues ($\beta = 15.41$, $p < 0.01$). Hypothesis 2 on regional employment is fully supported. A large number of HCs per 100,000 inhabitants per district significantly decreases the unemployment rate ($\beta = -0.09$, $p < 0.05$) and increases the number of trainees per 1,000 employees ($\beta = 1.10$, $p < 0.01$). The regression analysis does not support hypothesis 3a, but it does confirm hypothesis 3b, supporting the argument that high HC intensity positively affects the number of patents granted per 100,000 inhabitants per district. We find statistically significant support ($\beta = 7.42$, $p < 0.01$), implying that HC intensity significantly influences only the output of innovation, measured by patent intensity, not innovation input, i. e., R&D expenditures.

5.3 Spatial autocorrelation regression

Spatial autocorrelation is a common source of bias in regional-level analyses. Hence, we run a spatial autocorrelation regression analysis for each of the dependent variables, including our independent variable HC intensity and the control variables involved in our main analyses (see section 5.2). Therefore, we systematically consider which of the variables require the inclusion of a spatial lag. We suspect the dependent variables, the independent variable and the university- and firm-related control variables to be spatially autocorrelated. The regression model further includes the control variables population density and population average age, which we do not suspect to be spatially autocorrelated. In addition to including the spatial lags of the variables to assess the strength of spatial interactions, we further include spatial error terms to correct for the spatial autocorrelative biases (Anselin 2001). As the coefficients of the spatial autocorrelation regression analyses are a combination of direct and indirect effects, we perform an impact test that estimates the mean of the direct, indirect, and total influences of the independent and control variables on the reduced-form mean of the dependent variables. Table 3 presents the results of the impact test following the spatial autocorrelation regression analyses, including the direct, indirect, and total effects of HC intensity on the dependent variables. The direct effects report the change in the dependent variable within the same district. Accordingly, the indirect effects describe the spillover effects, i. e., the changes in the dependent variable in neighboring districts. The total

effect on a given dependent variable is the sum of the direct and indirect effects.

After controlling for spatial autocorrelation, we retest the effect of HC intensity on our dependent variables, starting with the regional economic performance dimension. While HC intensity does not affect a district's GDP per capita, it positively influences the business tax revenue ($\beta = 14.35$, $p < 0.05$) of the same district. For median income, we find a significantly positive direct ($\beta = 15.84$, $p < 0.05$), indirect ($\beta = 46.33$, $p < 0.01$), and total ($\beta = 62.16$, $p < 0.01$) effect of HC intensity. For the second dimension, regional employment, we detect a significantly negative indirect ($\beta = -0.15$, $p < 0.1$) and total ($\beta = -0.17$, $p < 0.05$) influence of the independent variable on the unemployment rate. Furthermore, HC intensity significantly affects the number of trainees per 1,000 employees directly ($\beta = 0.66$, $p < 0.01$) and in total ($\beta = 1.31$, $p < 0.05$). We find no significant effects for the regional innovation dimension. A comparison between the effects of HC intensity and C-DAX intensity on the dependent variables is discussed in section 6.1.

5.4 Robustness-checks and further analyses

In addition to the analyses presented above, we perform several robustness checks. First, we exchange several variables with alternative measures to detect divergent effects in the regression analysis. We replace the dependent variable median income with *household income*, retrieved from INKAR as the monthly household income in euros in 2016 per inhabitant per district. Household income is an alternative measure for regional economic performance, showing how income is distributed across districts. We discover a similar impact of HC intensity on household income ($\beta = 23.99$, $p < 0.01$) compared to median income. The coefficient is lower because the values for household income lie below the median income values.

Furthermore, we choose alternative measures for the control variable university intensity. First, we exchange the control variable with *technical college intensity*. The variable contains the number of technical colleges per 100,000 inhabitants per district in 2018, with data obtained from the Communal Education Database of the Statistical Offices of the Federal Republic of Germany and the Federal States. The significant influence of university intensity on median income, trainees per 1,000 employees and patent intensity now lose significance, while we detect a positive effect of technical college intensity on business tax revenues ($\beta = 50.81$, $p < 0.01$). The significance of the various effects of HC intensity on the different dependent

Table 3: Impact test following the spatial autocorrelation regression analyses.

<i>Dependent variables</i>	<i>Regional economic performance</i>			<i>Regional education</i>			<i>Regional innovation</i>			<i>Sample test</i>	
	GDP per capita	Median income	Business tax revenues	Unemployment rate	Trainees per 1,000 employed	R&D intensity	Patent intensity	Export intensity			
<i>Direct effects</i>											
HC intensity	172.98 (332.66)	15.84 (7.35)**	14.35 (5.68)**	-0.02 (0.04)	0.66 (0.15)***	-2,773.94 (108,799.5)	2.90 (116.53)	36,078.31 (397,427.3)			
C-DAX intensity	4,986.61 (1,021.93)***	105.11 (21.98)***	69.90 (17.30)***	0.10 (0.11)	-0.92 (0.51)*	41,627.67 (1,147,157)	48.85 (467.92)	133,053.5 (1,509,135)			
<i>Indirect effects</i>											
HC intensity	20.49 (817.24)	46.33 (13.96)***	-6.62 (13.10)	-0.15 (0.08)*	0.65 (0.56)	81,984.44 (1,287,534)	34.89 (451.65)	145,259.3 (100,400.8)			
C-DAX intensity	-980.68 (3,262.83)	57.30 (56.41)	-64.14 (55.53)	-0.06 (0.31)	1.01 (2.58)	-873,886 (1.41e+07)	-143.49 (1,999.67)	-555,527.2 (467,072.1)			
<i>Total effects</i>											
HC intensity	193.47 (836.89)	62.16 (14.08)***	7.73 (13.16)	-0.17 (0.08)**	1.31 (0.61)**	79,210.5 (1,395,225)	37.79 (567.53)	181,337.6 (383,322.7)			
C-DAX intensity	4,005.93 (3,624.70)	162.41 (62.29)***	5.76 (60.61)	0.04 (0.35)	0.09 (2.88)	-832,258.3 (1.52e+07)	-94.64 (2,464.52)	-422,473.6 (1,631,862)			

$n = 401$ districts; two-sided tests: * = $p \leq 0.10$, ** = $p \leq 0.05$, *** = $p \leq 0.01$; Coeff = coefficients; SE = standard error

Explanations: Further control variables are included in the model, which are not shown in this table: Population density, population average age, firm intensity, university intensity, and new business formation intensity. Model includes spatial lags of the dependent variables, the independent variable, the control variables C-DAX intensity, firm intensity, university intensity, and new business formation intensity, and spatial autoregressive errors. Generalized spatial two-stage least-squares (GS2SLS) estimator is used in order to fit multiple spatial lags.

variables remains unaffected. In addition, we combine the two academic education variables and test the effect of using the number of universities and technical colleges as a control variable in the regression analysis. Compared to those of the initial variable, the effects of *university and technical college intensity* on median income, trainees per 1,000 employees and patent intensity become insignificant, and we uncover a positive effect on business tax revenues ($\beta = 34.29$, $p < 0.05$). Again, the significance of the effect of HC intensity on the dependent variables remains unaffected. Thus, the number of universities affects regional development dimensions more significantly than the number of technical colleges.

As a further robustness check, additional control variables are integrated into the regression analysis. We calculate the number of VC investments per 100,000 inhabitants per district between 2011 and 2015, namely, *VC investment intensity*, to capture the number of innovative new businesses. Data on VC investments come from Spotfolio, a business-matching platform with a focus on innovative German high-tech firms. Except for a significantly negative effect on trainees per 1,000 employees ($\beta = -0.46$, $p < 0.01$), the additional control variable is found to have no effect. In addition, the dependent variable R&D intensity is used as a control variable for the dependent variable patent intensity in a supplementary regression analysis to examine the relationship between the two innovation variables. Slight scaling adjustments, i. e., recalculating the variable as the total corporate internal R&D expenditures in millions of euros, increase its applicability as a control variable. R&D intensity exerts a significantly positive influence on patent intensity ($\beta = 0.32$, $p < 0.01$). As expected, the innovation input of a district influences its innovation output.

As a final robustness check, we recalculate the independent variable HC intensity as the number of HCs per 100,000 employees per district. Data on the number of employees per district in 2017 stem from the Regional Database of the Statistical Offices of the Federal Republic of Germany and the Federal States. We find similar significant effects on the dependent variables in the regression analysis, except for the impact on business tax revenue, which loses significance. Unsurprisingly, effect sizes are smaller for HC intensity per 100,000 employees, as the number of employees per district is below the corresponding number of inhabitants. Additionally, we rerun the regression analyses using the *absolute number of HCs* per district as the independent variable. Significantly positive influences on median income, business tax revenue, and patent intensity persist.

A series of post hoc analyses, which do not focus on our hypotheses, completes the examinations of this study,

starting with the test of *VC investment intensity* as an additional dependent variable in the regression analysis. HC intensity does not significantly influence VC investment intensity, i. e., the number of innovative business formations. Thus, this dependent variable is not further examined.

Additionally, we perform a seemingly unrelated regression with the variables included in the main analysis, assuming correlation in the error terms across the equations. The significant and insignificant effects of HC intensity on the dependent variables remain, and the effect sizes are nearly equal to those found in the results of the linear regression models.

As HCs are argued to be mainly active in the manufacturing sector (Rammer/Spielkamp 2015, 2019), we would like to analyze whether the effects of HC intensity on these regional dimensions are driven by the manufacturing firms in the sample. Therefore, the NACE codes for the HCs are collected via Orbis; missing data are supplemented by a personal assessment of the industry after collecting information from the firm websites. We then divide the sample into two groups: firms mainly active in manufacturing, i. e., NACE codes ten to thirty-three, and firms in the remaining industries. HC intensity measured as the number of HCs per 100,000 inhabitants per district is then recalculated for the two groups, resulting in *manufacturing HC intensity* and *nonmanufacturing HC intensity*. Figure 4 shows the results of the linear regression analyses. Starting with exports as a quality assessment of our HC sample selection, only manufacturing HC intensity exerts a significant influence on regional-level export intensity ($\beta = 91,042.16$, $p < 0.01$).

Concerning the four regional development dimensions, we detect divergent influences of the two HC intensities on several dependent variables. In terms of regional economic performance, the regional median income is affected only by manufacturing HC intensity ($\beta = 38.73$, $p < 0.01$), as is the case for business tax revenues ($\beta = 16.24$, $p < 0.01$). The trainees per 1,000 employees are also affected only by the HC intensity of manufacturing firms ($\beta = 1.24$, $p < 0.01$), representing the differing influence of the different HCs on regional employment. As a measure of regional innovation output, patent intensity is affected by both manufacturing HC intensity ($\beta = 6.45$, $p < 0.05$) and nonmanufacturing HC intensity ($\beta = 16.55$, $p < 0.1$). In terms of the other dependent variables, we do not find significant effects for the two HC intensities. However, the differing results for exports and the four dependent variables presented above show that HCs are a group of firms that are indeed heterogeneous.

6 Discussion, limitations and outlook

6.1 Discussion

By analyzing regional HC intensity in the context of regional development, we reveal several significant effects on three regional development dimensions: regional economic performance, employment, and innovation. Regarding the first dimension of regional economic performance, we find that HC intensity exerts a significant influence on median income and business tax revenues. This shows that a portion of the value creation generated by HCs remains in their region and is passed on to the inhabitants of the region through salaries and to the governments of the districts in the form of business tax payments. A significant impact on GDP per capita cannot be confirmed. Hence, the production volume that HCs process locally seems to be smaller than expected. This aligns with the findings of Herstatt et al. (2017) that although HCs concentrate their production activities in their German headquarters, most firms pursue a cooperative production strategy and produce in BRIC countries, especially China and India. According to a study by Vonnahme & Lang (2019), 85 percent of the 129 HCs surveyed possess more than one location, while the mean value accounted for ten locations worldwide. This also implies that the production of HCs is not exclusively limited to the German headquarters. Furthermore, spatial autoregressive analyses reveal that there is no significant direct effect of HC intensity on GDP per capita but there is such an effect on both median income and business tax revenues. In addition, HC intensity has significant indirect and total effects on median income. Once again, although the insignificant effect of HC intensity on GDP per capita is somehow surprising given our initial argumentation for hypothesis 1a, it is in line with the results of our main analyses. Moreover, significant results for median income are reasonable, as inhabitants of neighboring districts move between districts to work at HC firms but receive their income in their home district. Business taxes, however, are paid in the district where the HC is located; i. e., HC intensity has only a direct effect on tax revenue.

For the second dimension, regional employment, we find support for the impact of regional HC intensity on both the regional unemployment rate and the number of trainees per 1,000 employees. Hence, HCs are essential employers and trainers in their districts. The previous literature stating that HCs invest highly into human capital strengthens this argument (e.g. Rammer/Spielkamp

2019). Furthermore, spatial autoregressive analyses show mixed effects of HC intensity on the regional unemployment rate. Although HC intensity does not influence the unemployment rate within the HCs' home districts, it has significant indirect and total effects, emphasizing their enormous regional scope as major employers. Due to continuous growth and mostly independent business activities, HCs require a large workforce that they attract supra-regionally and retain over the long run, thus contributing to increased employment levels across districts. Consequently, this finding again underlines the fact that employees travel between districts to work at HC firms. Additionally, HC intensity has both a significant direct and total effect on trainees per 1,000 employees. Although HCs train their own specialists within their home districts, their strong emphasis on trainees also has a clear effect beyond their home districts. Thus, HCs play a meaningful role in employment and training (e.g. Lehmann et al. 2019) both within and across districts.

HC intensity significantly affects the third dimension of regional innovation only in terms of innovation output, i. e., regional patent intensity, but not in terms of innovation input, measured by regional R&D intensity. Although HCs are associated with high R&D expenditures (e.g. Audretsch et al. 2018; Schlepphorst et al. 2016; Simon 2012), no regional-level impact on R&D intensity is found. This result corresponds with the findings of Rammer & Spielkamp (2015, 2019), who argue that HCs do not spend more on R&D than other firms but rather use resources more efficiently, thus enabling higher levels of innovation. HCs seem to innovate in a more efficient way. Furthermore, spatial autoregressive analyses show no significant direct, indirect or total effects of HC intensity on regional innovation – for either innovation input or output – which conflicts with prior research (e.g. Audretsch/Feldmann 2004). With regard to innovation output as measured by patent intensity, these results might indicate a shift within the innovation strategy of HCs away from purely formal protection mechanisms such as patents towards more multifaceted intellectual property protection strategies (e.g. secrecy) and open innovation approaches. This assumption would be to some extent consistent with the findings of Rammer & Spielkamp (2019), who conclude that HCs apply a complex intellectual property management system that combines different protection mechanisms such as patents, secrecy, and complexity of design. Also, Vonnahme & Lang (2019) find that most HCs pursue internal R&D and innovation activities often take place at the HCs' headquarters. They also find that regional innovation cooperation is of limited relevance. In line with Simon (2012), Vonnahme & Lang (2019) further show that

HCs often rely on non-R&D activities such as production or customer relations as sources of innovation. These activities are not covered by our two variables for regional innovation.

In addition to the effect of HC intensity on the dimensions of regional development, we further consider the effect of C-DAX firms on a regional level. Thus, we examine the results of an impact test conducted following the spatial autocorrelation regression analyses, including a comparison of the direct, indirect, and total effects of HC intensity and C-DAX intensity on the dependent variables. The results should be interpreted with the understanding that overlaps between the two groups are possible, as HCs may also be listed in the C-DAX. The issue of firm size should also be considered because C-DAX firms tend to be larger. Furthermore, the relevance of HCs differs across different spatial categories, as a large HC in a small peripheral town might possess stronger direct impacts compared to a small HC in an urban agglomeration (Lang et al. 2019). Interestingly, neither HC intensity nor C-DAX intensity significantly affects regional export intensity within either home or neighboring districts. While C-DAX firms are not associated with high levels of export activity per se, this result is surprising for HCs in particular, as they strongly emphasize international expansion. However, regarding the first dimension of regional economic performance, we find a significant direct effect of C-DAX intensity on each of the three measures: GDP per capita, median income, and business tax revenues. Because we find no significant direct effect of HC intensity on GDP per capita, our results indicate that C-DAX firms contribute more to a district's productive strength than HCs. Moreover, although we find a significant total effect of C-DAX intensity on median income, C-DAX intensity generates no significant spillover effects for neighboring districts. Thus, although total effects for median income are significant for both C-DAX firms and HCs, only HCs generate a significant indirect effect on median income. Consequently, employees of C-DAX firms seem to be less distributed across district boundaries, travelling less between districts for work than HC employees. For the regional economic performance dimension, it is clear that both C-DAX firms and HCs have a significant impact on their home district, but only HCs generate significant spillover effects, as they positively affect the median income of neighboring districts. For the second dimension of regional employment, we find no significant effects of C-DAX intensity on the unemployment rate, while HC intensity has significant indirect and total effects on the unemployment rate. Consequently, C-DAX firms influence neither their home nor their neighboring districts' unemployment rate. Nonetheless, similar to HC

intensity, C-DAX intensity has a significant direct effect on the number of trainees per 1,000 employees. Therefore, C-DAX firms, similar to HCs, contribute to the regional training of skilled workers. For the third dimension of regional innovation, similar to HC intensity, we find no significant effects of C-DAX intensity on either R&D intensity or patent intensity. Again, these results are debatable, particularly with regard to patent intensity. Firms listed on the C-DAX are typically larger, which is why we would have expected them to rely on patents for different reasons. According to Blind et al. (2006), strategic motives for patenting correlate positively with firm size. For example, by signaling successful innovation development and knowledge creation, patents function as helpful assets in negotiations with business partners.

6.2 Implications

Several implications for theory and practice arise from our study. Concerning our theoretical contribution, we add to the small and emerging stream of HC literature, as we examine the HC phenomenon on a regional level. Previous research on HCs has mainly focused on the internationalization (e.g. Audretsch et al. 2018), R&D, and innovation (e.g. Rammer/Spielkamp 2015, 2019) strategies of HCs, as identified by Schenkenhofer (2020). A rather small strand of the literature analyzes HCs in a geographic context, examining, for instance, the worldwide distribution of HCs (e.g. Audretsch et al. 2020; Lehmann et al. 2019) or the role of HCs in small towns and peripheral regions (e.g. Lang et al. 2019; Vonnahme/Lang 2019). Our study examines German HCs at the district level. We not only show the geographic distribution of HCs across German districts but also analyze the impact that HC concentration has on the regional development of the districts in which they are located. In doing so, we review the characteristics HCs are typically associated with and examine whether these characteristics have a visible impact at the regional level. The results of this study indicate that several typical HC characteristics have an impact at the regional level. The economic success of these firms leads to an increase in the regional median income and business tax revenues when HC intensity grows. A decreasing unemployment rate and a growing number of trainees associated with a higher HC intensity speak for the role of these firms as major and popular regional employers. While the significant influence of HC intensity on regional patent intensity highlights the fact that HCs file many patents, no support for the statement that HCs invest highly in R&D (e.g. Rammer/Spielkamp 2019) could be found at the regional

level. Thus, the firm-level characteristics of typical HCs are only partly detectable at the regional level.

Consequently, we also contribute to the literature on the determinants of regional development as a second theoretical contribution. Prior research has identified specific firm types as determinants of different dimensions of regional development. One such firm type is the start-up, as the relationship between new business formation and regional employment change is a prominent research topic (e.g. Fritsch 2008; Fritsch/Müller 2008). Furthermore, family firms are another firm type analyzed as a determinant of regional development (e.g. Basco, 2015; Block & Spiegel, 2013). Our study considers HCs as a determinant of regional development by examining the impact of regional HC intensity on regional-level variables. Moreover, we include a variety of regional development dimensions, namely, regional economic performance, employment, and innovation, and a set of variables to measure each of these dimensions. Applying this approach offers a comprehensive overview of the impact of HCs on the regional development of German districts. Consequently, we add to the research on specific firm types as determinants of regional development, as we identify HCs as impactful determinants at the regional level. The results indicate that regional HC intensity significantly influences each of the three dimensions analyzed. We find a clear impact on regional employment, as a high HC intensity reduces the regional unemployment rate and increases the number of trainees. For regional economic performance and innovation, we uncover only a partial impact: a high HC intensity increases only regional median income, business tax revenues, and patent intensity but not regional GDP and R&D intensity. Hence, HCs serve as an influential group of firms partly determining several dimensions of regional development.

Additionally, our results have practical implications, especially for policy makers at the regional level. We identify HCs as an important group of firms at the regional level and highlight their importance for the districts in which they are located. Hence, HCs contribute to the economic success of, employment in, and innovative performance of a district. Policy makers should consider the importance of such firms and keep them from moving to other locations. In addition, HCs can also influence soft factors of regional development that are difficult to measure, such as the image of a *region of world market leaders*. For example, the town Wertheim located in Baden-Wuerttemberg recently applied for adding the title *town of world market leaders* to their town sign (WirtschaftsWoche 2021). The regional ties of HCs also lead to the promotion of culture and sports and thus to an increase in the well-being of the local pop-

ulation. At the same time, the HCs themselves benefit from being actively involved in the regional development, as they may regard their involvement as an opportunity to actively shape their business environment (Lang et al. 2019). Further practical implications arise for the educational sector. The study confirms that successful and innovative firms are also located in smaller cities or peripheral areas, which can offer attractive jobs to future employees (e.g. Fritsch/Wyrwich 2021). In this context, the dual tertiary education model is also relevant, as it allows students to combine an academic education with practical training in technological leading firms (Schenkenhofer/Wilhelm 2020).

6.3 Limitations and future research

Our study has several limitations. *First*, the criteria utilized to construct the sample of HCs deviate from the initial criteria defined by Hermann Simon (1996). While the market leadership criterion is similar, we adjust the size criterion of revenues below five billion euros by including a minimum revenue level of ten million euros. Moreover, we add two more size criteria: firm age above ten years and a minimum of 50 employees, to exclude start-ups and very small firms from our sample. Hence, the upper-bound size restriction is similar to the initial definition, but we additionally use a set of lower-bound size restrictions. As the third HC criterion of Simon (1996), low public awareness, is difficult to measure and subjective, we do not include it in our study. This shortcoming of HC research has already been pointed out by Schenkenhofer (2020) who sees the development of a measure of the hidden criterion as a major avenue for future HC research.

A *second* methodological limitation is the disparate timeframes of the variables used, ranging from 2011 (patent intensity) to 2020 (HC intensity). Although we utilize the actual data available to us, we were forced to examine the influence of HC intensity on dependent variables from different years. Hence, a potential change in the data to date cannot be excluded. Nevertheless, changes at the regional level occur very slowly and are only clearly visible in the data after a longer period of time. Therefore, we consider this limitation to be rather unproblematic since most of the variables originate within five years of each other.

The *third* limitation of the study is its focus on German districts. Accordingly, the implications of the study are only partially transferable to other countries. By applying the study design to other countries, future research could increase the explanatory power of our results. Hence,

future research could investigate the impact of local HCs on the dimensions of regional development in the corresponding economy or compare different countries in an analysis. Indeed, previous studies have examined the national HCs of different countries in single-country studies (e.g. McKiernan/Purg Eds. 2013) and recently, Audretsch et al. (2020) compare several countries in a single study. Another avenue for future research in this context would be to go beyond the headquarter level. Vonnahme & Lang (2019) find that HCs organize their work in average with ten different locations in different regional settings often on a global scale. Analyzing the interplay between these locations and the distribution of value creation, production and innovation activities would increase our knowledge about the influence of HCs on regional development for headquarter and subsidiary locations. For the variables employed in our study, we anticipate differing degrees of headquarter effects. While we expect central as well as decentral effects for the three regional economic performance indicators, the staff composition of headquarters and subsidiaries can differ (e.g. Tarique et al. 2006). Concerning regional innovation activity, we assume that patent applications are centralized at the headquarters, while R&D activities also take place at subsidiaries (Vonnahme/Lang 2019).

Fourth, in addition to locational expansion, the unit of analysis in terms of the regional economic dimensions of the study could be extended. The focus of our paper lies in the three regional development dimensions: regional economic performance, employment, and innovation. Thus, only a part of regional development is covered, and statements regarding the effect of HCs are only valid for these three dimensions. To expand the explanatory power of these findings, future studies should include additional regional development dimensions and corresponding variables. The relationship between HCs and regional entrepreneurial culture serves as a promising dimension for analysis, as entrepreneurship and connected topics are a prominent research field in regional studies. For instance, previous research has examined the interplay between regional entrepreneurship cultures, regional knowledge bases, and new business formation (Fritsch/Wyrwich 2018). Moreover, Stützer et al. (2014) find that entrepreneurial culture has an effect on individual perceptions of founding opportunities, which in turn predicts regional start-up intentions and activity. Additionally, the actual debate on entrepreneurial ecosystems summarized by Schäfer & Mayer (2019) could also serve as a regional development dimension in future research. Not only further dimensions of regional development could be analyzed but also additional variables to increase the

understanding of the three regional development dimensions of our study. Especially, taking a multi-dimensional approach to the innovation dimension would be a promising avenue for future research. Besides the R&D expenditures and the number of granted patents, other variables such as new business formation in the high-tech sector (Richter 2020) or direct innovation counts (e.g. Acs et al. 2002; Makkonen/van der Have 2013) can be applied. Moreover, Block et al. (2021) point out the importance of *soft* types of innovation, introducing trademarks as an indicator for non-technological innovation at the regional level. Although several quantitative studies examine the R&D and innovation strategies of HCs (e.g. Herstatt et al. 2017; Rammer/Spielkamp 2015; Vonnahme/Lang 2019), qualitative and mixed-methods research could shed more light on how these strategies are shaped by regional characteristics and vice versa. Thereby, qualitative research designs could be used to better understand the role of HCs in regional innovation systems and knowledge networks (e.g. Cooke 2001; Fritsch/Slavtchev 2011) and precisely address the question of how and why HCs deliver added value in the region and how they differ from other (family) firms in their degree of locality and regional embeddedness (Baù et al. 2021; Stough et al. 2015). Qualitative research approaches are of particular relevance in the field of economic geography because, unlike quantitative analyses, they reduce concerns about measurement, provide important contextual information, and help develop compelling substantive arguments (Barthelt/Li 2020). For example, Schoenberger (1991) refers to the corporate interview as a qualitative research method in economic geography and Rutten (2019) uses qualitative comparative analysis (QCA) in order to investigate the relationship between openness values and regional innovation.

A *fifth* limitation of our study is the potential for reverse causality. We assume that HCs influence the regional development of their districts and thus, for example, ensure a higher GDP. In contrast, HCs could settle in districts that are already regionally successful and have, for example, a high GDP. However, the possibility of reverse causality has been mitigated, as the HCs in our sample have an average age of 92.51 years, and we have applied an age minimum of ten years to exclude start-ups. Hence, no firm in the sample recently settled in its district. Nevertheless, the potential problem of reverse causality cannot be completely excluded. To further reduce this issue, future research could examine historical data at the regional level and examine the past regional economic performance, employment and innovation of currently successful districts. Comparable analyses have already been performed in previous research. For instance, Fritsch & Müller (2008)

investigate historical data on regional employment and the impact of new business formation over time. Another example is a recent study on the historic causes behind the spatial distribution of innovation activities in Germany (Fritsch/Wyrwich 2021).

Finally, future research is necessary to expand knowledge on the phenomenon of HCs, especially at the firm level. Although an increasing number of studies on this phenomenon exist to date (see Schenkenhofer 2020), the number of scientifically published academic studies in the field is rather limited (e. g. Audretsch et al. 2018, 2020; Johann et al. 2021; Lehmann et al. 2019). Hence, further research is needed to better understand the inner workings of the HC phenomenon at the firm level as well as the external impact of this specific group of firms. The examination of the subgroup of younger HCs could be of particular interest, as they might have different dynamics, especially in terms of spatial patterns and the structural disadvantage of more rural regions. In this context, the presence of HCs might also have more impact than in urban regions and be of greater relevance to regional development issues. Future research could tie in with the previous work of Lang and colleagues (2019) to further examine these aspects. Due to their technological strength and extensive internationalization efforts, linking younger HCs with the born globals concept (e. g. Baum et al. 2011, 2015; Knight/Cavusgil 2004; Sui et al. 2012) could be a fruitful approach to future research. Similar to HCs, born global firms are associated with distinct organizational features, early internationalization, and superior performance (e. g. Knight/Cavusgil 2004). Although existing studies already offer further differentiations of early internationalizing firms, e. g. between born globals and born regionals (Baum et al. 2015; Lopez et al. 2009; Sui et al. 2012), insights on globally active, technology-oriented startups, their characteristics and dynamics could also be transferable to the HC phenomenon.

Acknowledgements: We acknowledge helpful and constructive comments from Michael Stützer and participants of the G-Forum 2020 as well as the 6th International Research Forum on Mittelstand on earlier versions of the manuscript. Special thanks is also given to the Research Data Center of the Donors' Association for Science Statistics for providing the district level R&D data. Also, we would like to thank the editor Sebastian Henn and the two reviewers of the ZFW for the constructive comments, which significantly improved the quality of our manuscript. Furthermore, we would like to thank the Donors' Association for Science Statistics and the German Savings Banks and Giro-Association (DSGV) for supporting our research.

References

- Acs, Z. J., Anselin, L. & Varga, A. (2002) Patents and innovation counts as measures of regional production of new knowledge. *Research Policy*, 31(7): 1069–1085.
- Ambos, B. & Mahnke, V. (2010) How Do MNC Headquarters Add Value? *Management International Review*, 50(4): 403–412.
- Anselin, L. (2001) Spatial econometrics. In: Baltagi, B. H. (ed.) *A Companion to theoretical econometrics* (pp. 310–330). Oxford: Blackwell.
- Audretsch, D. B. & Feldman, M. P. (2004) Knowledge spillovers and the geography of innovation. In: Henderson, J. V. & Thisse, J.-F. (eds.) *Handbook of Regional and Urban Economics*, Vol 4 (pp. 2713–2739). Amsterdam: Elsevier.
- Audretsch, D., Falck, O., Feldman, M. & Heblich, S. (2008) The Lifecycle of Regions. *CEPR Discussion Paper*, No. 6757.
- Audretsch, D. B., Lehmann, E. E. & Schenkenhofer, J. (2018) Internationalization strategies of hidden champions: Lessons from Germany. *Multinational Business Review*, 26(1): 2–24.
- Audretsch, D. B., Lehmann, E. E. & Schenkenhofer, J. (2020) A context-choice model of niche entrepreneurship. *Entrepreneurship: Theory and Practice*.
- Baù, M., Block, J., Discua Cruz, A. & Naldi, L. (2021) Bridging locality and internationalization – A research agenda on the sustainable development of family firms. *Entrepreneurship & Regional Development*, 1–16.
- Baum, M., Schwens, C. & Kabst, R. (2011) A typology of international new ventures: empirical evidence from high-technology industries. *Journal of Small Business Management*, 49(3): 305–330.
- Baum, M., Schwens, C. & Kabst, R. (2015) A latent class analysis of small firms' internationalization patterns. *Journal of World Business*, 50(4): 754–768.
- Basco, R. (2015) Family business and regional development – A theoretical model of regional familiness. *Journal of Family Business Strategy*, 6(4): 259–271.
- Bathelt, H. & Li, P. (2020) Building better methods in economic geography. *Zeitschrift für Wirtschaftsgeographie*, 64(3): 103–108.
- Becker, J. & Fuest, C. (2010) Internationalization and business tax revenue – Evidence from Germany. *International Tax and Public Finance*, 17: 174–192.
- Berleemann, M. & Jahn, V. (2016) Regional Importance of Mittelstand Firms and Innovation Performance. *Regional Studies*, 50(11): 1–15.
- Blind, K., Edler, J., Frietsch, R. & Schmoch, U. (2006) Motives to patent: Empirical evidence from Germany. *Research Policy*, 35(5): 655–672.
- Block, J. H. & Spiegel, F. (2013) Family firm density and regional innovation output: An exploratory analysis. *Journal of Family Business Strategy*, 4: 270–280.
- Block, J. H., Fisch, C., Ikeuchi, K. & Kato, M. (2021) Trademarks as an indicator of regional innovation: evidence from Japanese prefectures. *Regional Studies*: 1–20.
- Broekel, T. & Brenner, T. (2011) Regional factors and innovativeness: An empirical analysis of four German industries. *The Annals of Regional Science*, 47: 169–194.
- Chandler, A. D. (1991) The functions of the HQ unit in the multibusiness firm. *Strategic Management Journal*, 12(S2): 31–50.

- Cooke, P. (2001) Regional innovation systems, clusters, and the knowledge economy. *Industrial and Corporate Change*, 10(4): 945–974.
- Cooke, P., Gomez Uranga, M. & Etzebarria, G. (1998) Regional systems of innovation: An evolutionary perspective. *Environment and Planning A*, 30(9): 1563–1584.
- Dalgic, T. & Leeuw, M. (1994) Niche marketing revisited: Concept, applications and some European cases. *European Journal of Marketing*, 28(4): 39–55.
- Ermann, U., Lang, T. & Megerle M. (2011) Weltmarktführer: ein räumlicher und zeitlicher Überblick. In: *Nationalatlas aktuell 5*. Leipzig: Leibniz-Institut für Länderkunde (IfL).
- European Union (2018) Regions in the European Union: Nomenclature of territorial units for statistics – NUTS 2016/ EU-28. Luxembourg: Publications Office of the European Union.
- Frankfurter Allgemeine Zeitung (2019) *Deutschlands Innovationsführer*. Available online at: <https://www.faz.net/asv/deutschlands-innovationsfuehrer/> [Accessed 07 July 2020].
- Fritsch, M. (2008) How does new business formation affect regional development? Introduction to the special issue. *Small Business Economics*, 30: 1–14.
- Fritsch, M. & Müller, P. (2004) Effects of New Business Formation on Regional Development over Time. *Regional Studies*, 38(8): 961–975.
- Fritsch, M. & Müller, P. (2008) The effect of new business formation on regional development over time: The case of Germany. *Small Business Economics*, 30: 15–29.
- Fritsch, M. & Schroeter, A. (2011) Why does the effect of new business formation differ across regions? *Small Business Economics*, 36(4): 383–400.
- Fritsch, M. & Slavtchev, V. (2011) Determinants of the Efficiency of Regional Innovation Systems. *Regional Studies*, 45(7): 905–918.
- Fritsch, M. & Wyrwich, M. (2018) Regional knowledge, entrepreneurial culture, and innovative start-ups over time and space – An empirical investigation. *Small Business Economics*, 51(2): 337–353.
- Fritsch, M. & Wyrwich, M. (2021) Does Successful Innovation Require Large Urban Areas? Germany as a Counterexample. *Economic Geography*.
- Fryges, H. (2006) Hidden champions – How young and small technology-oriented firms can attain high export-sales ratios. *ZEW Discussion Paper*, 06–045: 1–29. Mannheim.
- Hamermesh, R. G., Anderson, M. J. & Harris, J. E. (1978) Strategies for low market share businesses. *Harvard Business Review*, 50(3): 95–102.
- Herstatt, C., Tiwari, R. & Buse, S. (2017) Innovating for emerging markets? An assessment of German Hidden Champions' strategies. In: Burr, W. & Stephan, M. (eds.) *Technologie, Strategie und Organisation* (pp. 219–238). Wiesbaden: Springer Gabler.
- Hezar, I., Dalgic, T., Phelan, S. & Knight, G. (2006) Principles of global niche marketing strategies: An early conceptual framework. In: Dalgic, T. (ed.) *Handbook of Niche Marketing* (pp. 25–63). New York, NY: The Haworth Press.
- Iyer, S., Kitson, M. & Toh, B. (2005) Social Capital, Economic Growth and Regional Development. *Regional Studies*, 39(8): 1015–1040.
- Jahn, V. (2018) The importance of owner-managed SMEs and regional apprenticeship activity: Evidence from the German Mittelstand. *Empirical Research in Vocational Education and Training*, 10(8).
- Johann, M., Block, J., & Benz, L. (2021). Financial performance of hidden champions: Evidence from German manufacturing firms. Forthcoming in: *Small Business Economics*.
- Kirchner, P. (2019) *Kompetenzentwicklung regionaler Wirtschaft. Fallstudien aus Heilbronn-Franken*. Industrie- und Handelskammer Heilbronn-Franken (Ed.). Ubstadt-Weiher: Verlag Regionalkultur.
- Kitson, M., Martin, R. & Tyler, P. (2004) Regional Competitiveness: An Elusive yet Key Concept? *Regional Studies*, 38(9): 991–999.
- Knight, G. A. & Cavusgil, S. T. (2004) Innovation, organizational capabilities, and the born-global firm. *Journal of International Business Studies*, 35(2): 124–141.
- Kotler, P. (Eds.) (1997) *Marketing Management – Analysis, Planning, Implementation, and Control*. Upper Saddle River, New Jersey: Prentice-Hall International, Inc.
- Landau, C. & Bock, C. (2013) Value Creation through Vertical Intervention of Corporate Centres in Single Business Units of Unrelated Diversified Portfolios – The Case of Private Equity Firms. *Long Range Planning*, 46(1–2): 97–124.
- Lang, T., Görmar, F., Graffenberger, M. & Vonnahme, L. (2019) *Hidden Champions und Stadtentwicklung: Die wirtschaftliche und gesellschaftliche Bedeutung innovativer Unternehmen für Kleinstädte in peripherer Lage*. Bonn: Bundesinstitut für Bau-, Stadt- und Raumforschung (BBSR).
- Langenscheidt, F. & Venohr, B. (2014) *Lexikon der deutschen Weltmarktführer*. Köln: Gabal.
- Lehmann, E. E., Schenkenhofer, J. & Wirsching, K. (2019) Hidden champions and unicorns: A question of the context of human capital investment. *Small Business Economics*, 52: 359–374.
- Lopez, L. E., Kundu, S. K. & Ciravegna, L. (2009) Born global or born regional? Evidence from an exploratory study in the Costa Rican software industry. *Journal of International Business Studies*, 40(7): 1228–1238.
- McKiernan, P. & Purg, D. (Eds.) (2013) *Hidden Champions in CEE and Turkey: Carving Out a Global Niche*. Berlin, Heidelberg: Springer.
- Makkonen, T. & van der Have, R. P. (2013) Benchmarking regional innovative performance: Composite measures and direct innovation counts. *Scientometrics*, 94: 247–262.
- Memili, E., Fang, H., Chrisman, J. J. & De Massis, A. (2015) The impact of small- and medium-sized family firms on economic growth. *Small Business Economics*, 45(4): 771–785.
- Pahnke, A. & Welter, F. (2019) The German Mittelstand: Antithesis to Silicon Valley entrepreneurship? *Small Business Economics*, 52: 345–358.
- Porter, M. (1980) *Competitive Strategy – Techniques for Analyzing Industries and Competitors*. New York, NY: The Free Press.
- Porter, M. (2003) The Economic Performance of Regions. *Regional Studies*, 37(6&7): 549–578.
- Rammer, C. & Spielkamp, A. (2015) Hidden Champions – Driven by Innovation: Empirische Befunde auf Basis des Mannheimer Innovationspanels. *ZEW-Dokumentation*, 15–03: 1–43. Mannheim.
- Rammer, C. & Spielkamp, A. (2019) German Hidden Champions: Competitive strategies, knowledge management and innovation in globally leading niche players. *Ekonomiaz* 95(1): 65–87.

- Rodriguez-Pose, A. (2013) Do Institutions Matter for Regional Development? *Regional Studies*, 47(7): 1034–1047.
- Röhl, K.-H. (2008) Die Zukunft der Familienunternehmen in Deutschland – Potenziale und Risiken in der globalen Wirtschaft. In: *Analysen – Forschungsberichte aus dem Institut der deutschen Wirtschaft Köln* (pp. 1–120).
- Rutten, R. (2019) Openness values and regional innovation: a set-analysis. *Journal of Economic Geography*, 19(6): 1211–1232.
- Schäfer, S. & Mayer H. (2019) Entrepreneurial ecosystems: Founding figures and research frontiers in economic geography. *Zeitschrift für Wirtschaftsgeographie*, 63(2–4): 55–63.
- Schlepphorst, S., Schlömer-Laufen, N. & Holz, M. (2016) Determinants of hidden champions: Evidence from Germany. *Working Paper*, 03/16: 1–20. Bonn, Bonn: Institut für Mittelstandsforschung (IfM).
- Schenkenhofer, J. (2020) Hidden champions: A review of the literature & future research avenues. *UO Working Paper Series*, 06–20, Augsburg.
- Schenkenhofer, J. & Wilhelm, D. (2020) Fuelling Germany's Mittelstand with complementary human capital: The case of the Cooperative State University Baden-Württemberg. *European Journal of Higher Education*, 10(1): 72–92.
- Schoenberger, E. (1991) The corporate interview as a research method in economic geography. *The Professional Geographer*, 43(2): 180–189.
- Seibold, L. K. C., Lantelme, M. & Kormann, H. (2019) *German family enterprises – A sourcebook of structure, diversity, growth and downfall*. Cham: Springer.
- Simon, H. (1996) You don't have to be German to be a "Hidden Champion". *Business Strategy Review*, 7(2): 1–13.
- Simon, H. (2012) *Hidden Champions: Aufbruch nach Globalia – Die Erfolgsstrategien unbekannter Weltmarktführer*. Frankfurt am Main: Campus.
- Simon, H. (2013) Hidden Champions – Die Avantgarde in Globalia. *Wirtschaftswissenschaftliches Studium (WiSt)*, 4: 185–191.
- Stimson, R. J., Stough, R. R. & Roberts, B. H. (2006) *Regional economic development: Analysis and planning strategy*. Berlin: Springer.
- Stough, R., Welter, F., Block, J. H., Wennberg, K. & Basco, R. (2015) Family business and regional science: "Bridging the gap." *Journal of Family Business Strategy*, 6(4): 208–218.
- Stuetzer, M., Obschonka, M., Brixy, U., Sternberg, R. & Cantner, U. (2014) Regional characteristics, opportunity perception and entrepreneurial activities. *Small Business Economics*, 42(2): 221–244.
- Sui, S., Yu, Z. & Baum, M. (2012) Prevalence and longitudinal trends of early internationalisation patterns among Canadian SMEs. *International Marketing Review*, 29(5): 519–535.
- Sullivan, D. (1994) Measuring the degree of internationalization of a firm. *Journal of International Business Studies*, 25(2): 235–342.
- Tarique, I., Schuler, R. & Gong, Y. (2006) A model of multinational enterprise subsidiary staffing composition. *International Journal of Human Resource Management*, 17(2): 207–224.
- Teplensky, J. D., Kimberly, J. R., Hillman, A. L. & Schwartz, J. S. (1993) Scope, timing and strategic adjustment in emerging markets: Manufacturers' strategies and the case of MRI. *Strategic Management Journal*, 14(7): 505–527.
- Thomi, W. & Werner, R. (2001). Regionale Innovationssysteme: Zur territorialen Dimension von Wissen und Innovation. *Zeitschrift für Wirtschaftsgeographie*, 45(1): 202–218.
- Toften, K. & Hammervoll, T. (2009) Niche firms and marketing strategy – An exploratory study of internationally oriented niche firms. *European Journal of Marketing*, 43(11/12): 1378–1391.
- Toften, K. & Hammervoll, T. (2010a) Strategic orientation of niche firms. *Journal of Research in Marketing and Entrepreneurship*, 12(2): 108–121.
- Toften, K. & Hammervoll, T. (2010b) Niche marketing and strategic capabilities: An exploratory study of specialised firms. *Marketing Intelligence & Planning*, 28(6): 736–753.
- Vonnahme, L. & Lang, T. (2019) *Peripher global: Ergebnisse der standardisierten Befragung zu Innovationsaktivitäten von Weltmarktführern in Deutschland*. Working Paper 18, SFB 1199 University of Leipzig.
- Voudouris, I., Lioukas, S., Makridakis, S. & Spanos, Y. (2000) Greek Hidden Champions: Lessons from Small, Little-known Firms in Greece. *European Management Journal*, 18(6): 663–674.
- WirtschaftsWoche (2020) Die 500 heimlichen Weltmarktführer 2021. *Sonderheft Nr. 1*, 1–98.
- WirtschaftsWoche (2021) *Warum Wertheim einen ungewöhnlichen Namensantrag stellt*. Available online at: <https://www.wiwo.de/my/unternehmen/mittelstand/stadt-der-weltmarktfuehrer-warum-wertheim-einen-ungewoehnlichen-namensantrag-stellt/27384334.html?ticket=ST-1623127-0wL7PsJkPREbu4dXEFc-ap2> [Accessed 05 August 2021].
- Yogeshwar, R. (Ed.) (2019) *Top 100 2019 – Innovationschampions: Die innovativsten Unternehmen im Mittelstand*. München: Redline.
- Zucchella, A. & Palamara, G. (2006) Niche strategy and export performance. *Advances in International Marketing*, 17(1): 63–87.

Appendix

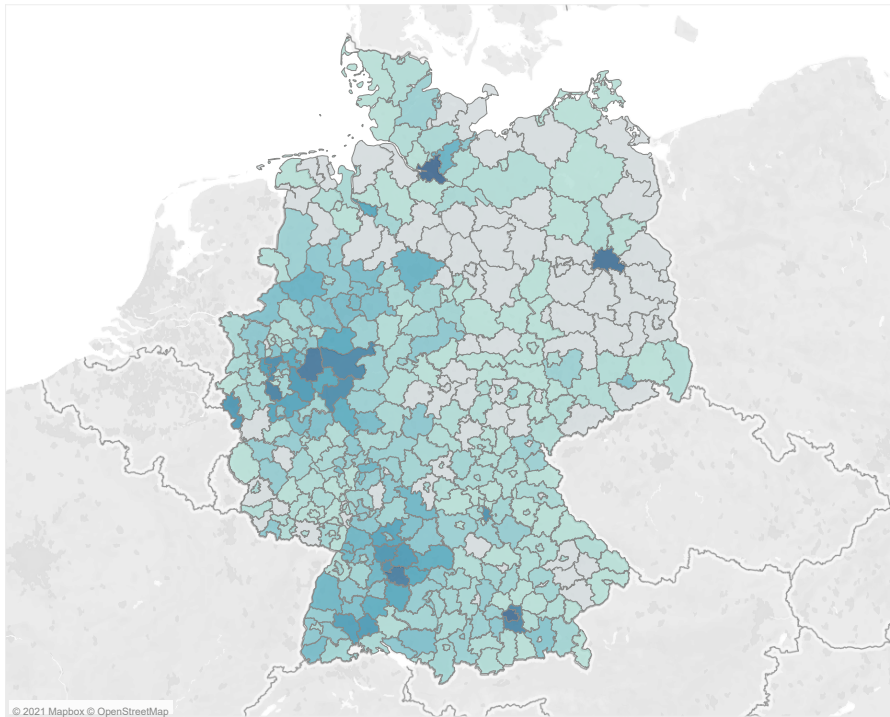


Figure A1: Regional distribution of HCs in Germany.

Notes: Distribution of the absolute number of HCs per district; darker colors represent an increasing number of HCs; grey colored districts possess zero HCs.

Source: Own representation, created via Tableau.

Table A1: Ranking of German districts sorted by descending HC intensity.

	District name	HC intensity	Absolute number of HCs		District name	HC intensity	Absolute number of HCs
1	Memmingen, city	13.69	6	14	Zollernalbkreis	6.88	13
2	Kaufbeuren, city	13.67	6	15	Wunsiedel i.Fichtelgebirge	6.83	5
3	Tuttlingen	12.13	17	16	Märkischer Kreis	6.79	28
4	Olpe	10.39	14	17	Rottweil	6.45	9
5	Vulkaneifel	9.90	6	18	München	6.31	22
6	Zweibrücken, city	8.77	3	19	Oberbergischer Kreis	6.24	17
7	Hochsauerlandkreis	8.45	22	20	Freudencity	5.94	7
8	Main-Tauber-Kreis	8.31	11	21	Darmcity, city	5.65	9
9	Hohenlohekreis	8.03	9	22	Heilbronn, city	5.56	7
10	Siegen-Wittgenstein	7.55	21	23	Neuwied	5.50	10
11	Schwarzwald-Baar-Kreis	7.53	16	24	Göppingen	5.44	14
12	Coburg, city	7.27	3	25	Miltenberg	5.44	7
13	Baden-Baden, city	7.26	4	26	Jena, city	5.39	6

Table A1: (continued)

	District name	HC intensity	Absolute number of HCs		District name	HC intensity	Absolute number of HCs
27	Bernkastel-Wittlich	5.34	6	63	Rhein-Hunsrück-Kreis	3.89	4
28	Hof	5.25	5	64	Bamberg, city	3.87	3
29	Starnberg	5.14	7	65	Nürnberg, city	3.86	20
30	Lahn-Dill-Kreis	5.12	13	66	Heidelberg, city	3.74	6
31	Esslingen	5.06	27	67	Gießen	3.72	10
32	Pirmasens, city	4.95	2	68	Lindau (Bodensee)	3.67	3
33	Stormarn	4.93	12	69	Emmendingen	3.63	6
34	Reutlingen	4.88	14	70	Südliche Weinstraße	3.62	4
35	Hagen, city	4.77	9	71	Remscheid, city	3.60	4
36	Amberg, city	4.77	2	72	Herford	3.59	9
37	Haßberge	4.73	4	73	Schwäbisch Hall	3.57	7
38	Soest	4.64	14	74	Ostallgäu	3.56	5
39	Heidenheim	4.53	6	75	Karlsruhe, city	3.51	11
40	Enzkreis	4.52	9	76	Ludwigsburg	3.49	19
41	Neumarkt i.d.OPf.	4.49	6	77	Städteregion Aachen	3.42	19
42	Aichach-Friedberg	4.49	6	78	Wesermarsch	3.39	3
43	Westerwaldkreis	4.46	9	79	Warendorf	3.24	9
44	Lörrach	4.37	10	80	Bodenseekreis	3.24	7
45	Heilbronn	4.37	15	81	Lübeck, city	3.22	7
46	Mettmann	4.32	21	82	Minden-Lübbecke	3.22	10
47	Ennepe-Ruhr-Kreis	4.32	14	83	Waldeck-Frankenberg	3.19	5
48	Vechta	4.24	6	84	Günzburg	3.18	4
49	Straubing, city	4.18	2	85	Neucity a.d.Waldnaab	3.18	3
50	Kulmbach	4.18	3	86	Ravensburg	3.17	9
51	Dillingen a.d.Donau	4.17	4	87	Main-Spessart	3.17	4
52	Landsberg am Lech	4.16	5	88	Stuttgart, city	3.15	20
53	Mainz, city	4.15	9	89	Pfaffenhofen a.d.Ilm	3.15	4
54	Ostalbkreis	4.14	13	90	Fulda	3.14	7
55	Neuburg-Schrobenhausen	4.14	4	91	Altenkirchen (Westerwald)	3.11	4
56	Frankenthal (Pfalz), city	4.12	2	92	Offenbach	3.11	11
57	Donnersbergkreis	3.99	3	93	Wuppertal, city	3.10	11
58	Rems-Murr-Kreis	3.99	17	94	Tübingen	3.08	7
59	Speyer, city	3.97	2	95	Rosenheim	3.07	8
60	Ulm, city	3.96	5	96	Alb-Donau-Kreis	3.06	6
61	Roth	3.94	5	97	Northeim	3.01	4
62	Fürth, city	3.91	5	98	Bielefeld, city	3.00	10

Table A1: (continued)

District name	HC intensity	Absolute number of HCs	District name	HC intensity	Absolute number of HCs
99 Lichtenfels	2.99	2	135 Ansbach, city	2.39	1
100 Hochtaunuskreis	2.96	7	136 Pforzheim, city	2.39	3
101 Verden	2.92	4	137 Nürnberger Land	2.35	4
102 Goslar	2.92	4	138 Würzburg, city	2.35	3
103 Bad Kissingen	2.91	3	139 Waldshut	2.34	4
104 Kempten (Allgäu), city	2.90	2	140 Offenbach am Main, city	2.33	3
105 Aschaffenburg	2.87	5	141 Coburg	2.30	2
106 Kusel	2.84	2	142 Neu-Ulm	2.30	4
107 Vogelsbergkreis	2.83	3	143 Fürstenfeldbruck	2.28	5
108 Böblingen	2.81	11	144 Garmisch-Partenkirchen	2.26	2
109 Mayen-Koblenz	2.80	6	145 Traunstein	2.26	4
110 Neckar-Odenwald-Kreis	2.79	4	146 München, city	2.24	33
111 Gütersloh	2.75	10	147 Flensburg, city	2.23	2
112 Ansbach	2.72	5	148 Köln, city	2.21	24
113 Trier, city	2.71	3	149 Kitzingen	2.20	2
114 Steinfurt	2.68	12	150 Wiesbaden, city	2.16	6
115 Mönchenglöblich, city	2.68	7	151 Landau in der Pfalz, city	2.14	1
116 Breisgau-Hochschwarzwald	2.66	7	152 Göttingen	2.13	7
117 Düsseldorf, city	2.58	16	153 Regionalverband Saarbrücken	2.12	7
118 Lippe	2.58	9	154 Main-Taunus-Kreis	2.10	5
119 Regen	2.58	2	155 Unterallgäu	2.08	3
120 Oberallgäu	2.57	4	156 Bamberg	2.04	3
121 Ortenaukreis	2.56	11	157 Marburg-Biedenkopf	2.03	5
122 Fürth	2.56	3	158 Hameln-Pyrmont	2.02	3
123 Schaumburg	2.54	4	159 Darmstadt-Dieburg	2.02	6
124 Calw	2.53	4	160 Biberach	2.00	4
125 Landshut	2.52	4	161 Osnabrück	1.96	7
126 Rhön-Grabfeld	2.51	2	162 Leipzig	1.94	5
127 Rhein-Sieg-Kreis	2.50	15	163 Merzig-Wadern	1.93	2
128 Kassel, city	2.48	5	164 Bayreuth	1.93	2
129 Karlsruhe	2.48	11	165 Passau, city	1.91	1
130 Bremen, city	2.46	14	166 Hamburg, city	1.90	35
131 Schwabach, city	2.45	1	167 Neustadt an der Weinstraße, city	1.88	1
132 Borken	2.43	9	168 Schweinfurt, city	1.85	1
133 Kiel, city	2.42	6	169 Ilm-Kreis	1.84	2
134 Worms, city	2.40	2			

Table A1: (continued)

District name	HC intensity	Absolute number of HCs	District name	HC intensity	Absolute number of HCs
170 Bonn, city	1.83	6	206 Höxter	1.42	2
171 Rendsburg-Eckernförde	1.83	5	207 Rheinisch-Bergischer Kreis	1.41	4
172 Osnabrück, city	1.82	3	208 Holzminden	1.41	1
173 Coesfeld	1.82	4	209 Ebersberg	1.41	2
174 Sonneberg	1.78	1	210 Saarpfalz-Kreis	1.40	2
175 Krefeld, city	1.76	4	211 Tirschenreuth	1.38	1
176 Bremerhaven, city	1.76	2	212 Essen, city	1.37	8
177 Koblenz, city	1.75	2	213 Bayreuth, city	1.34	1
178 Mühldorf a.Inn	1.74	2	214 Kyffhäuserkreis	1.33	1
179 Lüneburg	1.64	3	215 Regensburg, city	1.31	2
180 Kelheim	1.64	2	216 Freiburg im Breisgau, city	1.30	3
181 Rhein-Lahn-Kreis	1.64	2	217 Mannheim, city	1.29	4
182 Schmalkalden-Meiningen	1.63	2	218 Rhein-Neckar-Kreis	1.28	7
183 Paderborn	1.63	5	219 Freyung-Grafenau	1.28	1
184 Ammerland	1.61	2	220 Kassel	1.27	3
185 Duisburg, city	1.60	8	221 Bad Kreuznach	1.27	2
186 Rheingau-Taunus-Kreis	1.60	3	222 Solingen, city	1.26	2
187 Münster, city	1.59	5	223 Birkenfeld	1.24	1
188 Bad Tölz-Wolfratshausen	1.57	2	224 Saale-Holzland-Kreis	1.20	1
189 Ahrweiler	1.54	2	225 Main-Kinzig-Kreis	1.19	5
190 Weimar, city	1.54	1	226 Augsburg	1.19	3
191 Emsland	1.54	5	227 Mülheim an der Ruhr, city	1.17	2
192 Sigmaringen	1.53	2	228 Ludwigshafen am Rhein, city	1.17	2
193 Steinburg	1.52	2	229 Limburg-Weilburg	1.16	2
194 Wesel	1.52	7	230 Gelsenkirchen, city	1.15	3
195 Unna	1.52	6	231 Düren	1.14	3
196 Neunkirchen	1.51	2	232 Jerichower Land	1.11	1
197 Donau-Ries	1.50	2	233 Schwalm-Eder-Kreis	1.11	2
198 Kronach	1.49	1	234 Altenburger Land	1.11	1
199 Bergstraße	1.48	4	235 Segeberg	1.09	3
200 Weilheim-Schongau	1.48	2	236 Konstanz	1.05	3
201 Grafschaft Bentheim	1.47	2	237 Schwerin, city	1.04	1
202 Hildesheim	1.45	4	238 Region Hannover	1.04	12
203 Dresden, city	1.44	8	239 Regensburg	1.03	2
204 Sömmerda	1.44	1	240 Dortmund, city	1.02	6
205 Mainz-Bingen	1.42	3	241 Greiz	1.02	1

Table A1: (continued)

District name	HC intensity	Absolute number of HCs	District name	HC intensity	Absolute number of HCs
242 Eifelkreis Bitburg-Prüm	1.01	1	277 Alzey-Worms	0.77	1
243 Herzogtum Lauenburg	1.01	2	278 Oldenburg	0.77	1
244 Ostprignitz-Ruppin	1.01	1	279 Eichstätt	0.76	1
245 Viersen	1.00	3	280 Bad Dürkheim	0.75	1
246 Miesbach	1.00	1	281 Dithmarschen	0.75	1
247 Kaiserslautern, city	1.00	1	282 Erlangen-Höchstädt	0.73	1
248 Schleswig-Flensburg	1.00	2	283 Erding	0.73	1
249 Neucity a.d.Aisch-Bad Windsheim	1.00	1	284 Schwandorf	0.68	1
250 Eichsfeld	1.00	1	285 Rhein-Kreis Neuss	0.67	3
251 Werra-Meißner-Kreis	0.99	1	286 Frankfurt am Main, city	0.66	5
252 Wetteraukreis	0.98	3	287 Mittelsachsen	0.65	2
253 Amberg-Weizsach	0.97	1	288 Dachau	0.65	1
254 Kleve	0.96	3	289 Herne, city	0.64	1
255 Salzgitter, city	0.95	1	290 Zwickau	0.63	2
256 Oberhavel	0.95	2	291 Anhalt-Bitterfeld	0.63	1
257 Berchtesgader Land	0.95	1	292 Rotenburg (Wümme)	0.61	1
258 Kaiserslautern	0.94	1	293 Leverkusen, city	0.61	1
259 Ludwigslust-Parchim	0.94	2	294 Nordfriesland	0.60	1
260 Erfurt, city	0.94	2	295 Oldenburg (Oldenburg), city	0.59	1
261 Altötting	0.90	1	296 Hamm, city	0.56	1
262 Erlangen, city	0.89	1	297 Freising	0.56	1
263 Osterholz	0.88	1	298 Burgenlandkreis	0.55	1
264 Vogtlandkreis	0.88	2	299 Bochum, city	0.55	2
265 Rastatt	0.87	2	300 Barnim	0.55	1
266 Forchheim	0.86	1	301 Saalekreis	0.54	1
267 Bottrop, city	0.85	1	302 Aurich	0.53	1
268 Rhein-Erft-Kreis	0.85	4	303 Salzlandkreis	0.52	1
269 Wolfenbüttel	0.83	1	304 Passau	0.52	1
270 Meißen	0.83	2	305 Rostock, city	0.48	1
271 Berlin, city	0.82	30	306 Harz	0.47	1
272 Chemnitz, city	0.81	2	307 Vorpommern-Rügen	0.45	1
273 Braunschweig, city	0.81	2	308 Magdeburg, city	0.42	1
274 Görlitz	0.78	2	309 Halle (Saale), city	0.42	1
275 Cham	0.78	1	310 Harburg	0.40	1
276 Garmersheim	0.77	1	311 Heinsberg	0.39	1
			312 Mecklenburgische Seenplatte	0.39	1

Table A1: (continued)

District name	HC intensity	Absolute number of HCs	District name	HC intensity	Absolute number of HCs
313 Groß-Gerau	0.36	1	349 Rosenheim, city	0.00	0
314 Leipzig, city	0.34	2	350 Landshut, city	0.00	0
315 Bautzen	0.33	1	351 Deggendorf	0.00	0
316 Recklinghausen	0.33	2	352 Rottal-Inn	0.00	0
317 Pinneberg	0.32	1	353 Straubing-Bogen	0.00	0
318 Neumünster, city	0.00	0	354 Dingolfing-Landau	0.00	0
319 Ostholstein	0.00	0	355 Weiden i.d.OPf., city	0.00	0
320 Plön	0.00	0	356 Hof, city	0.00	0
321 Wolfsburg, city	0.00	0	357 Weißenburg-Gunzenhausen	0.00	0
322 Gifhorn	0.00	0	358 Aschaffenburg, city	0.00	0
323 Helmstedt	0.00	0	359 Schweinfurt	0.00	0
324 Peine	0.00	0	360 Würzburg	0.00	0
325 Diepholz	0.00	0	361 Augsburg, city	0.00	0
326 Nienburg (Weser)	0.00	0	362 Saarlouis	0.00	0
327 Celle	0.00	0	363 St. Wendel	0.00	0
328 Cuxhaven	0.00	0	364 Brandenburg an der Havel, city	0.00	0
329 Lüchow-Dannenberg	0.00	0	365 Cottbus, city	0.00	0
330 Heidekreis	0.00	0	366 Frankfurt (Oder), city	0.00	0
331 Stade	0.00	0	367 Potsdam, city	0.00	0
332 Uelzen	0.00	0	368 Dahme-Spreewald	0.00	0
333 Delmenhorst, city	0.00	0	369 Elbe-Elster	0.00	0
334 Emden, city	0.00	0	370 Havelland	0.00	0
335 Wilhelmshaven, city	0.00	0	371 Märkisch-Oderland	0.00	0
336 Cloppenburg	0.00	0	372 Oberspreewald-Lausitz	0.00	0
337 Friesland	0.00	0	373 Oder-Spree	0.00	0
338 Leer	0.00	0	374 Potsdam-Mittelmark	0.00	0
339 Wittmund	0.00	0	375 Prignitz	0.00	0
340 Oberhausen, city	0.00	0	376 Spree-Neiße	0.00	0
341 Euskirchen	0.00	0	377 Teltow-Fläming	0.00	0
342 Odenwaldkreis	0.00	0	378 Uckermark	0.00	0
343 Hersfeld-Rotenburg	0.00	0	379 Landkreis Rostock	0.00	0
344 Cochem-Zell	0.00	0	380 Nordwestmecklenburg	0.00	0
345 Trier-Saarburg	0.00	0	381 Vorpommern-Greifswald	0.00	0
346 Rhein-Pfalz-Kreis	0.00	0	382 Erzgebirgskreis	0.00	0
347 Südwestpfalz	0.00	0	383 Sächsische Schweiz-Osterzgebirge	0.00	0
348 Ingolcity, city	0.00	0			

Table A1: (continued)

	District name	HC intensity	Absolute number of HCs
384	Nordsachsen	0.00	0
385	Dessau-Roßlau, city	0.00	0
386	Altmarkkreis Salzwedel	0.00	0
387	Börde	0.00	0
388	Mansfeld-Südharz	0.00	0
389	Stendal	0.00	0
390	Wittenberg	0.00	0
391	Gera, city	0.00	0
392	Suhl, city	0.00	0
393	Eisenach, city	0.00	0
394	Nordhausen	0.00	0
395	Wartburgkreis	0.00	0
396	Unstrut-Hainich-Kreis	0.00	0
397	Gotha	0.00	0
398	Hildburghausen	0.00	0
399	Weimarer Land	0.00	0
400	Saalfeld-Rudolcity	0.00	0
401	Saale-Orla-Kreis	0.00	0

Explanation: Ranking of the 401 German Districts according to the descending number of HCs per 100,000 inhabitants per district; further including the absolute number of HCs per district.

Source: Own representation.

Table A2: Description of variables.

Variable name	Definition	Data Source	Category
GDP per capita	In € per district in 2016	INKAR	Dependent
Median income	Monthly salaries of full-time employees subject to social insurance contributions in € per district in 2017	INKAR	Dependent
Unemployment rate	Share of unemployed in the civilian labor force in % per district in 2017	INKAR	Dependent
Business tax revenues	Business tax revenues in € per inhabitant per district in 2017	INKAR	Dependent
Trainees per 1,000 employed	Number of trainees per 1,000 employees subject to social insurance contributions per district in 2017	INKAR	Dependent
R&D intensity	Total corporate internal R&D expenditures in tsd € per 100,000 inhabitants per district in 2015	Donors' Association for Science Statistics	Dependent
Patent intensity	Number of granted patents per 100,000 inhabitants per district between 2011 and 2015	EPO	Dependent
Export intensity	Export turnover in tsd € per 100,000 inhabitants per district in 2017	Regional Database of the Statistical Offices of the Federal Republic of Germany and the Federal States	Dependent
HC intensity	Number of HCs per 100,000 inhabitants per district in 2020	Own research	Independent
Population density	Number of inhabitants per km ² per county 2017	INKAR	Control
Population average age	In years per district in 2017	INKAR	Control
Firm intensity	Number of firms per 100,000 inhabitants per district in 2017	Regional Database of the Statistical Offices of the Federal Republic of Germany and the Federal States	Control
University intensity	Number of public and private universities per 100,000 inhabitants per district in 2018	Communal Education Database of the Statistical Offices of the Federal Republic of Germany and the Federal States	Control
C-DAX intensity	Number of firms listed in the C-DAX per 100,000 inhabitants per district in 2020	Deutsche Börse AG	Control
New business formation intensity	Number of newly established businesses per 100,000 inhabitants per district in 2017	INKAR	Control