Hochschule für
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BPS Working Paper No. 2
Research Paper

Berlin, 07/2023

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Paper No. 2, Date: 07/2023

BPS Working Paper Series*
Working Papers of the
Berlin Professional School at the
Berlin School of Economics and Law (HWR Berlin)
Badensche Str. 52, D-10825 Berlin

**The BPS Working Paper Series continues the IMB Working Paper Series published from 1998 until 2021*

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ISSN 2752-2199

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Abstract

There is still a rather small number of studies on gazelles in Germany, home to Europe's largest economy and its capital Berlin, one of Europe's main startup hubs. In particular, a recent overview on the occurrence of gazelles in Germany, which differentiates gazelles (up to five years old) from other high-growth firms (no age restriction) is missing. Applying descriptive statistics to a data set of 5,328 high-growth firms we provide such an overview in terms of regional and sectoral distribution of German gazelles as well as their spatial link to regional business clusters. We find that most German high-growth firms (and equally gazelles) exist in the most populated German states. They mostly exist in traditional business sectors like construction and manufacturing. Relatively more gazelles than older high-growth firms exist in the sector of further business-related services. In the sectors construction, information and communication, further business-related services, and art, entertainment and recreation, we identify weak but significant positive spatial associations between the number of cluster initiatives and the number of gazelles. No such association exists for the entirety of high-growth firms in Germany.

Keywords: gazelles, German gazelles, high-growth firms, distribution of gazelles, occurrence of gazelles, clusters, cluster embeddedness

Zusammenfassung

Noch immer gibt es wenige Studien über Gazellenunternehmen in Deutschland, obwohl Deutschland die größte Volkswirtschaft Europas darstellt und die Hauptstadt Berlin ein Zentrum von Unternehmensgründungen ist. Es mangelt insbesondere an aktuellen Studien, die Gazellen im engeren Sinne (bis zu fünf Jahre alt) von schnell wachsenden Unternehmen (keine Altersbeschränkung) unterscheiden. Unsere Studie von 5.328 schnell wachsenden Unternehmen in Deutschland verschafft einen aktuellen und differenzierten Überblick über die sektorale und regionale Verteilung dieser Firmen wie auch ihre Nähe zu offiziellen Clustern. Im Ergebnis finden sich die meisten Gazellen und schnell wachsenden Unternehmen in den bevölkerungsreichsten Bundesländern, vorwiegend in traditionellen Sektoren wie dem Bau- und dem verarbeitenden Gewerbe. Gazellen gibt es vergleichsweise häufiger im Sektor der weiteren Dienstleistungen. Eine signifikante, wenn auch schwache Korrelation zwischen den Standorten von Gazellen und Clustern ergibt sich für die Sektoren Baugewerbe, Informations- und Kommunikationswirtschaft, weitere Dienstleistungen sowie Kunst, Unterhaltung und Erholung.

Content

1. Introduction

David Birch (1979) has coined the term “gazelle” for the small number of firms, which demonstrate extraordinary growth over a certain period of time and thereby generate the majority of new jobs. This characteristic, presumably along with the catchy term, has created high interest in this type, or rather “species”, of firms, be it from researchers as well as from investors and policy makers around the world (Gaikwad, 2022).

One of the leading topics on gazelle research is the occurrence of such firms, either in terms of the spatial environment (Giner *et al*., 2017; Stam, 2005), the sectoral environment (Kubičková *et al*., 2018; Satterthwaite and Hamilton, 2017; Feindta *et al*., 2002) and the embeddedness into clusters or entrepreneurial ecosystems (Cowell *et al*., 2018; Stam and van de Ven, 2019; Martínez-Fierro *et al*., 2020). Such findings may serve policy makers, managers, founders and investors alike to gain a better understanding of the environmental conditions for founding and “breeding” gazelles for rapid growth and hence, above-average job and value creation.

To date, the results of gazelle studies are considerably ambiguous. While some authors find gazelles to occur predominantly in urban agglomeration areas and clusters (Giner *et al.,* 2017) as well as specific sectors like knowledge-intensive industries (Daunfeldt *et al.,* 2016; Kubičková *et al.*, 2018), IT, high-tech (Eckhardt and Shane, 2011) and services (Daunfeldt *et al.*, 2016; Satterthwaite and Hamilton, 2017; to a certain extent Henrekson and Johansson, 2010), others point out different results with broader regional (Borggren *et al.*, 2016; Li *et al.*, 2016) and sectoral distributions (Acs *et al.*, 2008; Henrekson and Johansson, 2010; Daunfeldt *et al.*, 2016; Li *et al.*, 2016).

One reason for the equivocal results on gazelle environments is surely the use of rather different definitions of gazelle firms in business practice as well as in literature. The Hurun Research Institute, for instance, releases the “Hurun Global Gazelle Index”, a list of “start-ups founded in the 2000s, worth over US$500mn, not yet listed on a public exchange and most likely to ‘go unicorn’, i.e. hit a valuation of US$1bn, within three years” (Hurun Research Institute, 2022). The American “Gazelle Index®”, on the other hand, includes “high-performing” companies “with 10 to 100 employees”, focusing on minority- and women-owned small businesses (Boston, 2011). In his practice-oriented book, Bradbury defines a gazelle as “any fast-growing company with over one million in revenue that increases its profits by at least 20 percent annually for four years or more. Over that four-year period, a gazelle grows so much that their greatest growth point is always found at the end of the four years” (Bradbury, 2016, p. xvi). These examples demonstrate that very different types of companies are called gazelles by business practitioners.

In literature, there is a widely acknowledged (Anton, 2019, p. 213), rather narrow, definition of gazelle firms by the OECD. According to this, enterprises up to 5 years old with average annualized growth greater than 20 percent per annum, over a three year period (resulting in a growth rate of at least 72,8 percent over three years), either measured by the number of employees or by turnover, are defined as gazelles (Eurostat, 2007). In addition, a “provisional size threshold has been suggested as 10 employees at the beginning of the growth period” (Eurostat, 2007, p. 61). Furthermore, the OECD defines enterprises that meet the same criteria as gazelles but are older than 5 years as “high-growth firms” (Eurostat, 2007). Many publications refer to the OECD definition of gazelles, but often also deviate from it slightly. Dautzenberg *et al.* (2012), for example, consider only employment growth, and not turnover growth, and do not put an age restriction to their definition of gazelle firms. Stam (2005, p. 122)

on the other hand, regards independent and privately held firms, which are younger than 11 years and older than 5 years, and which generated at least 20 full-time equivalents (FTEs) in employment after their first five years, as gazelles. Obviously, such different definitions of gazelles may result in very different findings on the antecedents and characteristics of their high growth (see also Minichberger and Schwingsmehl, 2019).

Besides the issue of lacking definitional clarity, there are heterogeneous methodological and theoretical perspectives applied in studying these firms, which hamper the comparability of reported findings (see e.g. Coad *et al.*, 2014; Delmar *et al.*, 2003; McKelvie and Wiklund, 2010). These are differences in the granularity of studies, in the external circumstances of regarded firms, for example with regard to business cycles, exogenous shocks etc. (Minichberger and Schwingsmehl, 2019) and rather lacking comparative and longitudinal studies (Gaikwad, 2022). Hence, there is a need for research that is clearly connectable to former studies and explicitly compares findings with these (Tomenendal *et al.*, 2022).

We contribute in this context with a new study of gazelles in Germany, strictly applying the OECD definitions of gazelles and high-growth firms and striving to compare the results with respective former studies (namely to Dautzenberg *et al.,* 2012 and Schlepphorst and Schlömer-Laufen, 2016). Germany is an interesting country to study gazelles for a number of reasons. First, the economy is the largest in Europe and the fourth largest in the world (Statista, 2022) so that economic characteristics are relevant on an international scale. Second, Germany's economy is characterized by diversified quality production (Sorge & Streeck 2016), which means flexible, high-value-added production capacities located throughout the country; the regional and sectoral occurrence of extraordinarily growing firms appears difficult to predict in this environment and is thus particularly interesting to study. Third, Germany has been divided after World War II into a Western and Eastern part with strong affiliations to the respective political and economic blocks. Even more than thirty years after German reunification, structural differences between West and East Germany are prevalent, and their effect on gazelle firms is a major area of gazelle research in Germany (Brenning *et al.*, 2017; Ochsner, 2018; Ochsner and Ragnitz, 2018). Finally, fourth, there is still a limited number of studies on gazelles in Germany, most of which have been conducted in the 2010s. Hence, a recent overview on the occurrence of gazelles in Germany, especially when differentiating strictly between gazelles and older high-growth firms according to the OECD definition, is prone to provide original and relevant findings.

In our empirical study, we analyze a data set of over 5,000 German gazelles and other high-growth firms in the pre-Corona years 2018 and 2019 with regard to the size and age of these firms, their regional and sectoral distribution as well as whether they reside within business clusters. Overall, the results from our empirical analysis are in line with those of major former studies, which apply the same or almost the same definition of high-growth firms and gazelles. We find that German high-growth firms (and equally gazelles) are distributed throughout the country and most of them exist in the most populated German states. They mostly exist in traditional business sectors like construction and manufacturing. Relatively more gazelles than older high-growth firms exist in the sector of further business-related services. In the sectors construction, information and communication, further business-related services and art, entertainment and recreation, we identify weak but significant positive spatial associations between the number of cluster initiatives and the number of gazelles. No such association exists for the entirety of high-growth firms in Germany.

The remainder of this article is structured as follows: In the second section, we summarize main findings from existing research on gazelles in Germany. The third section contains our

empirical study, detailing the methodological approach first and then presenting our statistical results and discussing these in the light of comparable former studies. In the final section we conclude and suggest avenues for further research.

2. Former Research on the Occurrence of Gazelles in Germany

While research on gazelle firms has blossomed internationally (Rocha and Ferreira, 2022), there is still a rather small number of studies on gazelles in Germany (Raffer and Tomenendal, 2022). Most of the existing studies have been conducted in the 2010s and have been commissioned by public institutions, like the Federal Ministry of Economic Affairs. The goal of former studies was often to compare regions and clusters in Germany, especially Western and East German ones, and to derive recommendations for policy makers in fostering the creation of gazelle firms and thereby the generation of economic value and jobs. In sum, Fritsch (2019: 139) summarizes, though, that studies on gazelles yield too heterogeneous results with regard to firm size, sectoral and spatial distribution, to identify potential gazelles early and to formulate "pick-the-winner-strategies" for policy makers or venture capitalists on the question of whom to support primarily for job and wealth creation.

The most comprehensive study on German gazelles to date is the one by Dautzenberg *et al.* (2012), which was commissioned by the German Federal Ministry for Economic Affairs with the goals to identify and characterize German gazelles, to describe their contribution to sectoral and structural change in Germany, to analyze growth drivers and barriers, and to assess the impact of public policy. To reach these goals the authors analyzed statistical data, surveyed firms and conducted case studies. In their study the authors included high-growth firms, as defined by the OECD, but only with regard to the threshold criterion of respective employment growth. The authors generated a number of relevant findings on the occurrence of these firms: First, the largest employment growth was detected in young high-growth firms, which started to grow immediately after startup, i.e. which are gazelles according to the OECD. Second, there are more high-growth firms in knowledge-intensive sectors than in other sectors, and third, these firms are often created in regional clusters.

Another major study on German gazelles in the context of the German Federal Ministry for Economic Affairs was conducted by Schlepphorst and Schlömer-Laufen (2016). The authors conducted an online survey among German companies with at least five employees, based on data from Creditreform, an established private provider of firm-level data. They compared a sample of gazelle companies, defined as companies with at least 72,8 percent employment or revenue growth between 2012 and 2015 and at least ten employees in the base year 2012 (i.e. high-growth firms according to the OECD definition), to a random sample of other firms. The authors received answers from 469 companies, 60 (13 percent) of which could be considered high-growth companies, which the authors synonymously call gazelles. In terms of regional distribution, most high-growth firms were found in the four most populous West-German states of North Rhine-Westphalia (32 percent), Baden-Wurttemberg (23 percent), Bavaria (13 percent) and Lower Saxony (10 percent) as well as the East-German state of Saxony Anhalt (7 percent); in North Rhine-Westphalia, Baden-Wurttemberg and Saxony Anhalt the shares of high-growth firms were higher than the respective shares of all firms. With regard to the sectoral distribution, most high-growth firms occurred in manufacturing/mining/energy (27 percent), information and communication technology (17 percent) and wholesale/retail (14 percent); the shares of high-growth firms in all of these sectors were considerably higher than the shares of all surveyed firms in these sectors.

Schulte detects gazelles, which he also calls „highflyers“, primarily in young and innovative sectors like IT and biotechnology (2002: 93). He claims that in these sectors, where the sectoral evolution is at an early stage, new market structures develop and small companies benefit from their flexible structures in terms of decision-making and organization, gazelles - as young companies - have an advantage. Arnold *et al.* (2014: 86) and Mattes (2013: 41, 46) also put forward that technology-intensive startups have a greater probability of becoming gazelles, which play a significant role in driving structural change and high growth in some regions in Germany, for example in Southern Germany.

The occurrence of gazelles in East Germany, also in comparison to West Germany, is a frequent research topic among German authors. Ochsner (2018) finds an underrepresentation of gazelles in East Germany and explains these by structural and socio-cultural factors, like the large number of very small firms in East Germany, having lower R&D spending and productivity, by few dense clusters in East Germany (with the exception of Berlin and some areas around larger cities), by the greater skills shortage compared to West Germany as well as by smaller growth ambitions of entrepreneurs in East Germany.

Brenning *et al*. (2017), in another study commissioned by the German Federal Ministry for Economic Affairs, and Ochsner/Ragnitz (2018) find that 8 percent of all East German companies are gazelles according to their definition. This definition entails an annual growth in employment of at least 10 percent in the six years between 2011 and 2016, i.e. an increase in employment by 77 percent or more during this period. If the annual employment growth of a firm amounted to at least 20 percent during the three years of 2014, 2015 and 2016, which means the firm has increased employment during this period by 73 percent or more, this firm is called “super gazelle” by the authors, which is the equivalent to Dautzenberg *et al*.’s (2012) definition of a gazelle and the OECD’s definition of a high-growth firm. Overall, Brenning *et al*. (2017) and Ochsner/Ragnitz (2018) characterize the typical East German gazelle as relatively small (with 10-19 employees), more than 10 years old, active in the industrial or consumer goods sector and located in the states of Berlin or Saxony. These firms create almost every second new job in East Germany. With regard to industry clusters, East German gazelles appear more frequently in consumer-oriented services, manufacturing and research- and knowledge-intensive services. East German industry clusters with the comparably highest shares of gazelles are research- and knowledge-intensive services as well as other services.

When it comes to the link between gazelles and clusters, the “European Cluster Panorama” has brought further interesting results for the whole of Germany. In this publication, gazelles are defined as companies which are less than 5 years old and have shown a yearly employment growth of more than 10 percent over a period of three years (Ketels/Protsiv 2016: 18). According to the authors this wider gazelle definition is used to be more inclusive in capturing dynamic developments than by deploying the narrower 20 percent growth threshold. On this basis, more than 76.700 gazelles have been identified in traded industries (i.e. industries that concentrate in particular regions but sell products or services across regions and countries) in Europe. It turned out, first, that, 25.000 of the gazelles are located in strong clusters. Second, in strong clusters, gazelles are substantially larger. Third, gazelles play an important role in emerging industries, which are characterized by “the establishment of an entirely new industrial value chain, or the radical reconfiguration of an existing one, driven by a disruptive idea (or convergence of ideas) leading to turning these ideas/opportunities into new products/services with higher added value” (Heffernan/Phaal 2009, cited from Ketels/Protsiv 2016: 4). Fourth, among the 39 European regions with the highest traded industry employment in emerging industries, fourteen are in Germany, with ranks 2 to 8 taken

by the German regions around Stuttgart (in Baden-Wurttemberg), Darmstadt (in Hesse), Munich (in Bavaria), Düsseldorf, Köln, (both in North Rhine Westphalia), Karlsruhe and Tübingen (both in Baden-Wurttemberg) (Ketels/Protsiv 2016: 15f.).

In sum, former studies on high-growth firms and gazelles in Germany tend towards a broader definition of a gazelle and to find that rather younger firms create more jobs, are more often in West than in East Germany, in knowledge-intensive sectors and in regional clusters. As these studies use quite different definitions of their objectives of studies, pursue different goals and use different methods, their comparability is somewhat limited. In addition, major studies are up to a decade old. Therefore, we conduct a topical empirical study on German gazelles and high-growth firms, in which we use the same data source as Dautzenberg *et al.* (2012) and Schlepphorst and Schlömer-Laufen (2016), namely the Creditreform database, and make a distinction between gazelles and older high-growth firms according to the OECD definition so that an update of findings and comparison of these, particularly with those of the two mentioned seminal publications is possible.

3. Recent Occurrence of Gazelles and High-Growth Firms in Germany

3.1 Method and Data

For our empirical analysis of German gazelles we deploy a data set of 5,328 high-growth firms drawn from the Creditreform database covering the entirety of German firms. Our sampled data set includes organizational information like company name, address, year of foundation, and business sector as well as the number of employees and total turnover for the years 2015 to 2019. For identification of high-growth firms, we use the latter two variables and the years 2018 and 2019. Due to the pandemic and the Russian invasion in Ukraine, which are both related to major economic insecurities, we refrain from analyzing the more recent years 2020 to 2022. For validity reasons, we dropped all companies from the data set, which had the purpose of buying other firms; for such holdings it remains unclear whether growth is organic or based on newly bought firms. In addition, we dropped all firms which showed extraordinary but implausible growth based on, for example, a high one-time jump of turnover from year t-1 to year t that dropped to its initial level in year t+1.

All firms in our sample show an average annualized growth greater than 20 percent over a three-year period either in terms of number of employees or in terms of turnover, equaling to a minimum of 72.8 percent growth over three years, measured either in 2018 or 2019. These growth thresholds originate in the widely-used OECD definition of high-growth firms and gazelles (Eurostat, 2007). At the beginning of the growth period, the firm needs to have at least ten employees. The OECD uses firm age to differentiate between these two groups, gazelles being firms which meet the growth criteria and which are not older than five years and „high-growth firms“ being firms which meet the growth criteria irrespective of firm age. We used the variable „year of foundation“ to single out all gazelles in our dataset of high-growth firms. The data structure allows us to compare gazelles of the years 2018 and 2019 to high-growth firms in the same year which are older than five years. At the point in time when the firms in our database met the growth criterion (either in 2018 or in 2019), only approximately 5 percent, exactly 294 out of the 5,328 firms, have been gazelles when following the OECD definition.

Table I provides annual means of the two main variables used for the identification of high growth and compares average values for gazelles with the annual averages of older high-growth firms. As expected, both the average number of employees and the average total annual turnover show remarkable annual growth over the period 2015 to 2019, which covers both growth periods used for identification. Unsurprisingly, older high-growth firms are on average larger in terms of employees and turnover. For example, in 2019 older high-growth firms had an average turnover more than twice as high as the turnover of an average gazelle. Compared to that, the average older high-growth firm was only 41 percent larger in terms of employees than the average gazelle (41.3 versus 58.2).

	Gazelles		Older High-Growth Firms	
Year	Average No. of Employees	Average Turnover (in Million Euros)	Average No. of Employees	Average Turnover (in Million Euros)
2019	41.3	5.39	58,2	11,05
2018	40.7	4.85	54,1	9,96
2017	35.1	4.05	48,5	8,42
2016	30.2	3.30	43,1	6,89
2015	24.4	2.12	37,5	6,00

Table I: Employees and Turnover of German Gazelles and High-Growth Firms (Source: Own creation)

As our sample contains firms which qualify as high-growth firms or gazelles by employment and/or turnover growth, we include companies which may not have sufficient growth in employment but meet the criterion in terms of turnover (and vice versa). This is the explanation why the growth of mean values in turnover and employment as presented in Table I do not meet the growth criteria themselves.

Our empirical analysis of German gazelles is mainly descriptive. We investigate the sample in terms of regional distribution and business sector distribution (following the official classification scheme of the German Office of Statistics, Destatis 2008). The regional analysis covers federal states as well as two-digit postal code regions of which Germany has 99. In addition, we analyze whether the occurrence of gazelles in a certain region coincides with the existence of business clusters. For this reason, we collected information about the location of clusters from and as defined by the official German cluster platform (Federal Ministry for Economic Affairs and Climate Action, 2022). Based on the spatial distribution of business clusters and gazelles – evaluated on the level of two-digit postal code regions – we calculate standard correlation coefficients evaluating the association of the number of clusters and the number of gazelles across postal code regions. We do that for each of the 21 business sectors separately.

3.2 Results

In the following, we present findings with regard to the distribution over firm size in terms of number of employees, German states, and business sectors. Throughout the results section we compare gazelles with older high-growth firms and also the entirety of high-growth firms (gazelles and older high-growth firms). In addition, we present correlation coefficients for those clusters in which they show a sufficient degree of significance.

Distribution over Company Size

Every second high-growth firm in Germany can be attributed to the smallest employment size category of 10 to 19 employees (see Table II). These are 190 gazelles and 2,477 older high-growth firms. One third of the overall population of 2018/2019 high-growth firms has between 20 and 49 employees, and this share comprises 84 gazelles and 1,713 older high-growth firms. One in ten firms has between 50 and 99 employees and one in 20 between 100 and 499 employees. This depicts the fact that most high-growth firms in Germany are relatively small enterprises.

Comparing the relative distribution of gazelles versus older high-growth firms over firm size at the beginning of the growth period shows that the share of very small firms (10 to 19 employees) among gazelles lies at 64.4 percent whereas it is at 49.2 percent among older high-growth firms. This relation switches in higher size categories. The distribution indicates that at the beginning of the growth period upcoming gazelles are in relative terms more often small companies than older high-growth firms. This is hardly surprising given that gazelles are younger than high-growth firms. Because of their extreme growth the small share of 1.7 percent of gazelles which reached employee numbers of more than 100 within their maximum five years of existence is of special interest.

Firm Size Categories (No. of Employees)	Gazelles	Older High-Growth Firms	All High-Growth Firms (Gazelles + Older HG Firms)
10-19	64.6 %	49.2 %	50.1 %
20-49	28.6 %	34.0 %	33.7 %
50-99	5.1 %	10.8 %	10.5 %
100-499	1.4 %	5.6 %	5.4 %
500 and more	0.3 %	0.4 %	0.4 %
Total	294 (100%)	5,034 (100 %)	5,328 (100 %)

Table II: Firm Size Categories of German Gazelles and High-Growth Firms (Source: Own creation; firm size categories were built with employment data for the year 2015)

Distribution over German States

Germany is a federal country which consists of 16 states as an intermediate level between the federal and the local government level. Three out of these 16 are city states (Berlin, Bremen, Hamburg). Table III gives an overview of the spatial distribution of gazelles across German states compared to older high-growth firms older than five years.

	Gazelles	Older High-Growth Firms	All High-Growth Firms (Gazelles + Older HG Firms)
Baden-Wurttemberg	8.8 %	12.1 %	11.9%
Bavaria	8.2 %	15.5 %	15.1 %
Berlin	4.8 %	5.3 %	5.3 %
Brandenburg	4.8 %	3.1 %	3.2 %
Bremen	0.3 %	0.3 %	0.3 %
Hamburg	0.7 %	1.1 %	1.1 %
Hesse	11.9 %	9.2 %	9.4 %
Mecklenburg Western-Pomerania	2.0 %	1.4 %	1.4 %
Lower Saxony	9.5 %	7.3 %	7.4 %
North Rhine-Westphalia	25.5 %	25.0 %	25.0 %
Rhineland-Palatinate	6.5 %	5.0 %	5.1 %
Saarland	1.4 %	1.4 %	1.4 %
Saxony	6.8 %	5.9 %	5.9 %
Saxony Anhalt	4.1 %	2.3 %	2.4 %
Schleswig-Holstein	2.4 %	3.1 %	3.1 %
Thuringia	2.4 %	2.0 %	2.0 %
Total	294 (100 %)	5,034 (100 %)	5,328 (100 %)

Table III: State Distribution of German Gazelles and High-Growth Firms (Source: Own creation)

The general finding is that the 294 gazelles distribute rather similarly across German states compared to their 5,034 older counterpart high-growth firms. About one quarter of all firms is

located in North Rhine-Westphalia. Also, Bavaria, Baden-Wurttemberg, and Hesse have high shares of fast-growing firms. These states are also the most populous ones. When analyzing the absolute numbers of gazelles across two-digit postal code regions we observe, however, that there are several regions in East Germany which have comparably high numbers of gazelles (see Figure 1).

Interesting are differences between the groups. It is Bavaria in which the shares of gazelles versus older high-growth firms differ most substantially. Whereas 8.2 percent of all gazelles are located in Bavaria, the state is home to 15.5 percent of all older high-growth firms. Also, existent but less pronounced is this difference in Baden-Wurttemberg. These two states have a traditionally strong industrial base with many large and established firms which may explain this finding. Compared to that, North Rhine-Westphalia and Hesse have slightly higher shares of gazelles than older high-growth firms. The same is true for most East German states. Particularly pronounced is this difference in Saxony Anhalt which is home to 4.1 percent of all German gazelles of the years 2018 and 2019 but only for 2.3 percent of all older high-growth firms. For the urban city states Berlin, Hamburg and Bremen, one would assume higher shares of gazelles compared to older high-growth firms, based on former studies. However, we do not find the like.

Distribution over Business Sectors

The distribution of all high-growth firms (gazelles and older firms) over business sectors shows that the German economy, also in terms of high-growth firms, is dominated by the more traditional sectors. More than one quarter of all high-growth firms of the years 2018 and 2019 can be attributed to the construction sector and 20.5 percent to the manufacturing sector, followed by the wholesale/retail sector (15.3 percent) (see Table IV). Only then come business-related services (7.6 percent) and freelance, scientific, and technical services (7.5 percent).

	Gazelles	Older High-Growth Firms	All High-Growth Firms (Gazelles + Older HG Firms)
Manufacturing	16.7 %	20.7 %	20.5 %
Water Supply	0.7 %	1.3 %	1.3 %
Construction	24.2 %	25.7 %	25.6 %
Wholesale/Retail	12.6 %	16.5 %	15.3 %
Mobility and Warehouses	8.8 %	6.8 %	6.9 %
Hotels and Restaurants	3.7 %	2.3 %	2.4 %
Information and Communication	3.1 %	4.8 %	4.7 %
Real Estate	1.4 %	1.1 %	1.1 %

Freelance, Scientific and Technical Services	4.1 %	7.7 %	7.5 %
Further Business-Related Services	14.3 %	7.2 %	7.6 %
Health and Social Services	4.1 %	1.3 %	1.4 %
Art, Entertainment, Recreation	2.7 %	1.1 %	1.2 %
Further Services	2.0 %	1.7 %	1.7 %
Total	294 (100 %)	5,034 (100 %)	5,328 (100 %)

Table IV: Sector Distribution of German Gazelles and High-Growth Firms (Source: Own creation; the table includes all business sectors in which the share of all high-growth firms (gazelles and older) is at least 1 percent)

The comparison of this distribution with the distribution of the sector-related gross value added of 2019 (where manufacturing and wholesale/retail had the largest shares, but the construction sector was not as relevant) indicates that most high-growth firms do not necessarily appear in sectors with the largest shares in the economy. They also relate to temporary, sometimes business-cycle related dynamic growth as one could observe it in the construction sector in the years prior to the pandemic (Raffer and Tomenendal, 2022). From this perspective the relevance of the construction sector can be explained by high demand for construction firms in the years following 2015, which led many of them to hire more staff (HDB, 2018). This indicates that dynamic environments support firm growth.

The comparison of the relative shares of gazelles versus older high-growth firms shows that the shares of gazelles are lower than the shares of older high-growth firms in these traditional business sectors which build the backbone of the German economy. A remarkable finding relates to the sector „further business-related services“, which comprise leasing services or temporary employment agencies. 14.3 percent of all German gazelles of the years 2018 and 2019 can be attributed to this sector but only 7.2 percent of all older high-growth firms. In this sector, high firm growth among companies which are younger than five years is particularly widespread.

Cluster Initiatives and Gazelles

In a next step, we take a look into the coincidence of German gazelles and business clusters. For this reason, we collected primary data from the German cluster platform which makes detailed information on more than 400 cluster initiatives publicly available (Federal Ministry for Economic Affairs and Climate Action, 2022). Data about these clusters and the original firm-level data covering all German high-growth firms of the years 2018 and 2019 have been aggregated at the two-digit postal code region level and used for analyzing spatial correlations.

We calculated standard correlation coefficients separately for each of the 21 business sectors in the official classification. In interpretative terms, a high, positive, and significant correlation coefficient in a certain sector indicates that across Germany (divided in 99 two-digit postal code regions) the occurrence of cluster initiatives is significantly associated to the number of gazelles: Where many cluster initiatives exist in a certain sector one could also expect many gazelles. Nothing can be said about causality, however.

Figure 1 shows the distribution of German gazelles and cluster initiatives across two-digit postal code regions. Interestingly, two of the three regions with the highest number of gazelles are located in West Germany and one in East Germany in the region around Dresden. Postal code regions with a particularly high number of cluster initiatives exist in Schleswig-Holstein, Lower Saxony but also in Baden-Wurttemberg and Berlin. The visual inspection of these two maps does not reveal any obvious spatial coincidence, however.

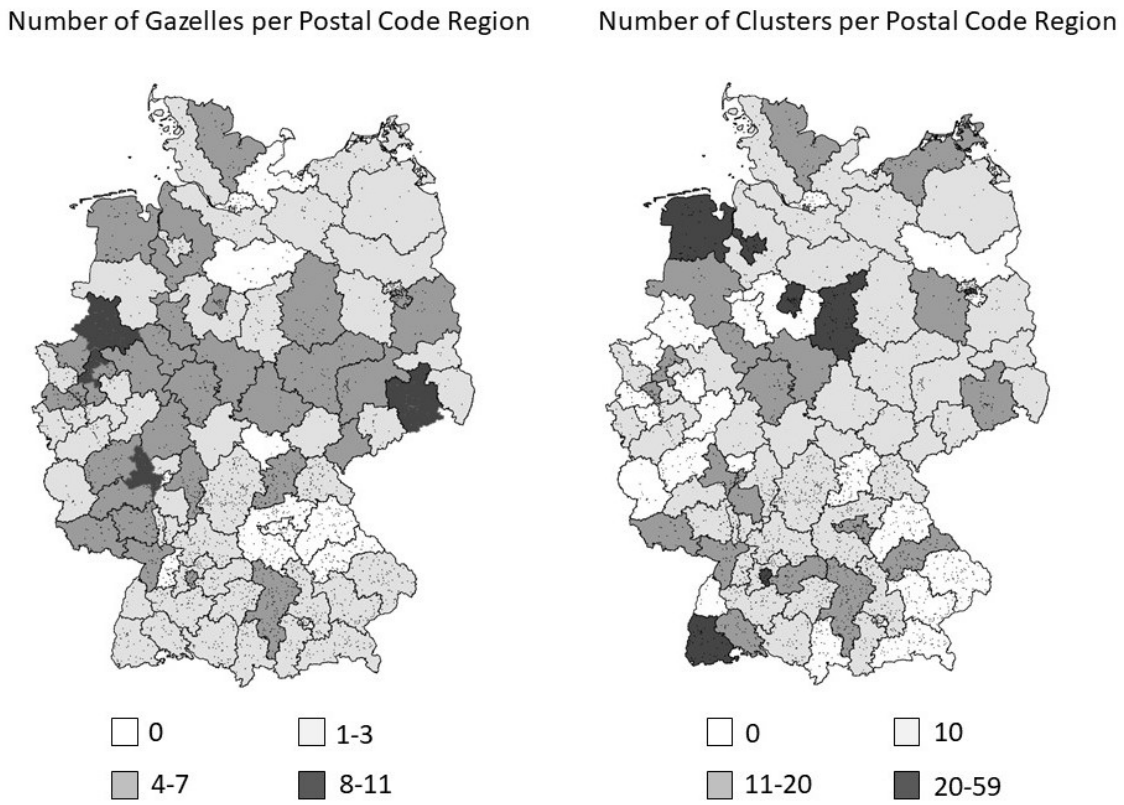

Figure 1: Distribution of German Gazelles and Cluster Initiatives over two-digit Postal Code Regions (Source: Own creation)

In the next step, we calculated standard correlation coefficients for the entirety of high-growth firms and for gazelles separately. Whereas there is no significant correlation in any of the 21 business sectors for the entire population of high-growth firms of the years 2018 and 2019, we find positive and significant correlation coefficients for the construction sector, for information and communication, for further business-related services and for art, entertainment, and recreation (see Table V). All coefficients range between 0.2 and 0.27 and describe a very weak association of the occurrence of clusters and gazelles. In each case, however, it is significantly different from zero.

		Number of Gazelles			
		Construction	Information and Communication	Further Business-Related Services	Art, Entertainment, Recreation
Number of Clusters	Construction	0.21**			
	Information and Communication		0.26**		
	Further Business-Related Services			0.20*	
	Art, Entertainment, Recreation				0.27***

*Table V: Correlation coefficients indicating Positive Significant Associations between Clusters and Gazelles across German two-digit Postal Code Regions. * Significant at the 0.1 level; ** sig. at the 0.05 level; *** sig. at the 0.01 level. (Source: Own creation)*

Thus, in these four business sectors there is a (weak) association between the number of gazelles and the number of business clusters and therefore a tendency that young high-growth firms appear where cluster initiatives exist. Although one cannot draw any conclusions about causality from simple correlation coefficients the firm and cluster age perspective allows us to acknowledge that in many cases cluster initiatives are older than gazelle firms which are by definition five years or younger. From this fact we draw the hypothesis that in regions with higher numbers of cluster initiatives the appearance of high growth among young firms in the four business sectors is more likely. But still, we can say nothing about the relevance of cluster initiatives for gazelle growth since we do not consider further potential drivers like regional economic developments or specific state-level business subsidy schemes.

3.3 Summary and Discussion of Empirical Results

In sum we obtained the following empirical results from our descriptive analysis of high-growth firms of the years 2018 and 2019:

- There are 5,328 German high-growth firms in the pre-pandemic years 2018 and 2019. 294 of these are not older than five years and can therefore be called gazelles following the standard OECD definition. In Dautzenberg *et al*.'s seminal study of 2012, there were still 587 gazelles in the year 2010, which were not older than five years then. This comparison implies that the number of gazelles decreased considerably between 2010 and 2019. One potential explanation for this development is the shrinking overall number of new firms entering the market: Between 2010 and 2020, their number dropped by close to 50 percent (Statista, 2020). In this sense, gazelles follow the

general trend of startups and young firms in Germany (Raffer and Tomenendal 2022, p. 46). The trend started before the Covid-19 pandemic and continued subsequently.

- German gazelles are usually smaller in size (measured in number of employees of the year 2015) than older high-growth firms. As we deploy the respective OECD definitions this finding is not surprising and confirms that the studied companies are generally growing.
- With regard to the distribution over the 16 German states there are no remarkable differences between gazelles versus older high-growth firms. Most gazelles exist in the German states of North Rhine-Westphalia, Bavaria, and Baden-Wurttemberg which are also the most populous ones. These findings are in line with former studies, especially Schlepphorst and Schlömer-Laufen (2016). In line with previous findings (Ochsner, 2018) we show that in total, less populated East German states have lower shares of gazelles and high-growth firms compared to West Germany. Yet, there are some areas around larger Eastern German cities, like Berlin and Dresden (in Saxony) and in Saxony Anhalt with a comparably higher share of gazelle firms now.
- With regard to the distribution over business sectors, most gazelles exist in traditional sectors like the construction and manufacturing sector. Relatively more gazelles than older high-growth firms exist in the sector „further business-related services“, which comprises – among other firm types – temporary employment agencies or leasing agencies. This particular phenomenon has not explicitly been found in former studies (see Dautzenberg *et al*., 2012; Schlepphorst and Schlömer-Laufen, 2016).
- In the construction sector as well as the sectors information and communication, further business-related services, and art, entertainment, and recreation we identify weak but significant positive spatial associations between the number of cluster initiatives and the number of gazelles. In other words: In a region with one or more cluster initiatives in these sectors, there is the tendency that also gazelles in the same sector appear. No such association exists for the entirety of high-growth firms. While sector-specific patterns of clustering of gazelles have been found before (Dautzenberg *et al*., 2012, p. 65), our clear differentiation between high-growth firms and gazelles is a topical, original finding.

4. Conclusion

We conclude by referring back to our four arguments we have formulated above, why Germany is an interesting country to study with regard to the occurrence of gazelles and take this as a basis to position our findings in a broader context. We put emphasis on differentiating younger gazelles from older high-growth firms, as defined by the OECD (Eurostat 2007). Our reflections lead us to suggestions for further research.

First, as our findings are mainly in line with former studies on gazelles and high-growth firms in Germany, which have overall led to heterogeneous results (Fritsch, 2019), we join in to conclude that it remains challenging to understand factors that contribute to high growth of companies and to predict where these will occur in the future (Coad and Srhoj 2019). This is especially true for older high-growth companies. Breeding younger gazelles, however, appears to be supported by cluster initiatives in certain sectors like information and communication,

further business-related services as well as art, entertainment and recreation, but these are only weak associations.

We find that overall, the number of high-growth firms has decreased in Germany over the last decade, just as the number of startups. In addition, our results for Europe's largest economy are very similar to those for smaller countries, for example the small but comparably developed Netherlands, where "no clear general spatial pattern of gazelles" can be found either (Stam, 2005, p. 125).

In the Netherlands, there is some concentration of knowledge-intensive businesses in highly urbanized areas and gazelles in high-tech manufacturing in rural areas (Stam, 2005, p. 126). This spatial distribution is, secondly, also found in Germany, where the economy is characterized by diversified quality production (Sorge & Streeck 2016). Here, regions and areas with a strong industrial base throughout the whole country are prone to host some more high-growth firms without that particular centers of occurrence could be identified. The phenomenon of young gazelles, located in urban areas and active in knowledge-intensive/IT-driven sectors, is perceivable in Germany, but only accounts for a very small share of high-growth firms.

Third, the East- vs West-German divide is partially still visible. Especially in rural areas of Mecklenburg Western-Pomerania and Brandenburg, there are hardly any high-growth firms to be found (see Figure 1). This can be assigned to the economic heritage of these regions. In some urban growth regions, like Berlin and Dresden, there exist however a considerable number of young gazelles.

Fourth, it may be concluded that our update of former studies has shown that a de-averaging in terms of analyzing high-growth firms and gazelles is fruitful and necessary. When regarding young gazelles, the discussion is about fostering startups with a scalable that is high-growth-generating, business model. Such a business model is presumably easier to find in IT- and service-related businesses. Regarding older high-growth firms, our study does not reveal major peculiarities compared to all kinds of firms. This means that very different reasons and drivers for growth may occur and need to be found. For such studies, more data-driven, longitudinal studies are needed, in combination with deep-dive case studies (Tomenendal *et al*., 2022). These should focus on comparing East- vs. West-German gazelles as well as those located in rural vs. urban areas as well as those among different sectors. Additionally, further case-study-based research should strive to understand better the relationship between business clusters and the occurrence of gazelles that is how clusters may foster gazelle growth and respective regional job and value creation.

Acknowledgments

We gratefully acknowledge financial support from IFAF Berlin.

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Working Papers of the Berlin Professional School at the Berlin School of Economics and Law

1 Bruche, Gert, Digital Platform Strategy - A Theory Primer with Selected Conceptual Add-ons, 10/2022, 28 Seiten/pages

Imprint

Series Editor
Head of Berlin Professional School

ISSN 2752-2199

Print
HWR Berlin

Berlin, July 2023

www.berlin-professional-school.de