Education and Migration of Entrepreneurial and Technical Skill Profiles of German University Graduates

Research Paper

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Abstract. In times of increased demand for skilled workers, targeting the right universities and locations for recruitment has become increasingly important, particularly for startups. This paper examines the provision of entrepreneurial and technical skill profiles by German universities and the migration of such profiles after graduation. In addition to the quantity and concentration of profiles per university, the findings reveal how cities and states retain talent. The results show how universities strengthen the availability of skilled workers in their region. Hotspots such as North Rhine-Westphalia, Bavaria and Berlin also attract the largest share of talent from surrounding areas, while retaining an above-average number of talents. Companies and Startups can evaluate different locations for their location choice and recruitment strategy. Local governments and policy-makers are made aware of how they are affected by out-migration and whether they can compete with the top startup hotspots in terms of talent retention.

Keywords: Entrepreneurship, Location factors, Skills, STEM, Universities

1 Introduction

Demographic, business and technological trends have intensified the demand for skilled workers. Professionals with a Science, Technology, Engineering or Math (STEM) background are in exceptionally high demand (Bundesministerium für Wirtschaft und Klimaschutz, 2022). According to the Institute of the German Economy, the skills gap in this area amounts to around 308,000 specialists (Anger et al., 2023). The availability of skilled workers has become one of the most relevant challenges for startups when scaling their businesses (Kollmann et al., 2022). To this end, entrepreneurial, managerial, and technical competencies are the most critical roles that significantly influence the success of digital business models (Chandler & Jansen, 1992).

The availability of human capital significantly impacts company's choice of location, and the presence of universities is central to this availability (Calcagnini et al., 2016). Therefore, businesses strongly desire to place nearby universities (Audretsch et al., 2017). However, the fact that people may change their location after graduation is es-

sential when evaluating the locations' availability of talents. Simultaneously, local governments are getting increasingly interested in the impact of talent outflow and their competitive standing among leading tech hotspots and their academic institutions. Audretsch & Lehmann (2004) showed that the number of firms located close to a university is positively influenced by the knowledge capacity of this region and the knowledge output of a university. These regional location factors are frequently covered by the media, highlighting the competition among tech hotspots to secure the top position in Germany for startups and technology companies (Tagesspiegel, 2025).

Existing rankings, such as the German Startup Monitor or the CHE-Ranking do not disclose the exact availability of entrepreneurial and technical profiles for talent recruiting issues. Hence, the study aims to adopt a practical approach to collecting and analyzing more empirical data on the matter, exploring the following research questions:

RQ1. Which big universities in Germany have the greatest impact on the availability of entrepreneurship and STEM profiles in their corresponding region?

RQ2. To what extent are the German tech hotspots of Berlin, Munich and NRW succeeding in attracting and retaining this talent from the big universities?

The remainder of this research paper is organized as follows. The next chapter outlines related concepts, including a description of common profile competencies and the impact of universities on startup location choice. Chapter 3 covers the methodology by introducing the LinkedIn platform as a vast database via the alumni tab of universities. Chapter 4 depicts the results according to the availability, retention, and attraction of graduate profiles. Chapter 5 discusses the key results of this study and their respective causes concerning previous literature. The paper concludes with Chapter 6, by listing contributions to theory and practice, limitations and future research calls.

2 Background

Numerous research studies have emphasized the development of human capital in entrepreneurial business and STEM fields as a key driver of the economic success of cities and regional economies (Stewart et al., 2020). Chandler & Jansen (1992) distinguish between entrepreneurial, managerial, and technical-functional functions as three roles that a founder profile must hold to be successful. Recent empirical studies on the German startup scene confirm that teams include predominantly startup profiles with previous business and technical knowledge (Kollmann et al., 2022). Cities and regions that offer entry to highly qualified and well-educated students enable entrepreneurs and organizations to readily access the talent they need, fostering the development of new ideas and accelerating growth (Audretsch et al., 2017).

Various rankings serve as indicators which German universities are best in developing entrepreneurial and technological talent. Regarding university rankings, a set of technical universities consistently appears across these studies (cf. Fiedler et al., 2023;

Fritzsche et al., 2022; Hirschfeld et al., 2024). For instance, TU München usually securing top spots in all rankings is widely known for its high number of produced startups (Fiedler et al., 2023). However, neither of the rankings consider graduates who may leave a university location after graduation, nor migrant graduates who move to a location from universities in other cities. At the same time, technological advances and societal developments have increased human mobility, especially for knowledge workers. De Haas (2021) recognizes this by defining human mobility as people's ability (freedom) to choose where to live - including the option to stay - rather than the act of moving itself. Therefore, migration can be seen as a function of aspirations and capabilities within a given set of geographical opportunities. We argue that this is particularly true for entrepreneurs and STEM graduates, who tend to have timely skills and can choose from a wide range of job opportunities.

Only a few studies have quantified German graduates' migration patterns. Haußen & Übelmesser (2015) revealed in a panel study that around two-thirds of graduates tend to remain in the university federal state for their first jobs. Bavaria retains the highest share of their graduates, closely followed by NRW, while Bremen and Brandenburg see the fewest graduates choosing to stay (ibid.). Menke (2022) found that only four federal states (Bavaria, Baden-Württemberg and the city states of Berlin and Hamburg) boast a positive migration balance, drawing more university graduates for their labor markets than they produce. Fiedler et al. (2023) examine migration patterns from university clusters to startup and tech clusters by analyzing commercial register entries. They reveal that many founders who graduated in Berlin tend to remain in the capital city, with only a few opting to leave. In contrast, a noteworthy proportion of graduates migrate from other federal states to Berlin. As regards, startup founders, Fiedler et al. (2024) found that only Berlin and Munich had more than 60% of founders remaining in proximity to their universities. For other locations, this value was around 30–40%.

In Germany, state tax revenue is the primary funding source for higher education and startup development programs. Students and founders usually do not make direct financial contributions to cover education expenses. Consequently, a state that funds these development costs can reap the benefits only if university graduates stick to their region (Fischer & Wigger, 2019). As a result, the ability of cities and regions to retain and attract talent is a topic of intense debate among practitioners and policymakers. This study aims to shed further light on the role of university graduates in Germany and their movement between cities in relation to the availability of skilled workers.

3 Methodology

The data collection was conducted during the first half of 2024. The first step of data collection was the selection of considered universities. A ranking developed by Fritzsche et al. (2022) rates large German universities according to their startup support. However, some major universities are not represented due to ongoing changes in structure, startup support, or methodological issues (ibid.). To ensure a comprehensive analysis of the Berlin hotspot, the three most prominent universities in Berlin - Freie Universität Berlin, Technische Universität Berlin, and Humboldt-Universität zu Berlin -

were subsequently added to the sample. In summary, the selection encompasses a total of 43 universities, being highly representative for talent development.

The second step extracts alumni data for the selected universities from social media. Among online business networks, LinkedIn stands out with its extensive global reach of over 950 million members, including more than 21 million in the DACH region (LinkedIn, 2023c). The introduction of university pages on LinkedIn in 2013 ushered in the ability to access alumni data (Allen, 2013). LinkedIn's alumni profiles offer a comprehensive, user-friendly, and pertinent data resource well-suited for pursuing accountability-focused objectives (Case et al., 2016). The alumni tab of LinkedIn's university pages provides high-level insights into a university's alumni base (LinkedIn, 2023b). Several filter categories can be used to narrow down search results. It is possible to filter alumni according to their start and end years of study. Additionally, a keyword search within a free-text box is possible, supporting Boolean operators, such as AND, NOT, and OR (LinkedIn, 2023d). The maximum number of operators is limited to five, a measure designed to protect members from data misuse by deterring profile scraping (LinkedIn, 2023a). Furthermore, users can filter alumni based on their workplaces, locations, skills, fields of study, and degree of connectedness. Users can customize filters by clicking the "Add" button.

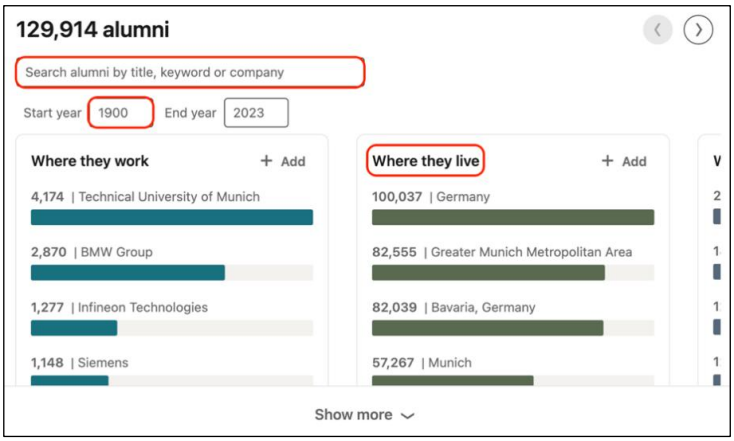

Figure 1. Filter categories on a LinkedIn alumni tab

The paper distinguishes managerial and Entrepreneurial profiles (EP) and Technical profiles (TP) as two separate skill sets. EPs encompass keywords associated with business administration, business development, and startup foundations. TPs include expertise in engineering or informatics. The final list of keywords has been developed after a careful review of the most prevalent keywords and their synonyms from personal profiles on the LinkedIn alumni tab for German universities. Regarding the constraint of six keywords, the six keywords with the highest percentage of profiles that feature that keyword were selected, resulting in the following final search strings:

For EP: *Business Development OR Betriebswirtschaftslehre OR Geschäftsentwicklung OR Founder OR Startup OR Entrepreneurship*

For TP: *IT OR Engineering OR Informatik OR Digital OR Tech OR Ingenieur*

Considering that the average age at graduation is 25 years (Statistisches Bundesamt, 2022), a 30-year timeframe to filter the study period from 1994 to 2023 was chosen. The total sample collected comprises 2,406,164 alumni, further subcategorized into 320,921 EP and 457,539 TP. On average, each of the 43 universities included in the sample features 7,463 EP with a standard deviation of 4,036. In the context of TP, each university maintains 10,640 TP on average. However, the notable disparity is evidenced by a standard deviation of 8,276.

The data analysis is organized into three main dimensions:

- Availability of EP and TP and their percentage on the total number of alumni
- Retainment of EP and TP, i.e. profiles that are still living in the city (CityR) and federal state of the university (StateR) after graduation, as well as their percentage on all graduates (%CityR, %StateR)
- Migration of startup profiles to German startup hotspots. According to the German Startup Monitor (Hirschfeld et al., 2024), most startups have their headquarters in the federal states of Berlin, Bavaria and North Rhine-Westphalia (NRW). By using the state filter on the LinkedIn alumni tab, the respective graduates of every university that live in the three states were counted.

4 Results

4.1 Availability of Profiles

Table 1 displays the availability of EP and TP. TU München has the highest availability of EP with 20,134 alumni, followed by LMU München with 18,343 EP. In third place is Universität zu Köln, although their 13,727 EP places them considerably behind. Together, they contribute to 16.3% of the total EP in the sample. On the other end of the spectrum, Universität Bielefeld has the lowest number of EP, with 2,716. The average concentration of EP across the universities stands at 13.5%. The EP concentration range extends from 9.4% to 21.4%, where Universität Augsburg has the highest value with 21.4%. In contrast, RKU Heidelberg exhibits the lowest share of EP at 9.4%.

Table 1. Number of identified alumni profiles for all 43 universities (sorted by city name)

University	Total	Total EP	Total TP
RWTH Aachen	102,928	13,064	32,128
Universität Augsburg	32,515	6,963	5,756
Freie Universität Berlin	101,701	12,914	11,780
Humboldt-Universität zu Berlin	85,808	11,189	11,127
Technische Universität Berlin	92,980	12,604	25,483

Universität Bielefeld	22,111	2,716	3,016
Ruhr-Universität Bochum	59,805	6,634	10,992
Technische Universität Braunschweig	37,061	4,144	10,688
Universität Bremen	35,838	5,353	7,193
Technische Universität Darmstadt	59,836	6,810	17,784
Technische Universität Dortmund	37,804	4,211	9,107
Technische Universität Dresden	68,435	7,351	17,841
Heinrich-Heine-Universität Düsseldorf	45,422	6,081	5,369
Universität Duisburg-Essen	58,565	8,995	13,168
Albert-Ludwigs-Universität Freiburg	64,868	6,644	8,793
Justus-Liebig-Universität Giessen	36,827	4,650	3,933
Georg-August-Universität Göttingen	61,684	7,967	6,859
Universität Hamburg	87,744	12,414	10,637
Martin-Luther-Universität Halle-Wittenberg	23,659	3,394	3,519
Leibniz Universität Hannover	48,895	5,198	10,790
Ruprecht-Karls-Universität Heidelberg	74,010	6,969	8,301
Friedrich-Schiller-Universität Jena	30,100	3,962	4,399
Universität Kassel	24,875	3,657	5,595
Christian-Albrechts-Universität Zu Kiel	37,595	4,660	4,863
Universität zu Köln	88,780	13,727	9,520
Universität Leipzig	46,000	6,116	6,071
Goethe-Universität Frankfurt Am Main	81,968	9,749	8,817
Philipps-Universität Marburg	37,583	4,903	4,573
Ludwig-Maximilians-Universität München	124,003	18,343	16,043
Technische Universität München	126,895	20,134	43,366
Universität Münster	71,314	11,707	8678
FAU Erlangen-Nürnberg	73,145	9,711	16,812
Carl Von Ossietzky Universität Oldenburg	18,126	2,993	3,744
Universität Paderborn	27,995	4,891	7,063
Universität Potsdam	29,757	4,622	4,458
Universität Regensburg	34,397	5,608	4,868
Universität des Saarlandes	36,802	5,148	6,310
Universität Siegen	22,446	4,024	5,178
Universität Stuttgart	65,254	7,726	20,985
Karlsruher Institut Für Technologie	69,805	8,928	24,153
Eberhard Karls Universität Tübingen	55,395	5,791	6,756
Bergische Universität Wuppertal	23,185	3,373	4,900
Julius-Maximilians-Universität Würzburg	42,248	4,883	6,123
Average of all 43 universities	55,957	7,463	10,640

The university with the highest TP availability, by a significant margin, is TU München, with a total of 43,366 TP, followed by RWTH Aachen, which maintains almost 26% fewer TP. TU Berlin comes in third place with a TP count of 25,483. The combined

contribution of these three technical universities represents 22.1% of the overall TP. Universität Bielefeld has the lowest TP count with only 3,016 TP. The average TP concentration across universities stands at 18.6%, surpassing the concentration of EP. There is a considerable variation in TP distribution among the universities, from 10.7% to 34.6%. KIT Karlsruhe has the highest TP concentration, followed closely by TU München at 34.2%. In contrast, JLU Giessen exhibits the lowest TP concentration.

4.2 City and State Retainment of Profiles

Table 2 displays the retention of EP of universities in their corresponding city. FU Berlin retains 8,881 EP and therefore the most alumni. Followed by TU München with 8,260 retained EP. The least number of EP can be retained by Philipps-Universität Marburg (381). Regarding EP retention rates, FU Berlin has the highest retention rate with 68.8%, followed by TU Berlin (48.5%) and Universität Hamburg (47.4%). The lowest retention rate is found at EKU Tübingen with 7.3%. The measured average retention rate for EP is 21.4% which corresponds to an average number of 1,932 retained EP.

Table 2. Top 25 universities in city retention (CityR) for entrepreneurship profiles (bold figures represent top 5 in each column)

University	Total EP	% of EP	**CityR**	% CityR
Freie Universität Berlin	**12,914**	12.7%	**8,881**	**68.8%**
TU München	**20,134**	15.9%	**8,260**	41.0%
LMU München	**18,343**	14.8%	**7,714**	**42.1%**
Technische Universität Berlin	12,604	13.6%	**6,116**	**48.5%**
Universität Hamburg	12,414	14.1%	**5,888**	**47.4%**
Humboldt-Universität zu Berlin	11,189	13.0%	4,923	**44.0%**
Universität zu Köln	**13,727**	15.5%	4,241	30.9%
Goethe-Uni Frankfurt Am Main	9,749	11.9%	3,073	31.5%
Universität Münster	11,707	**16.4%**	2,048	17.5%
RWTH Aachen	**13,064**	12.7%	2,021	15.5%
HHU Düsseldorf	6,081	13.4%	1,984	32.6%
TU Dresden	7,351	10.7%	1,868	25.4%
Universität Leipzig	6,116	13.3%	1,730	28.3%
Universität Stuttgart	7,726	11.8%	1,712	22.2%
Universität Duisburg-Essen	8,995	15.4%	1,585	17.6%
Universität Bremen	5,353	14.9%	1,524	28.5%
KIT Karlsruhe	8,928	12.8%	1,356	15.2%
Leibniz Universität Hannover	5,198	10.6%	1,300	25.0%
Universität Augsburg	6,963	**21.4%**	1,257	18.1%
GAU Göttingen	7,967	12.9%	915	11.5%
ALU Freiburg	6,644	10.2%	912	13.7%
TU Darmstadt	6,810	11.4%	867	12.7%
CAU Kiel	4,660	12.4%	862	18.5%
FAU Erlangen-Nürnberg	9,711	13.3%	845	8.7%

Universität Regensburg	5,608	**16.3%**	839	15.0%
…				
Universität Paderborn	4,891	**17.5%**	822	16.8%
Universität Oldenburg	2,993	**16.5%**	535	17.9%
Average of all 43 universities	7,463	13.5%	1,932	21.4%

Table 3 illustrates the retention of TP of universities in their corresponding city. TU München retains 17,689 TP and therefore most alumni, followed by TU Berlin with 12,608 retained TP. The fewest TP can be retained by Philipps-Universität Marburg (318). TU Berlin has the highest retention rate with 49.5%, followed by Universität Hamburg (47.1%) and FU Berlin (47.1%). The lowest retention rate is found at Philipps-Universität Marburg with 7.0%. The measured average retention rate for TP is 23.0% which corresponds to an average number of 2,847 retained TP.

Table 3. Top 25 universities in city retention (CityR) for technical profiles (bold figures represent top 5 in each column)

University	Total TP	% of TP	**CityR**	% CityR
TU München	**43,366**	**34.2%**	**17,689**	40.8%
TU Berlin	**25,483**	27.4%	**12,608**	**49.5%**
RWTH Aachen	**32,128**	**31.2%**	**7,052**	21.9%
LMU München	16,043	12.9%	**6,770**	**42.2%**
Universität Stuttgart	**20,985**	**32.2%**	**5,668**	27.0%
Freie Universität Berlin	11,780	11.6%	5,546	**47.1%**
KIT Karlsruhe	**24,153**	**34.6%**	5,062	21.0%
Universität Hamburg	10,637	12.1%	5,009	**47.1%**
TU Dresden	17,841	26.1%	4,764	26.7%
Humboldt-Universität zu Berlin	11,127	13.0%	4,574	**41.1%**
TU Darmstadt	17,784	**29.7%**	3,211	18.1%
Leibniz Universität Hannover	10,790	22.1%	3,130	29.0%
FAU Erlangen-Nürnberg	16,812	23.0%	2,958	17.6%
Goethe-Uni Frankfurt Am Main	8,817	10.8%	2,843	32.2%
Universität zu Köln	9,520	10.7%	2,761	29.0%
Universität Duisburg-Essen	13,168	22.5%	2,703	20.5%
TU Braunschweig	10,688	28.8%	2,485	23.3%
Universität Bremen	7,193	20.1%	2,210	30.7%
TU Dortmund	9,107	24.1%	2,023	22.2%
Ruhr-Universität Bochum	10,992	18.4%	1,715	15.6%
Universität Leipzig	6,071	13.2%	1,711	28.2%
Universität Kassel	5,595	22.5%	1,686	30.1%
HHU Düsseldorf	5,369	11.8%	1,564	29.1%
ALU Freiburg	8,793	13.6%	1,561	17.8%
Universität Paderborn	7,063	25.2%	1,475	20.9%
Average	10,640	18.6%	2,847	23.0%

Table 4 displays the state retention, i.e. graduates that are still living in the federal state of their university. In total, 143,940 EP currently reside in their university's federal state, corresponding to 44.9% of all EP. Regarding TP, 45.0% or 205,800 have chosen to live in their university's federal state. North Rhine-Westphalia (NRW) boasts the highest production of EP, with a count of 79,423. Furthermore, NRW achieves a remarkable retention rate of 51.5%. NRW also takes the lead in the production of TP, with a total of 109,119 profiles. 49.7% and therefore less than every second TP lives in NRW. Bavaria retains 54.1% of its graduates with EP profile and 55.3% of its graduates with TP profile within the federal state, demonstrating the highest retention rates. The lowest retention is measured for Brandenburg, both in EP and TP with 13.0% and 13.4%. Additionally, Saarland, Saxony-Anhalt, and Thuringia experience low retention rates in addition to their already relatively low general availability of TP.

Table 4. State retention (StateR) of EP and TP profiles
(bold figures represent top 3 in each column)

State	Total EP	% StateR	Total TP	% StateR
Brandenburg	4,622	13.0%	4,458	13.4%
Berlin	**36,707**	**54.3%**	**48,390**	47.0%
Baden-Württemberg	36,058	34.8%	68,988	41.7%
Bavaria	**65,642**	**54.1%**	**92,968**	**55.3%**
Bremen	5353	36.0%	7,193	31.9%
Hesse	29,769	39.9%	40,702	41.0%
Hamburg	12,414	47.4%	10,637	**47.1%**
North Rhine-Westphalia	**79,423**	**51.5%**	**109,119**	**49.7%**
Schleswig-Holstein	4,660	30.3%	4,863	27.7%
Saarland	5,148	26.0%	6,310	23.0%
Saxony	13,467	32.3%	23,912	33.2%
Saxony-Anhalt	3,394	17.9%	3,519	19.2%
Thuringia	3,962	20.3%	4,399	22.5%
Lower Saxony	20,302	31.1%	32,081	36.2%
Average	22,923	44.9%	32,681	45.0%

4.3 Migration of Profiles to Hotspots

Table 5 shows the number and share of educated EP and migrated EP living at the respective hotspot. NRW has the highest number of staying educated profiles (40,869), i.e. graduates that stay in the state after graduation. However, the retention rate (51,5%) is lower than the retention rate of Berlin and Bavaria. Of all EP based in Berlin, a lot of talent is migrated (49,4%). Bavarias' share of migrated EP is less (31,9%) while NRW migrates the least EP with distance (22,2%).

Table 5. Educated and migrated entrepreneurship profiles of startup and tech hotspots

State	Educated EP	% StateR	Migrated EP	% Migr. EP
Berlin	19,920	54,3%	19,435	49,4%
Bavaria	35,506	54,1%	16,666	31,9%
NRW	40,869	51,5%	11,656	22,2%

Table 6 displays the corresponding number and share of educated TP and migrated TP living at the respective hotspot. NRW has again the highest number of staying educated profiles (54,282) while their retention rate (49,7%) is between the retention rates of Berlin and Bavaria. Of all TP based in Berlin, fewer TP are migrated (46,9%). Bavarias' share of migrated EP is 32,7% while NRW migrates the least EP with distance (19,8%).

Table 6. Educated and migrated technical profiles of startup and tech hotspots

State	Educated TP	% StateR	Migrated TP	% Migr. TP
Berlin	22,728	47,0%	20,109	46,9%
Bavaria	51,405	55,3%	24,999	32,7%
NRW	54,282	49,7%	13,423	19,8%

5 Discussion

The study's findings highlight leading universities in Germany with respect to the availability and retention of entrepreneurship and technological profiles to their corresponding region. Our rankings underline the leading positions of universities in other rankings, with respect to their importance to startup support (Fritzsche et al., 2022; Hirschfeld et al., 2024; Fiedler et al., 2023). The correlation between the number of TP and the total number of alumni is significantly weaker than the relation between EP and and the total number of alumni. The lower mobility of TP may reflect both the specialization and reputation of technical universities as well as a stronger path-dependence of technical labor markets, where location-specific absorptive capacities limit flexibility compared to more generalist entrepreneurial profiles.

Regarding the retention of founder profiles, the study reasonably shows that universities in large metropolitan areas have the highest proportion of city retention. This is most likely related to the availability of jobs in large cities. However, among the largest cities, there are significant differences between Berlin, Munich and Hamburg, which all have significantly higher city retention rates than the universities in Cologne and Frankfurt am Main. Thus, some cities are clearly better at keeping their EP and TP graduates in the region than others, likely exacerbating the shortage of skilled workers for companies and startups. Even though no balances are calculated for the federal states, the results partly confirm an earlier study by Menke (2022) and Fiedler et al. (2024) which found that only a few places in Germany can show a positive migration balance for graduates. To this end, the results inform the discussion on the imbalance of talent retention between cities and federal states and corresponding concerns about educational budgets, which in Germany is largely financed by the federal states.

For some cities and states, considerable differences between retention of EP and TP have been found. Hotspots rather retain a higher percentage of EP than TP. Berlin has the largest difference by retaining 7.3% more EP than TP. Such differences may indicate that a city or region is missing to provide attractive job opportunities in the tech industry to retain talent. The reverse scenario is observed in Baden-Württemberg. Their retention rate of TP is 6.9% above the retention rate of EP (34.8%).

In the realm of startup and tech ecosystems, the three hotspots under investigation present considerable differences. First, the data underlines findings from earlier panel studies, that hotspots also hold most university alumni (Haußen & Übelmesser, 2015). Second, the hotspots of Berlin and Bavaria are much more successful than NRW in attracting profiles from outside the state. In return, NRW benefits from its high total number of graduates and manages to keep a high proportion of them in the state. At the same time, NRW serves as a primary source of startup profiles for the other two hotspots.

The findings juxtapose both strengths and weaknesses of talent retention in NRW and also reflect current debates in NRW about the maturity of startups. Studies have shown that, on average, startups in Berlin and Munich employ significantly more people than in Bavaria and Berlin and surroundings, thus providing many more job opportunities for EP and TP (Küster & Russ, 2020). The high number of universities and their graduates in EP and TP profiles is vital for NRW and can compensate for a large part of the talent drain. For Berlin, it is obvious that the demand for startup profiles will most likely not be met by the local universities. If other regions catch up and develop a broader and more mature startup and tech scene, the essential influx of talent could decrease. Finally, the results of the study support Bavaria's competitive positioning, as the state is strong both in educating profiles and in attracting them from other regions.

6 Conclusion and Outlook

The goal of the empirical analysis was to investigate the impact of universities on the availability of entrepreneurial and technological profiles in their corresponding region. Apart from talent profiles' availability and distribution across universities, this research uncovers how federal states draw in and keep talent. The findings indicate that specific universities generate a majority of profiles, enhancing the pool of skilled workers in their vicinity. Moreover, this study analyzed that hotspots Bavaria, Berlin and NRW attract a significant share of talent from other federal states and retain an above-average number of skilled individuals.

The results of this study encompass a range of implications for research, practice and politics. The study uses a novel research method by analyzing LinkedIn university pages, which is not widely used in academia. Despite important limitations, LinkedIn as a primary data source is shown to be a viable repository of readily available information from a large alumni base. The data allows to systematically evaluate each university and region's availability of talent profiles. For policymakers and university lead-

ers, the study highlights regions and universities that excel or lag in their profile concentrations and retention rates. Depending on the level of success, governments can promote startup development or further enhance regional development strategies.

This study is naturally beset with limitations associated with sample selection and data collection. Regarding the sample, the analysis only focuses on a subset of universities, which may yield different aggregated results when considering the whole higher education system. The study examines only movements from the university sample to three specific hotspots, making it impossible to assess a comprehensive balance between inbound and outbound migration. It is also essential to acknowledge that the study does not encompass all talents: Firstly, not every graduate has a LinkedIn profile, which can lead to selection and activity bias. Secondly, duplicate profiles on university pages arise, especially when individuals complete degrees at different universities or transfer between institutions. Thirdly, the search string is limited to five Boolean operators, excluding specific profiles from the analysis if they do not align with the filtering criteria. Fourthly, the locational filter only accounts for the exact city of the university, disregarding profiles that specify a larger metropolitan region as their residence. Fifthly, many profiles may not indicate their place of residence, thus not being considered and potentially leading to underestimating talent retention or movement. Sixthly, some graduates may be filtered into both EP and TP when fitting keywords in both search strings. Thus, this study cannot and does not aggregate EP and TP figures.

There is considerable potential for future research on this topic. The LinkedIn database presents a vast opportunity, as it offers a unique source of extensive business data and is readily accessible. There is a lack of studies exploring the intricacies of the LinkedIn search algorithm and how it precisely matches keywords to profiles. A comprehensive understanding of this mechanism would catalyze an increase in research endeavors. Many opportunities for further data analysis remain untapped and we see considerable value in extending the methodological rigor in the next iteration. For instance, additional profiles from other universities can be considered, including a scenario where every university page on LinkedIn is analyzed. Such procedures would enable an analysis of profile balances across various locations, revealing which areas are gaining or losing profiles. Time series analysis can be conducted to inspect temporal changes by filtering profiles based on their start and end years. Secondary data sources can also be juxtaposed with social media data to gain additional insights. Factors such as the vitality and cost of living of regions can be used to understand their competitiveness.

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