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Star recruitment and internationalization effects: an analysis of the Alexander von Humboldt professorship programme

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Abstract

We investigate the impact of policies aimed at attracting foreign-based star scientists on the internationalisation of host institutions. In particular, we examine the case of the Alexander von Humboldt Professorship (AvHP) programme, which—since 2008—offers substantial funding to top scholars willing to move from abroad to a German university. Based on a difference-in-differences approach, we test whether the university departments that recruit an AvHP recipient increase the number of internationally co-authored publications and the recruitment of new, high-quality researchers from abroad. Results are very heterogeneous across broad scientific fields, with a significant and positive effects in the Social sciences and null or negative results in all others.

Keywords Star scientists · Science policy · Peer effects · Learning by hiring

JEL Classification J61 · J24 · I23 · O31

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1 Introduction

Scientists' mobility has increased significantly over the recent decades, transforming the academic sector into a global marketplace characterised by diverse, multicultural teams and permanent scientific migrations, as well as temporary transitions for foreign researchers (Franzoni et al., 2012; Appelt et al., 2015; Czaika & Orazbayev, 2018). Relatedly, much research has focused on assessing whether mobile scientists increase not only their own productivity (Jonkers & Tijssen, 2008; Jonkers & Cruz-Castro, 2013; Baruffaldi et al., 2020; Tartari et al., 2020), but also that of other scientists in the institutions they join (Waldinger, 2010, 2012; Slavova et al., 2016; Borjas et al., 2018). Based on the observation that the distribution of scientific productivity is highly skewed, many studies focus in particular on "star scientists", variously defined as the most productive scholars and/or as the recipients of prizes and other forms of acknowledgement for their contribution to science advancement (Azoulay et al., 2010; Oettl, 2012; Waldinger, 2016; Agrawal et al., 2017; McHale et al., 2023; Yadav et al., 2023). A similar focus characterises a twin set of studies on star inventors and the impact on the firms that recruit them (Zucker & Darby, 1996; Lacetera et al., 2004; Kehoe & Tzabbar, 2015).

This attention paid to stars can be justified on both pragmatic and substantive grounds. A star's visibility make it easier for the researcher to track his/her career moves, co-authorship patterns and personal influence. At the same time, stars' human and social capital is such that they can influence many collaborators at once and exert a disproportionate impact on the organizations that manage to recruit them, relative to their average peer. In addition, many countries have recently introduced a number of highly-publicised and often fairly large research awards aimed at attracting foreign-based star scientists, with the ultimate goal of enhancing the research capabilities and global standing of their home institutions. Some programs target relatively junior scientists, with a proven potential and promising research projects, but in most cases they aim at senior ones. For example, the Danish National Research Foundation's (DNRF) Niels Bohr Professorship, launched in 2013 (when substituted the DNRF Professor programme, established in 2007) and funded until 2022, aimed at "enriching Danish research communities by attracting top-tier scholars from abroad."[1] Similarly, the Research Professorship and Future Research Leadership Programmes, run by the Science Foundation Ireland (SFI) since 2003, has the ambitious goal of recruiting "20 world-class researchers to Ireland annually by 2025"[2] with individual funds lasting up to 10 years. The data and methods produced by star scientist studies can and have been put to use to evaluate these policies' effectiveness.

In this paper we analyse the Alexander von Humboldt Professorship (AvHP) programme, launched by the homonym foundation in 2008 and still running, which offers substantial funding to top foreign-based scientists who decide to relocate

[1] See DNRF website (https://dg.dk/en/niels-bohr-professorship, last visited: May 2024).

[2] See the "SFI Strategy 2025—Delivering Today, Preparing for Tomorrow" website (https://www.sfi.ie/strategy, last visit: May 2024).

to Germany for a minimum period of 5 years. Among its primary objectives, the AvHP programme lists the increase of the international attractiveness of the host institutions and the German scientific system in general. We therefore investigate whether and to what extent the arrival of an AvHP-sponsored scientist in a German university results in an increase of foreign recruitment from abroad, and/or the number of international collaborations, as measured by co-authorship between local and foreign-based researchers. It is worth noting that the AvHP programme target both German and foreign nationals, but it largely works as a policy for return migration, as about half of the professorships are granted to German scientists moving back home after a considerable time spell abroad.

As a first step in our research, we compiled the list of all the AvHP recipients between 2009 and 2020, complete with their foreign affiliations before moving to Germany, their host German university, scientific field, and year of award. Second, we collected publication data from the Scopus Elsevier database for both these scientists and their German-based colleagues, active in the same disciplines, between 2005 and 2020. Based on this information, we identified the AvHP recipients' departments of affiliation within their host universities (host departments), as well as the departments active in the same scientific disciplines in other German universities (other departments). We used this information also to measure, for each department, the number of internationally co-authored publications, the recruitment of new researchers from abroad, and the quality of their publications (as per the SCImago Rank of the journals in which they appear).

We then employed a Difference-in-Differences estimation approach, by which we compared our internationalisation measures in the host departments before and after the arrival of an AvHP recipient, relative to the other departments.

Our results vary considerably across different scientific fields. In Health and Life sciences, we find negative and significant impact on both international collaborations and recruitment from abroad. Instead, in Social sciences, we find positive and significant effects both on internationally co-authored publications and international recruits per year. We do not find significant effects in the Physical sciences. While we had no *a priori* theoretical reason to expect these results, we propose some possible substantive explanations in the conclusions.

The remainder of this paper is organized as follows: Sect. 2 provides an overview of the relevant literature and outlines the background of the AvHP program. In Sect. 3, we detail the data utilized, describe the variables, and present the empirical strategy employed. Section 4 reports the findings of our empirical analysis. Finally, Sect. 5 summarizes the conclusions and discusses potential implications of the findings.

2 Context

2.1 Star scientists

Star scientists have been at the centre of social scientists' attention for a long while. Dating back to Lotka's (1926) seminal work, bibliometric studies have established that the distribution of scientific productivity across individuals is highly asymmetric, with a very small percentage of researchers (the stars) producing a disproportionate amount of publications and receiving an even more disproportionate amount of citations (de Solla Price, 1963; Cole & Cole, 1972; Redner, 1998; Brzezinski, 2015; Nielsen & Andersen, 2021). Stars also accumulate a disproportionate social capital, based on the number of their co-authors as well as their distribution across different scientific communities (Newman, 2001). Scientific prizes and appointments to scientific society confer them status and visibility (Zuckerman, 1978; Ma & Uzzi, 2018).

Many studies, both mathematical, economic and sociological, have been dedicated to explaining the cumulative mechanisms behind this regularity (Allison et al., 1982; Azoulay et al., 2014; Shen et al., 2014; Azoulay & Lynn, 2020). A few others, generally more recent, have investigated the stars' influence on their collaborators and colleagues. They stand at the crossroads of the economic literature investigating peer effects (in science as well as in other social endeavours; Sacerdote, 2014) and the managerial research on organisational "learning by hiring" (Song et al., 2003; Slavova et al., 2016). This is also the position of our paper.

Peer effects studies focus on personal interactions between stars and other researchers. Depending on methodology and data availability, these interactions can be directly observed, based for example on co-authorship data, or inferred by a common affiliation to a department or laboratory. They generally measure such effects at the individual level, knowing that they can be originated by a number of mechanisms, such as knowledge sharing (including research questions and practices), the creation of team-specific capital (complementary knowledge assets), emulation ("raising the bar" with the personal example) and, possibly, reputational spillovers.

Learning-by-hiring studies search instead for effects at the department or laboratory level. These may capture, at an aggregate level, the peer effects and related mechanisms mentioned above, but also some effects specific to organizations, such as the increased visibility that receiving a star may confer them, thus making them more attractive for research sponsors as well as talented PhD candidates or researchers in search of a better job place.

Both types of studies face identification issues related to assortative matching and selection. Namely, star scientists may both associate themselves to co-authors of similar quality or self-select into departments hosting similar-quality peers (or committing to hire them). For this reason, a number of highly influential studies have focused on the loss, rather than the acquisition, of star scientists, due to exogenous shocks.

Azoulay et al.'s (2010) seminal quasi-experiment consider around 10,000 elite life scientists (defined on the basis of either their scientific production, funding record or prizes received), of which around 1% having incurred in a premature and sudden death. By selecting for each dead star one or more (living) control peer, and by comparing their co-authors' citation-weighted publications before and after the star's death, the study find that treated co-authors experienced a decline in quality-adjusted productivity ranging from 5% to 8%. Oettl (2012) refine these results by classifying stars according to the intensity and type of support they provide to their peers, based on information contained in the acknowledgements notes of scientific papers. Helpful stars, and in particular those providing advice rather than merely sharing data or facilities, appear to be the only one to produce peer effects. Khanna (2021) further finds that the effects of star deaths on their coauthors are negatively related to the latter's collaboration network size.[3]

Waldinger (2010, 2012) examines the effects of Jewish scientists' sudden fled from German universities in the 1930s, following the ascent to power of the Nazi party. Due to the uneven distribution of such academics across departments, the shock left some of them relatively unaffected, while hitting hard others. When it did so, it generally reduced the average scientific quality of the department (as measured by citation-weighted publications), due to the disproportionate share of high-quality Jewish academics, relative to all others. While PhD students' long term productivity and career outcomes were negatively affected by the loss of their Jewish professors (although these were not necessarily their supervisors), the same did not apply to the professors' colleagues. However, Waldinger (2016) finds that effects *at the departmental levels* were indeed negative, both in the short and in the long run. While the short run effects result from the difficulty of replacing the lost academics, with as consequence a reduction in size of the affected departments, the long run effects depend on a decline in the quality of new recruits, with the loss-affected departments losing their capacity to attract high-quality ones, relative to the unaffected ones. These results suggest that star scientists may matter more for their role in producing and attracting human capital (respectively, good PhD students and talented researchers), than for the peer effects they may exert on their department colleagues.

While robust, the evidence from loss-based studies is difficult to generalise. In particular, we do not know whether contemporary recruitment decisions or policies would produce results of the same sign and magnitude, also due to the different contexts in which they occur. When interested to such decisions and policies, however, researchers need to accept weaker identification strategies, while at the same time producing circumstantial evidence in favour of a causal interpretation of results. Agrawal et al. (2017) provide a good example, which has set a precedent for further studies. The authors examine 140 evolutionary biology departments in the United States over around 30 years, along with their citation-weighted publications. They define as stars in a given year any scientist in the top 90th percentile of the cumulative productivity distribution up to the previous years. These stars' moves across departments are detected by changes in their affiliations, as reported on their publications. By defining as treated the departments recruiting a star at a given point in time, and as controls all the other departments (both those never recruiting a star and those not having yet recruited one) they produce a Difference-in-Differences estimation of various star-recruiting effects. In particular, and in line

[3] Information in acknowledgements text is also used by Sasidharan et al. (2024), in this case as evidence of an exchange having occurred between the acknowledged star and the acknowledging authors. Such exchange affects the subsequent productivity of the acknowledging authors mostly in the short run and especially for the least productive ones.

with Waldinger's results, they find that the productivity of incumbent department members (those already present at the star's arrival) remains unchanged, while the quality of the new recruits increases.

When applying a similar methodology to small economies such as Denmark, Ireland and New Zealand, McHale et al. (2023) find instead positive productivity effects both at the department's level and for individual incumbent scientists. Yadav et al. (2023) dig deeper and find that much of the productivity effects is driven by co-authorships with the incoming stars as well as by the co-authors' productivity increases following the collaboration with the star.

2.2 The Alexander von Humboldt Professorship programme

Established in 2008, the Alexander von Humboldt Professorship (AvHP) is the most visible item within a vast array of measures put in place by the German government, over the past 20 years or so, in order to attract scientific talent from around the world (for an overview, see Abbott, 2017). It is awarded by the homonym foundation, which administers this and other internationally-oriented grants and prizes, with funding from both the Federal Ministry of Education and Research and other German ministers and international organizations.[4]

With €5 millions allocated for experimental disciplines and €3.5 millions for theoretical ones over a five-year period, the AvHP is the richest individual grant of Germany, with a maximum of ten grants awarded each year. On top of the grant, the AvHP recipients obtain a permanent full professorship at the host university. Nominations come from universities, often in association with other research institutions, and with the agreement of nominees. Eligible researchers must have an outstanding research record and a permanent position outside Germany, regardless of their nationality. In fact, half of the recipients are German nationals (see Fig. 1), which makes of the AvHP programme as much as a tool for return migration as one for immigration to Germany.

As of 2020, a total of 80 AvHPs had been awarded. When breaking them down by broad scientific areas, the AvHPs appear to be rather evenly distributed, with the exception of a very few recipients in Health Sciences, and with a majority of awards goes to the Physical Sciences (see Fig. 2). The AvHP programme has been so far characterized by a strong gender bias, with no female recipients during its first five years of the program's existence and a very slow catch up in the following ones (see again Fig. 2).[5]

According to an independent survey of 50 recipients conducted in 2017, none of these would have moved to Germany absent the AvHP award but none

[4] For a comprehensive list, see: DAAD (2021) and the "Research in Germany" website (https://www.research-in-germany.org/en.html, last visit: April 2024)

[5] The breakdown of AvHP recipients by scientific field does not come from information provided by the Alexander von Humboldt Foundation, but from our own bibliometric analysis. In a nutshell, we assign each AvHP recipient to the scientific field in which he/she has the most of his/her publications. For details, see Sect. 3.1.

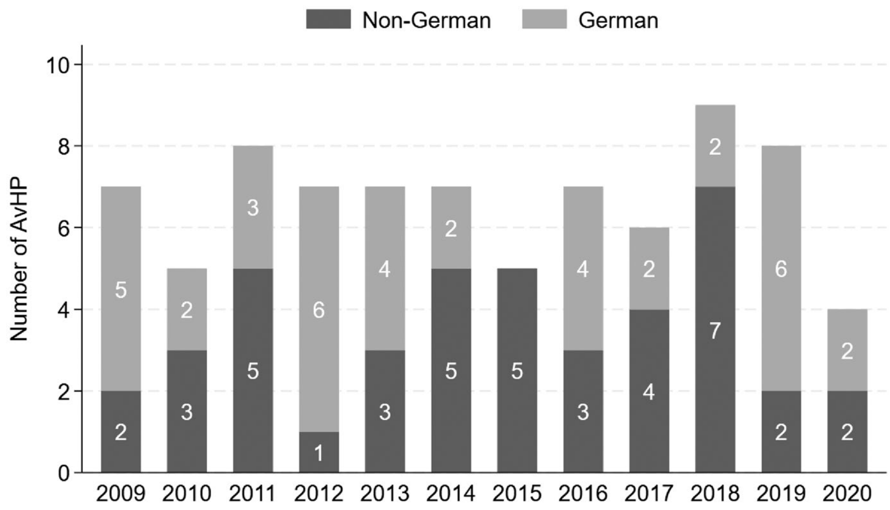

Fig. 1 Number of AvHP, by year and birth country of recipients (2009–2020). We retrieve the birth country information from AvHP recipients' profile pages on the Alexander von Humboldt Foundation website

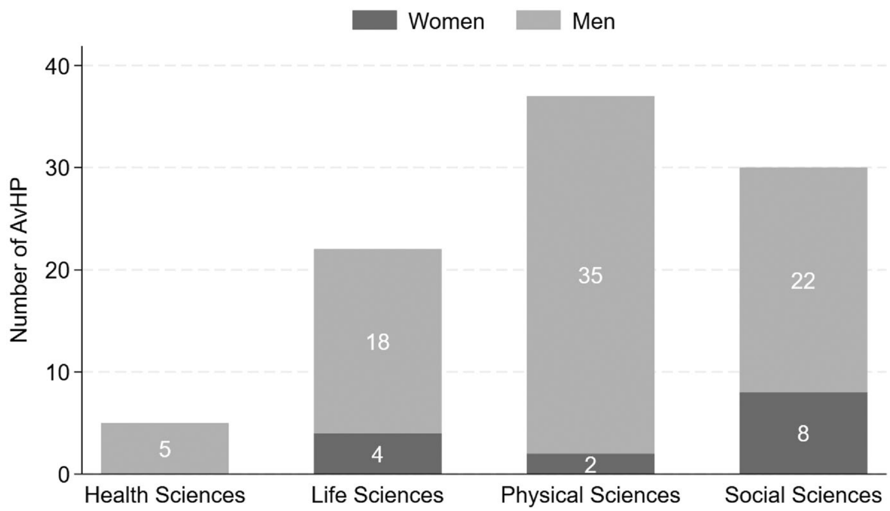

Fig. 2 Number of AvHP, by scientific field and gender of recipients (2009–2020). We determine AvHP recipients' scientific fields based on the field where they have the highest number of publications. For further information, refer to Sect. 3.1. We derive gender information from AvHP recipients' profile pages on the Alexander von Humboldt Foundation website

planned to leave the country once spent all the grant money (Warta et al., 2017). A complementary bibliometric exercise for 14 recipients reveals an increase in the number of papers co-authored by the AvHP recipients and their colleagues at the host universities, as well as by the latter and the AvHP recipients' other coauthors abroad. While these results suggest that the AvHP programme, may have met its targets, no systematic evaluation we are aware of has been conducted so far, especially in relation to the wider literature on star scientists' impact. To the best of our knowledge, the Warta et al.'s survey is the only systematic evaluation exercise of the AvHP programme commissioned so far by the Alexander von Humboldt Foundation; nor we could find a similar exercise, let alone an econometric analysis, in the scholarly literature.[6]

Among the many science policy initiatives undertaken by the German Federal government at around the same time of the AvHP programme, it is necessary to mention the Excellence Initiative, due to its complementarity with the AvHP and the possible confounding effects when it comes to estimating the AvHP programme's impact. Launched in 2005 in collaboration with the State governments, it vastly increased the Federal budget for scientific research, with the explicit aim of promoting high-quality research nationwide and enhance the global attractiveness and competitiveness of individual universities and research institutes. From 2006 to 2019 it financed 47 projects presented by 28 universities, distributed across three different funding lines, namely those for:

(i) Graduate Schools, for attracting young researchers;
(ii) Clusters of Excellence, for supporting specific projects in internationally competitive research fields at a university or university consortium, also in collaboration with non-academic partners;
(iii) Institutional Strategies, for supporting universities' actions aimed at further developing their leading international role based on successful participation to the Clusters of Excellence programme.

Under the new name of Excellence Strategy, in 2019, this policy has been renewed, in particular for the Clusters of Excellence and Institutional Strategies funding lines (the latter now renamed Universities of Excellence). We do not dispose of in-depth evaluation exercises of this policy, especially for what concern its effects on recruitment. Some studies, instead, focus on its impact on scientific productivity, including measures of international collaborations, but with mixed results (Bornmann, 2016; Möller et al., 2016; Menter et al., 2018; Cantner et al., 2023).[7]

[6] The full survey results are available at https://www.humboldt-foundation.de/en/entdecken/zahlen-und-statistiken/evaluation, with a synthesis in English (last visit: April 2024).

[7] For details on the Excellence Initiative, see: https://www.dfg.de/en/research-funding/funding-initiative/excellence-initiative; and for its continuation as Excellence Strategy: https://www.dfg.de/en/research-funding/funding-initiative/excellence-strategy (last visit of both: April 2024).

3 Data and methods

3.1 Data

We base our analysis on a comprehensive dataset sourced from Elsevier's Scopus, an abstract and citation database of scientific literature that includes over 77 million publications in journals, books or conference proceedings worldwide over a time period that vastly exceeds that of our interest. We use the dataset to identify all the researchers active each year, from 2005 to 2020, in the German university departments eligible to the AvHP programme, along with the publications they have produced, both before and after the 2005–2020 time interval. We further identify the departments having received an AvHP grant and produce various measures of the grant's impact. In order to do so, we proceed in various steps.

First we consider only journal articles and associate them to the journals' scientific fields, as defined by Scopus' own "All Science Journal Classification" (ASJC). In particular, we identify 27 scientific fields distributed across four macro-groups (Life Sciences, Physical Sciences, Health Sciences, and Social Sciences). We also associate each publication to the SCImago Rank score (SJR) of the journal in which they appear, in the publication year (for the articles published prior to 1999, for which no SJR is available, we assigned that of 1999).[8]

Second, we proceed to identify all the authors appearing on such journals and affiliated, in one or more years between 2005 and 2020, to a German university. To this end, we exploit a key feature of Scopus, namely its provision of a unique author identifier (AU-ID). This is automatically generated whenever a researcher first publishes an item included in the database, and subsequently extended, also automatically, to all further publications by the same researcher, on the basis of his/her name, affiliation, field and coauthors, with the possibility for the researcher both to manually correct false attributions and to regroup into one any multiple identifiers he/she may have received by mistake. The reliability of Scopus author identifiers has been attested by a number of studies. Kawashima and Tomizawa (2015) provide evidence of its high rate of precision and recall. Aman (2018) compares it favourably, for a sample of scientific prizes recipients, to other publicly available author identifiers (such as ORCID and ResearcherID). Moed et al. (2013) and Moed and Halevi (2014) use it successfully to investigate researchers' international mobility.[9]

[8] Scopus' ASJC is a hierarchical classification of journals across 309 subject categories, 27 thematic areas (to which in this paper we refer as scientific fields) and the four groups mentioned in the text. Most journals are assigned to just one thematic area and less than 3% to more than three (with a handful of generalist journals reaching nine). The SJR score consists of a positive numeric value that is meant to capture the average eigenvector centrality of the articles appearing on the same journal in the global network of per-article citations, for all the journals and citations included in Scopus. The indicator is normalized by the journal's size (number of published articles per year) and varies yearly, as it considers, for each year, only the citations in the following three years. The higher its value the higher the journal's centrality.

[9] Precision refers to the minimization of false positives, namely the number of distinct individual authors

Last, we identify the various German university departments to which the authors of our interest are or have been affiliated, along with any non-German affiliation they may also have had. To this end, we exploit another important Scopus feature, namely the provision of affiliation information on each individual author appearing on a paper. First, we retain only the affiliations to entities eligible to the AvHP programme, namely universities. This implies excluding not only business firms, but also public research organizations such as the Max Planck institutes, the Fraunhofer laboratories and the non-university hospitals.

The university affiliations come with both information on their location and a unique identifier (AF-ID). Despite having already been used to study, among others, German scientists' return migration (Zhao et al., 2022), these identifiers come with two main problems.

First, not all affiliations are properly disambiguated, as they appear on different publications (even by the same author) with different names, each of which receives a distinct identifier. Second, they are provided at different organizational levels. Most often, identifiers refer to entire universities, but sometimes they point at specifici departments or laboratories therein, which may end up getting distinct identifiers. As explained below, our analysis takes place at the department level, for which the Scopus affiliation identifiers are too sparse for being useful. Hence, we decided to retain only the identifiers at the university level, which left us with the problem of how to identify departments therein. We come back on this point below.

Bearing these technicalities in mind, we retrieved our data of interest in two steps. First, we retrieved all the scientific articles with at least one German-affiliated author and published between 2005 and 2020, for a total of approximately 1.5 million articles and 878 thousands unique authors (authors with the same identifier). Second, for these authors, we further retrieved all publications since their first one, irrespective of their affiliations (in other words, we added to their publications with a German affiliation also those with non-German ones). This results in a total of 5,387,098 articles, for the same set of authors.

We then proceeded to assigning each author to a particular scientific field by choosing the ASJC category most frequently associated to his/her publications. In case of equal frequency, we selected the one associated to the most recent publication. We then exploited the information thus created to identify departments inside universities. To this end, we examined, for each university, all the scientific fields associated with its affiliated authors. By considering as a department each unique university-field combination, we then created our own department identifiers, mostly following Agrawal et al.'s (2017) methodology. For example, we consider all authors associated with the ASJC "26 - Mathematics" at the University of Heidelberg as part of the "Department of Mathematics" at the University of Heidelberg, whether or not a department with that exact name actually exists. In other words, we create an artificial departmental structure that proxies the real one,

Footnote 9 (continued)

associated by mistake to the same identifier. Recall refers to the minimization of false negatives, namely the number of multiple identifiers wrongly created for the same individual.

which we cannot observe directly. This results in 1368 departments across 132 institutions.[10]

One important limitation of this methodology is its lack of precision, which depends on the faults of Scopus unique identifiers (as discussed above) and produces a very high dimensional heterogeneity.

In many universities, a department - as we identify it - may result simply from the appearance, in a given year, of one or a few authors affiliated to the university and publishing in one of the 27 ASJC category. We limit this problem by retaining only the departments counting at least one active author in each year of our observation period. Still, the number of active authors in each department/year observation ranges from 1 to 2558. This suggests that while many of the departments we define as such correspond rather well to existing ones, others are - in fact - little more than laboratories inside larger departments we do not observe or, at the opposite end, aggregations of multiple (unobserved) departments.

We could remedy to this by trimming at both ends of our departments' size distribution, but two difficulties stand in the way of this solution. First, we do not have information on the size distribution of existing (unobserved) departments. Hence, whatever upper and lower threshold size we would set would be arbitrary. Second, some existing (unobserved) departments may have been either created or closed during our observation period, in order to, respectively, regrouping or splitting the activities of scientists active in the same field, also in consequence of the arrival of an AvHP recipient. In this case, our departments allow for some continuity of observation of the same field community within the university, unaffected by the AvHP programme, better than the formal departmental structure in the university.

Given these impediments, we decided not to drop any department from our data sample, but to produce two different regression samples and test our hypothesis on both. We come back on this point when discussing our regression strategy.

We finally identified all AvHP recipients by manually matching their names to the authors in our sample and considered their arrival in the departments between 2009 and 2020. Starting from a list of 80 AvHP recipients during that period, we retained only 70 for our analysis, as we excluded those who had joined a department where other AvHP recipients were already present. For each recipient we retained, we know his/her German university of affiliation, scientific field, their department (as per our definition), and the year in which he/she received the award and moved to Germany.

3.2 Empirical strategy

We study how the arrival in a German university's department of an AvHP recipient impacts on the department's internationalization. Our empirical strategy centers on a Difference-in-Differences (DiD) event analysis of two groups of

[10] Notice that, even if we could observe the real departmental structure, this could vary over time during our period of interest, due to mergers between departments and/or splitting of existing ones. This would also impose a methodological choice similar to the one we took.

departments, treated and untreated (control), with the treatment being the AvHP recipient's presence in the department.

We estimate the following baseline model:

$$Y_{i,t} = \alpha AvHP_{i,t>\tau} + X'_{i,t-1}\beta + \delta_t + \mu_i \quad (1)$$

where $Y_{i,t}$ is the impact variable for department i in year t and $AvHP_{i,t>\tau}$ is our treatement variable, which takes value one if i is a treated department for all years $t > \tau$ (with τ being the year in which the department recruit for the first time an AvHP-sponsored scientist) and zero otherwise. The model also includes a number of time-varying controls ($X_{i,t-1}$) as well as fixed effects for both years (δ_t) and departments (μ_i).

The identification of parameter α, which captures the effect of AvHP on the outcome variables, emerges from the staggered arrival of AvHP recipients. We observe all years from 2005 to 2020, with the first AvHP arrival in 2009 and the last in 2020.

Concerning the impact variable $Y_{i,t}$, we consider three measures:

(i) the total count of internationally co-authored publications in the department/year ($INT\_PUB_{i,t}$);
(ii) the count of new international recruits, which we define as authors who publish while affiliated with department i in year t, after having published only with non-German institutions in years prior to t ($INT\_ARR_{i,t}$);
(iii) the new international recruits' quality, as measured by the mean SJR of their stock of papers published up until year $t-1$ ($SJR\_INT_{i,t}$).

For comparison purposes, we also produce a set of twin output variables for publications with exclusively German-affiliated co-authors ($GER\_PUB_{i,t}$) and new recruits from within Germany ($GER\_ARR_{i,t}$), as well as two output variables consisting, respectively, of the share of internationally co-authored publications over the total publications in the department/year ($SH\_INT\_PUB_{i,t}$) and the share of international recruits over the total recruits ($SH\_INT\_ARR_{i,t}$).

Coming to the time-varying controls $X_{i,t-1}$, these include the department's size, as proxied by the number of affiliated researchers with at least one publication in year $t-1$ ($NB\_RES_{i,t-1}$), under the expectation that larger departments are at the same time more attractive for potential AvHP recipients and more likely to internationalize. Additionally, two dummy variables control for whether, in year $t-1$, the department's university was receiving support from the German Excellence Initiative, *via* the Clusters of Excellence funding line ($CLUS\_EXC_{i,t-1}$) and/or the Institutional Strategies one ($INST\_STRAT_{i,t-1}$). Once again, we expect this type of support to have possibly increased at the same its recipients' opportunities to internationalise and chances to successfully attract an AvHP recipient.

When using a count dependent variable (number of publications or recruits), we run Poisson regressions. Otherwise we run OLS ones. In both cases, we employ robust standard errors clustered at the department level. We experiment

Table 1 Summary statistics (regression sample 1)

	Control				Treated			
	Mean	SD	Min	Max	Mean	SD	Min	Max
INT_PUB	64.05	78.41	0	612	100.78	98.02	0	682
GER_PUB	87.81	106.55	0	807	110.92	96.15	5	755
SHR_INT_PUB	0.36	0.17	0	1	0.42	0.17	0	0.80
INT_ARR	6.81	8.33	0	65	9.82	8.49	0	54
INT_ARR	17.43	38.87	0	331	20.89	34.96	0	308
SH_INT_ARR	0.36	0.25	0	1	0.40	0.22	0	1
NB_RES	151.11	212.45	1	1630	196.01	194.21	6	1590
CLUS_EXC	0.12	0.33	0	1	0.17	0.37	0	1
INST_STRAT	0.28	0.45	0	1	0.47	0.50	0	1
Observations	648				471			

Unit of analysis: department-year. The left panel refers to the treated departments before the AvHP arrival ("Not yet treated"); the right panel refers to the treated departments after the AvHP arrival ("Treated")

Table 2 Summary statistics (regression sample 2)

	Control				Treated			
	Mean	SD	Min	Max	Mean	SD	Min	Max
INT_PUB	26.22	48.87	0	1185	100.78	98.02	0	682
GER_PUB	38.23	68.04	0	1437	110.92	96.15	5	755
SHR_INT_PUB	0.35	0.19	0	1	0.42	0.17	0	0.80
INT_ARR	2.37	4.41	0	102	9.82	8.49	0	54
INT_ARR	6.61	19.67	0	518	20.89	34.96	0	308
SH_INT_ARR	0.33	0.31	0	1	0.40	0.22	0	1
NB_RES	60.76	122.60	1	2558	196.01	194.21	6	1590
CLUS_EXC	0.02	0.16	0	1	0.17	0.37	0	1
INST_STRAT	0.16	0.36	0	1	0.47	0.50	0	1
Observations	21,416				471			

Unit of analysis: department-year. The left panel refers to the departments that never host an AvHP ("Never treated") and to the treated departments before the AvHP arrival ("Not yet treated"); the right panel refers to the treated departments after the AvHP arrival ("Treated")

with two regression samples (1 and 2), based on as many definitions of the treated and control groups.

For regression sample 1, we consider only the 70 departments having hosted, during our observation interval, an AvHP recipient and exploit the recipients' staggered arrival to create the control group. In practice, in each year, the treated group consists of the departments who have already recruited their AvHP recipient and the control group of those that have not yet done so. For regression sample 2, we consider instead the entire data sample (1368 departments), with the

Table 3 AvHP impact on the number of host department's publications (regression sample 1)

	Poisson				OLS
	(1)	(2)	(3)	(4)	(5)
	INT_PUB	GER_PUB	INT_PUB	GER_PUB	SH_INT_PUB
AvHP	0.026	−0.011	0.034	−0.156***	0.006
	(0.036)	(0.028)	(0.056)	(0.050)	(0.023)
NB_RES	0.002***	0.002**	0.002***	0.001*	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)
CLUS_EXC	−0.074	−0.063	−0.039	−0.049	−0.003
	(0.046)	(0.077)	(0.044)	(0.058)	(0.014)
INST_STRAT	−0.008	−0.013	0.001	−0.017	0.006
	(0.061)	(0.062)	(0.054)	(0.051)	(0.015)
AvHP × Life			−0.136**	0.021	−0.010
			(0.063)	(0.071)	(0.025)
AvHP × Physical			−0.020	0.146	−0.002
			(0.059)	(0.091)	(0.024)
AvHP × Social			0.724***	0.677***	0.005
			(0.112)	(0.090)	(0.029)
Department FE	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓
Observations	1049	1049	1049	1049	1049
R^2	0.898	0.872	0.903	0.881	0.843

Robust standard errors clustered at the department level in parenthesis

*** p<0.01, ** p<0.05, * p<0.10. Columns 1 to 4 report the pseudo-R^2, column 5 reports the adjusted-R^2

control group now including also all departments that have never recruited an AvHP recipient, at least during our observation period.

In neither case, the treated and control departments are matched on their size or any other relevant characteristic, for which we control instead in the regressions.

While slightly unorthodox, the regression sample 1 has two advantages over sample 2. First, the size heterogeneity of the overall sample is relatively contained. Second, the treated and control observations are generally more similar with respect to most of the of time-varying controls $X_{i,t-1}$.

Tables 1 and 2 report the summary statistics for the outcome and explanatory variables for regression sample 1 and 2, respectively. We notice that the treated departments have larger values on all dimensions in both samples. Looking at the departments' size, we observe a greater homogeneity among departments in regression sample 1, whereas regression sample 2 includes both very small and very large departments. For this reason, when using sample 2, we run a number of robustness checks based on the exclusion of potential outliers (very small departments).

4 Results

Columns (1) and (3) of Table 3 report our estimates of equation 1, with international collaborations as the dependent variable and based on regression sample 1. The estimated coefficient for *AvHP* in column (1) is positive but not significant, which suggests that AvHP recipients had no meaningful impact on their departments' production of scientific articles written in collaboration with international co-authors. Notice that we include in the count also the articles co-signed by the AvHP recipients themselves. When excluding them, the results do not change.

This baseline results mask however some substantial heterogeneity across scientific fields. In column (3) we interact our treatment variable with three dummies taking value equal to one for, respectively, the departments belonging to the Life sciences, the Physical sciences or the Social sciences (with Health sciences as the reference case). While the impact of the AvHP recipients remain non-significant in both the reference case and the Physical sciences, it turns out to be negative and significant for the Life Sciences and positive and significant for the Social sciences. For the Life Sciences, the estimated coefficients of *AvHP* and $AvHP \times Life$ translate into an incidence ratio of around −0.10 ($e^{\beta_{AvHP}+\beta_{AvHP\times Life}}$), which in turn indicates an average decrease in the number of internationally co-authored papers of around 9.7%, following the arrival of an AvHP recipient in the department. For the Social Sciences, the estimated coefficients of *AvHP* and $AvHP \times Social$ jointly suggests an increase of around 113%, that is a doubling of international collaborations.

When inspecting the AvHP's impact on the number of articles written exclusively in collaboration with German-affiliated co-authors (columns 2 and 4), the results are similarly heterogeneous, with an increase of publications in the Social sciences, a decrease in the Health sciences and non significant changes in the Life sciences and the Physical sciences. Overall, these results suggest a similar impact of AvHP recipients on international and national collaboration. This is confirmed by the OLS estimates in column (5), which refer again to 1, but with the share of international collaborations (instead of the count) as the dependent variable. In this case, no coefficient related to the AvHP's impact is ever significant, which suggests no shift in the international orientation of the departments.[11]

It is worth noting that the AvHP programme is not the only one for which we do not find any (aggregate) impact. In fact, when looking at the estimated parameters for the two time-varying controls for the universities' involvement in the German Excellence Initiative, ($CLUS\_EXC_{i,t-1}$ and $INST\_STRAT_{i,t-1}$), we never find them to be significant. As for the departments' size ($NB\_RES_{i,t-1}$), its estimated coefficient is generally positive and significant, as expected.

[11] In online Appendix A, we conduct a similar analysis but with a focus on foreign AvHP recipients. Utilising information on their birth country, we define the *AvHP* variable to be equal to one only for those host departments which receive a non-German AvHP. Results reported in Table A.1 demonstrate a significant and positive coefficient for *AvHP* concerning the number of publications, both internationally co-authored and not, only within the field of Social Sciences, while no effect is found for other fields.

Table 4 AvHP impact on the number of host department's publications (regression sample 2)

	Poisson				OLS
	(1)	(2)	(3)	(4)	(5)
	INT_PUB	GER_PUB	INT_PUB	GER_PUB	SH_INT_PUB
AvHP	−0.068***	−0.052	−0.018	−0.152***	0.007
	(0.026)	(0.034)	(0.045)	(0.058)	(0.020)
NB_RES	0.003***	0.002***	0.003***	0.002***	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
CLUS_EXC	−0.039	−0.053	−0.026	−0.049	0.006
	(0.028)	(0.033)	(0.026)	(0.031)	(0.008)
INST_STRAT	0.037	0.009	0.038	0.008	−0.005
	(0.030)	(0.037)	(0.030)	(0.037)	(0.007)
AvHP × Life			−0.176***	−0.018	−0.009
			(0.055)	(0.066)	(0.022)
AvHP × Physical			−0.078	0.082	−0.005
			(0.055)	(0.078)	(0.022)
AvHP × Social			0.666***	0.620***	0.003
			(0.104)	(0.082)	(0.027)
Department FE	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓
Observations	20,504	20,519	20,504	20,519	20,519
R^2	0.884	0.883	0.884	0.883	0.455

Robust standard errors clustered at the department level in parenthesis

*** p<0.01, ** p<0.05, * p<0.10. Columns 1 to 4 report the pseudo-R^2, column 5 reports the adjusted-R^2. In models 1 and 3, The number of observations is lower because departments with zero values for the outcome variable across all years are excluded from the analysis

In Table 4 we run the same exercises of Table 3, but for the regression sample 2. The sign and significance of the estimated coefficients do not change. What changes, albeit not dramatically, is the estimated magnitude of the effects. In the case of international collaborations, the results in column (3) suggest a negative impact of the AvHP recipients of around 18% in the Life Sciences and a positive one of around 91% in the Social sciences. Based on the average number of publications by department in the different field (which is much higher in the Life sciences than in the Social sciences), these percentage changes correspond, respectively, to an average loss of approximately 14 publications per year in the Life sciences and a gain of 7 in the Social sciences.

Due to the significant heterogeneity in the size of departments in sample 2, we conduct a series of robustness checks by progressively excluding the smallest departments based on various size thresholds. Specifically, we test four different thresholds, excluding departments that fall within the 1st, 5th, 10th, and 25th percentiles of the size distribution, respectively. This approach mitigates concerns

Table 5 AvHP impact on the number of host department's new recruits (regression sample 1)

	Poisson				OLS
	(1)	(2)	(3)	(4)	(5)
	INT_ARR	GER_ARR	INT_ARR	GER_ARR	SH_INT_ARR
AvHP	0.034	−0.049	−0.147	−0.246***	0.052
	(0.060)	(0.033)	(0.114)	(0.086)	(0.035)
NB_RES	0.001	0.001	0.001	0.001	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)
CLUS_EXC	−0.059	0.075	−0.020	0.008	0.004
	(0.116)	(0.068)	(0.115)	(0.059)	(0.034)
INST_STRAT	0.115	−0.020	0.114	−0.059	−0.017
	(0.106)	(0.119)	(0.088)	(0.112)	(0.031)
AvHP × Life			−0.000	0.304**	−0.071*
			(0.125)	(0.122)	(0.038)
AvHP × Physical			0.139	0.235***	−0.055
			(0.122)	(0.073)	(0.034)
AvHP × Social			1.086***	0.738***	0.081
			(0.138)	(0.107)	(0.053)
Department FE	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓
Observations	1049	1049	1049	1049	1025
R^2	0.561	0.847	0.574	0.850	0.342

Robust standard errors clustered at the department level in parenthesis

*** p<0.01, ** p<0.05, * p<0.10. Columns 1 to 4 report the pseudo-R^2, column 5 reports the adjusted-R^2. In model 5, the number of observations is lower because the years with zero arrivals (both from abroad and Germany) are excluded from the analysis

regarding the influence of very small departments on the results. Our findings, detailed in the online appendix B, remain consistent across these checks.

In Tables 5 and 6 we replace the count of publications per year with that of new recruits, also per year, and distinguish between those from foreign institutions ($INT\_ARR_{i,t}$) and from German ones ($GER\_ARR_{i,t}$), respectively for regression samples 1 and 2.

For regression sample 1 (Table 5), we find, once again, no general effects (the estimated coefficient of *AvHP* in columns 1 and 2 is not significant) and some heterogeneous effects across scientific fields. In particular, estimates in column (3) indicate that the arrival of an AvHP recipient in a Social sciences department increases the number of new recruits from abroad of more than 150%. Based on the average number of new recruits per year in the Social sciences department, this corresponds to an increase of 2 new international arrivals per year. The effect for the Health and the Life sciences appears to be negative, but not significant. It

Table 6 AvHP impact on the number of host department's new recruits (regression sample 2)

	Poisson				OLS
	(1)	(2)	(3)	(4)	(5)
	INT_ARR	GER_ARR	INT_ARR	GER_ARR	SH_INT_ARR
AvHP	−0.056	−0.098**	−0.179**	−0.271***	0.041
	(0.049)	(0.049)	(0.089)	(0.101)	(0.035)
NB_RES	0.002***	0.001**	0.002***	0.001**	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
CLUS_EXC	0.042	0.039	0.056	0.023	0.004
	(0.052)	(0.060)	(0.049)	(0.060)	(0.020)
INST_STRAT	0.083*	0.062	0.081**	0.056	−0.004
	(0.042)	(0.053)	(0.041)	(0.053)	(0.013)
AvHP × Life			−0.046	0.259**	−0.080**
			(0.111)	(0.130)	(0.040)
AvHP × Physical			0.065	0.232**	−0.068*
			(0.106)	(0.108)	(0.037)
AvHP × Social			1.026***	0.715***	0.067
			(0.132)	(0.128)	(0.052)
Department FE	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓
Observations	19,979	20,474	19,979	20,474	17,077
R^2	0.595	0.817	0.596	0.817	0.209

Robust standard errors clustered at the department level in parenthesis

*** p<0.01, ** p<0.05, * p<0.10. Columns 1 to 4 report the pseudo-R^2, column 5 reports the adjusted-R^2. In models 1 and 3, The number of observations is lower because departments with zero values for the outcome variable across all years are excluded from the analysis. In model 5, the number of observations is lower because the years with zero arrivals (both from abroad and Germany) are excluded from the analysis

becomes significant when, in a set of unreported exercises, we aggregate the two fields into a common category and re-run all regressions.[12]

As for recruits from German institutions, estimates of the *AvHP* coefficient and its interactions in column 4 are always significant, and imply a substantial magnitude for both the Health and the Social sciences (respectively, a decrease of around 21% and an increase of around 64%, which correspond, respectively, to 24 fewer arrivals and 2 additional arrivals per year).

Estimates in column (5) suggest no significant effects on the proportion of international versus German recruits, except for a small negative effect for the Life sciences.

[12] The results are available upon requests.

Table 7 AvHP impact on new recruits' quality (OLS)

	Regression Sample 1		Regression Sample 2	
	(1)	(2)	(3)	(4)
	SJR_INT	SJR_INT	SJR_INT	SJR_INT
AvHP	0.082	−0.054	0.037	−0.030
	(0.073)	(0.177)	(0.054)	(0.152)
NB_RES	−0.001	−0.001*	−0.000	−0.000
	(0.001)	(0.001)	(0.000)	(0.000)
CLUS_EXC	0.065	0.055	0.080	0.078
	(0.133)	(0.133)	(0.059)	(0.059)
INST_STRAT	0.099	0.093	0.050	0.049
	(0.105)	(0.101)	(0.051)	(0.051)
AvHP × Life		0.188		0.128
		(0.241)		(0.229)
AvHP × Physical		0.135		0.056
		(0.181)		(0.166)
AvHP × Social		0.142		0.065
		(0.189)		(0.173)
Department FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
Observations	934	934	12,030	12,030
Adjusted-R^2	0.744	0.743	0.453	0.453

Robust standard errors clustered at the department level in parenthesis

*** p<0.01, ** p<0.05, * p<0.10. Columns 1 and 2 consider only treated departments

For regression sample 2 (Table 6), the results are similar, albeit more frequently significant and more sizeable, including those in column (5) on the proportion of international and German new recruits. Quite interestingly, we find for the first time some significant effect of the German Excellence Initiative, witness the estimated coefficient of $INST\_STRAT_{i,t-1}$ in columns (1) and (3).

Table 7 reports our estimates of 1 with the quality of new international recruits as the dependent variables, for both regression samples 1 and 2 (the quality being measured by the mean SJR of their stock of papers published up until before the recruitment year). Neither the coefficient of *AvHP* not those of the interactions with the scientific field dummies are significant, which suggests that the arrival in a department of an AvHP recipient does not increase the quality of new international recruits, not even in the Social sciences where we had observed a positive impact on the number of recruits.

5 Discussion and conclusions

Based on a set of DiD regressions and an extensive bibliometric database, we have tested the impact of the Alexander von Humboldt Professorship (AvHP) programme on the internationalization of German university departments in the years from 2009 to 2020. We obtained rather mixed results, depending on the broad field of studies considered. For the Health and the Life sciences we found negative and significant effects, at the departmental level, on both international collaborations (as measured by the number of publications with international co-authors) and the number of new recruits from abroad. Instead, we found positive effects for both indicators in the Social sciences and no significant effects for the Physical sciences.

Except for the qualitative evaluation of 14 AvHP recipients (by Warta et al., 2017; see Sect. 2.2), there is no former study on the same subject to which we can compare ours. But we can compare our results to those obtained by Agrawal et al. (2017) (whose methodology we borrowed and adapted to our purposes) as well as by McHale et al. (2023) and Yadav et al. (2023), who also use data and methods similar to ours.

According to Agrawal et al.'s (2017) theoretical model and findings, a star's arrival in a department may generate both negative effects on the incumbent department members' productivity, due to a competition for resources, and positive effects on the productivity of new recruits, with whom the stars are more likely to collaborate. On a similar note, Borjas and Doran (2015) propose and find that immigrant scientists joining a US department may lower the productivity of the incumbents with whom they compete in the space of ideas. Our results of a negative impact of the AvHP recipients on the number of publications (both internationally and nationally co-authored) in the Health and Life sciences could depend on this crowding-out effect. In particular, the star scientists could absorb more of the existing resources (including some formerly available for the incumbents) than they bring along, while at the same time incurring in rapidly declining marginal productivity. This could result in a net loss of publications for the department.

A crowding-out effect could also explain another findings of ours, namely that - in the Life Sciences - the AvHP recipients impact negatively on the number of new recruits, both from abroad and from Germany. In this case, the stars would divert resources from the expansion of the department *via* new recruitment towards investments in their laboratories.

As for the other scientific fields, in the Social sciences the effects of the AvHP programme are both positive and significant (both for international publications and new recruits), while we find no significant effects in the Physical sciences. While possibly disappointing, in the second case, for the German policy-makers, these results are compatible with Agrawal et al.'s (2017) theoretical framework: in the case of the Social sciences the positive impact of the AvHP on new recruits would offset any negative one on incumbents, while in the Physical sciences the two would offset each other.

Our mixed results are generally in contrast with those by McHale et al. (2023) and Yadav et al. (2023), who generally find that star arrivals generate positive effects. Their studies, however, refer to small countries with very open and flexible universities, such as Ireland and Denmark. Our results may differ due to the difficulty of combining the ambitions of the AvHP programme with the complexity and lack of flexibility of the German academic system. For example, while the AvHP programme provides generous funding for its recipients, it does nothing to alter their universities' recruitment system, which in Germany contemplates tenure only for full professors and no tenure-track pathways.

Our study comes with a number of limitations. First, we could elaborate upon our explanation for the differences we find across scientific fields. Conditional on the validity of our general argument, namely that scientific stars may both displace incumbents and increase the productivity of new recruits and/or bring new resources, we have no clear a priori on why, according to our results, the former effect would be prevalent in the Life Sciences and, respectively, equivalent and inferior to the latter in the Social and Physical sciences. This may have to do with differences in the starting conditions of the departments as well as the different economics of research across fields. It may be that, prior to the launch of the AvHP programme, departments in the Social Sciences were less exposed to international research than those in the Life and Physical Sciences, so that the marginal effect of recruiting a star would be higher for them than for others. It may also be that research in the Social Sciences is less costly than in other fields, so that incoming stars divert less of the existing resources to their laboratories. Testing for these hypotheses, as we are set to do in our future research, it will require first to collect information on their plausibility, *via* interviews to the AvHP recipients and/or the departments' directors, and, second, to measure separately the effects of the AvHP programme on the incumbent scientists and on the new arrivals. When doing so, we will also examine whether AvHP recipients influence international collaborations or arrivals, particularly with countries part of their scientific network, possibly due to their prior direct experience through employment or collaborations. We already partially address the latter topic in the online appendix A, where we make a first attempt to study the impact of non-German AvHP recipients (with mixed results).

Second, our regression samples are rather rudimentary. In particular, our strategy to identify departments by combining university identifiers with scientific fields, suffers of two drawbacks: first, the university identifiers are noisy, with multiple identifiers for the same entity; second, the field categorization we use is rather broad. Improving on this requires to proceed jointly in two directions, which we intend to follow in our future research. First, we plan to undertake a thorough disambiguation of Scopus university identifiers, in order to consolidate all universities with different identifiers into one. Second, we will replace the present field categorization based on the 27 ASJC thematic areas with one using the 309 ASJC subject categories (or an aggregation thereof). The disambiguation of universities should reduce the number of spurious entities in the dataset, while the finer categorization of scientific fields should eliminate the very large entities resulting from the aggregation of different real-life departments.

One last important limitation of our study relates to our identification strategy. The recruitment of an AvHP recipient is a rather endogenous treatment, with a very strong possibility that the recruiting departments are at the same time investing in attracting stars and internationalizing. This suggests to refrain from making too strong causal inferences, at least in the case where we estimate a positive impact of the AvHP programme, namely in the Social sciences. As for where we find a negative effect (in the Health and Life sciences), it could be that time-specific shocks at the departmental level have biased our estimates. Two possible solutions to be implemented in future research will consist in building a control sample by collecting (sensitive) information on the German university departments that had unsuccessfully applied for an AvHP grant; and/or in finding some exogenous antecedent of successful applications, such a previous collaboration ties between the departments and the AvHP recipients.

Also concerning future lines of research, it is worth remarking that our methodology, possibly refined, could be extended to study the impact of other policy initiatives for attracting scientific stars or other highly qualified scientists from abroad, included the "reverse brain drain" measures undertaken by many European countries in recent years, including Italy.

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Data availability Part of the the data that support the findings of this study were used under licence and so are not publicly available.

Declarations

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

References

Abbott, A. (2017). The secret to Germany's scientific excellence. *Nature, 549*, 18–22.

Agrawal, A., McHale, J., & Oettl, A. (2017). How stars matter: Recruiting and peer effects in evolutionary biology. *Research Policy, 46*, 853–867.
Allison, P. D., Long, J. S., & Krauze, T. K. (1982). Cumulative advantage and inequality in science, *American Sociological Review*, 615–625.
Aman, V. (2018). Does the Scopus author ID suffice to track scientific international mobility? A case study based on Leibniz laureates. *Scientometrics, 117*, 705–720.
Appelt, S., van Beuzekom, B., Galindo-Rueda, F., & de Pinho, R. (2015). Which factors influence the international mobility of research scientists? *Global mobility of research scientists* (pp. 177–213). Elsevier.
Azoulay, P., Graff Zivin, J. S., & Wang, J. (2010). Superstar extinction. *The Quarterly Journal of Economics, 125*, 549–589.
Azoulay, P., & Lynn, F. B. (2020). Self-Citation. Cumulative advantage, and gender inequality in science. *Sociological Science, 7*, 152–186.
Azoulay, P., Stuart, T., & Wang, Y. (2014). Matthew: Effect or Fable? *Management Science, 60*, 92–109.
Baruffaldi, S. H., Marino, M., & Visentin, F. (2020). Money to move: The effect on researchers of an international mobility grant. *Research Policy, 49*, 104077.
Borjas, G. J., & Doran, K. B. (2015). Which peers matter? The relative impacts of collaborators, colleagues, and competitors. *Review of Economics and Statistics, 97*, 1104–1117.
Borjas, G. J., Doran, K. B., & Shen, Y. (2018). Ethnic complementarities after the opening of China: How Chinese graduate students affected the productivity of their advisors. *Journal of Human Resources, 53*, 1–31.
Bornmann, L. (2016). Is the promotion of research reflected in bibliometric data? A network analysis of highly cited papers on the Clusters of Excellence supported under the Excellence Initiative in Germany. *Scientometrics, 107*, 1041–1061.
Brzezinski, M. (2015). Power laws in citation distributions: Evidence from Scopus. *Scientometrics, 103*, 213–228.
Cantner, U., Grashof, N., Grebel, T., & Zhang, X. (2023). *When excellence is not excellent: The impact of the excellence initiative on the relative productivity of German Universities*. Tech. rep.: University Library of Munich.
Cole, J. R., & Cole, S. (1972). The Ortega Hypothesis: Citation analysis suggests that only a few scientists contribute to scientific progress. *Science, 178*, 368–375.
Czaika, M., & Orazbayev, S. (2018). The globalisation of scientific mobility, 1970–2014. *Applied Geography, 96*, 1–10.
DAAD. (2021). *Evaluation des Programms Alexander von Humboldt-Professur—Internationaler Preis für Forschung in Deutschland*. Deutscher Akademischer Austauschdienst.
de Solla Price, D. J. (1963). *Little science, big science*. Columbia University Press.
Franzoni, C., Scellato, G., & Stephan, P. (2012). Foreign-born scientists: Mobility patterns for 16 countries. *Nature Biotechnology, 30*, 1250–1253.
Jonkers, K., & Cruz-Castro, L. (2013). Research upon return: The effect of international mobility on scientific ties, production and impact. *Research Policy, 42*, 1366–1377.
Jonkers, K., & Tijssen, R. (2008). Chinese researchers returning home: Impacts of international mobility on research collaboration and scientific productivity. *Scientometrics, 77*, 309–333.
Kawashima, H., & Tomizawa, H. (2015). Accuracy evaluation of Scopus Author ID based on the largest funding database in Japan. *Scientometrics, 103*, 1061–1071.
Kehoe, R. R., & Tzabbar, D. (2015). Lighting the way or stealing the shine? An examination of the duality in star scientists' effects on firm innovative performance. *Strategic Management Journal, 36*, 709–727.
Khanna, R. (2021). Aftermath of a tragedy: A star's death and coauthors' subsequent productivity. *Research Policy, 50*, 104159.
Lacetera, N., Cockburn, I. M., & Henderson, R. (2004). Do firms change capabilities by hiring new people? A study of the adoption of science-based drug discovery. *Business strategy over the industry lifecycle* (pp. 133–159). Emerald Group Publishing Limited.
Lotka, A. J. (1926). The frequency distribution of scientific productivity. *Journal of the Washington Academy of Sciences, 16*, 317–323. publisher: Washington Academy of Sciences.
Ma, Y., & Uzzi, B. (2018). Scientific prize network predicts who pushes the boundaries of science. *Proceedings of the National Academy of Sciences, 115*, 12608–12615.

McHale, J., Harold, J., Mei, J.-C., Sasidharan, A., & Yadav, A. (2023). Stars as catalysts: An event-study analysis of the impact of star-scientist recruitment on local research performance in a small open economy. *Journal of Economic Geography, 23*, 343–369.

Menter, M., Lehmann, E. E., & Klarl, T. (2018). In search of excellence: A case study of the first excellence initiative of Germany. *Journal of Business Economics, 88*, 1105–1132.

Moed, H. F., Aisati, M., & Plume, A. (2013). Studying scientific migration in Scopus. *Scientometrics, 94*, 929–942.

Moed, H. F., & Halevi, G. (2014). A bibliometric approach to tracking international scientific migration. *Scientometrics, 101*, 1987–2001.

Möller, T., Schmidt, M., & Hornbostel, S. (2016). Assessing the effects of the German Excellence Initiative with bibliometric methods. *Scientometrics, 109*, 2217–2239.

Newman, M. E. (2001). The structure of scientific collaboration networks. *Proceedings of the National Academy of Sciences, 98*, 404–409.

Nielsen, M. W., & Andersen, J. P. (2021). Global citation inequality is on the rise. *Proceedings of the National Academy of Sciences, 118*, e2012208118.

Oettl, A. (2012). Reconceptualizing stars: Scientist helpfulness and peer performance. *Management Science, 58*, 1122–1140.

Redner, S. (1998). How popular is your paper? An empirical study of the citation distribution. *The European Physical Journal B-Condensed Matter and Complex Systems, 4*, 131–134.

Sacerdote, B. (2014). Experimental and quasi-experimental analysis of peer effects: Two steps forward? *Annual Review of Economics, 6*, 253–272.

Sasidharan, A., McHale, J., & Harold, J. (2024). Star help and knowledge transfer: an event study analysis of star interactions observed from acknowledgement texts. *The Journal of Technology Transfer,* 1–49.

Shen, H., Wang, D., Song, C., & Barabási, A.-L. (2014). Modeling and predicting popularity dynamics via reinforced Poisson processes. In *Proceedings of the AAAI conference on artificial intelligence* (vol. 28).

Slavova, K., Fosfuri, A., & De Castro, J. O. (2016). Learning by hiring: The effects of scientists' inbound mobility on research performance in academia. *Organization Science, 27*, 72–89.

Song, J., Almeida, P., & Wu, G. (2003). Learning-by-hiring: When is mobility more likely to facilitate interfirm knowledge transfer? *Management science, 49*, 351–365.

Tartari, V., Di Lorenzo, F., & Campbell, B. A. (2020). "Another roof, another proof'': The impact of mobility on individual productivity in science. *The Journal of Technology Transfer, 45*, 276–303.

Waldinger, F. (2010). Quality matters: The expulsion of professors and the consequences for PhD student outcomes in Nazi Germany. *Journal of Political Economy, 118*, 787–831.

Waldinger, F. (2012). Peer effects in science: Evidence from the dismissal of scientists in Nazi Germany. *The review of economic studies, 79*, 838–861.

Waldinger, F. (2016). Bombs, brains, and science: The role of human and physical capital for the creation of scientific knowledge. *Review of Economics and Statistics, 98*, 811–831.

Warta, K., Geyer, A., & Gorraiz, J. (2017). *Funding your research in Germany*. Technopolis Group.

Yadav, A., McHale, J., & O'Neill, S. (2023). How does co-authoring with a star affect scientists' productivity? Evidence from small open economies. *Research Policy, 52*, 104660.

Zhao, X., Aref, S., Zagheni, E., & Stecklov, G. (2022). Return migration of German-affiliated researchers: Analyzing departure and return by gender, cohort, and discipline using Scopus bibliometric data 1996–2020. *Scientometrics, 127*, 7707–7729.

Zucker, L. G., & Darby, M. R. (1996). Star scientists and institutional transformation: Patterns of invention and innovation in the formation of the biotechnology industry. *Proceedings of the National Academy of Sciences, 93*, 12709–12716.

Zuckerman, H. (1978). Views: The sociology of the Nobel Prize: Further notes and queries: How successful are the Prizes in recognizing scientific excellence? *American Scientist, 66*, 420–425.