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Determinants of the career pathways of doctorate holders: Evidence from eight European universities

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Abstract

In recent years, we have seen an increase in the shares of doctorate holders working outside academia due to the lack of academic opportunities. However, the literature on job opportunities for early-career researchers overlooks the heterogeneous career paths, and the factors impacting these. We study doctorate holders' careers in research and nonresearch positions across the various employment sectors (academic, business, and other nonacademic) using multiorganisation survey data of 1,678 doctorate holders from eight European universities. Our results show different profiles of PhD holders depending on the career path they follow. First, related to career-related motivations, an important share of doctorate holders aims for a researcher career outside academia when starting a PhD, meaning that nonacademic research careers are not to be seen solely as a 'forced' choice. Second, preferences for specific job attributes are also relevant: doctorate holders working as researchers in academic and nonacademic sectors are more driven by intellectual challenge and independence than salary. For business research careers, collaborating with nonacademic partners during the PhD and receiving private funding are important factors. Third, personal characteristics like gender and parenthood also impact career choices for early-career researchers.

Keywords PhD · Doctorate holders career paths · Employment sector · Research careers · Doctoral training

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Introduction

The careers of doctorate holders have received increasing attention from both researchers and policymakers due to the increasing number of new doctorate holders, which contrasts with the steady trend of jobs available in academia (Schillebeeckx et al., 2013; OECD, 2021; Teelken et al., 2023). An increasing share of doctorate holders is transitioning to nonacademic careers (Carriero et al., 2023), primarily due to a lack of career opportunities and permanent academic positions (Bebiroglu et al., 2020; Boman et al., 2021; Höhle, 2024). However, much of the literature focuses on academic careers (Broström, 2019; Cañibano et al., 2019), limiting our understanding of what characteristics of the new generations of doctorate holders determine how they navigate through these heterogeneous paths. For example, it is unclear to what extent doctorate holders employed outside academia utilise advanced research training and skills (OECD, 2023). Despite emerging evidence that PhD skills are valued in the nonacademic labor market (Passaretta et al., 2019), factors such as R&D intensity in companies and region-specific opportunities affect the hiring rates of doctorate holders (Cruz-Castro & Sanz-Menéndez, 2005; Garcia-Quevedo et al., 2012; Hnatkova et al., 2022; Rehs & Fuchs, 2022; Sarrico, 2022).

Furthermore, research on the determinants of doctorate holders' careers often simplifies alternative career opportunities into a dichotomy of academic versus nonacademic jobs, overlooking broader sectorial opportunities such as business, the public sector, and nonprofit organizations (Mangematin, 2000; Marini, 2022; Roach & Sauermann, 2010), or failing to acknowledge their involvement in research activities. To the best of our knowledge, three exceptions exist: Bloch et al. (2015) identified five categories of positions (university positions with research-based employment, business sector positions with research and nonresearch employment and other sectors including not-for-profit institutions, with research and nonresearch employment). More recently, Goldan et al. (2023) replicated the five sectors from the study by Bloch et al. (2015), while Carriero et al. (2023) distinguished between four paths: research jobs at public institutions, business research and nonresearch jobs, and government and nonprofit sector jobs. Various employment sectors differ in working conditions and reward structures, attracting different groups of doctorate holders; however, the literature on the determinants of doctorate holders' careers remains scarce (Goldan et al., 2023).

By addressing the research question regarding the factors that determine doctorate holders' various career paths, we contribute to the literature in three ways. First, we combine employment sectors (academic, business, and other nonacademic sectors) with engagement in research, defining six distinct career paths. The nonresearch academic career path is relatively understudied but is likely to become more important for doctorate holders as universities expand their services (Berman & Pitman, 2010; de Jong & del Junco, 2023). Second, while many studies are based on data from a single country (Bloch et al., 2015; Carriero et al., 2023; Goldan et al., 2023; Marini, 2022; Waaijer, 2017), a region (Bebiroglu et al., 2019; Rehs & Fuchs, 2022), or an organization (Bartsch et al., 2024; Mangematin, 2000) or in a specific research field (Morettini et al., 2019; Roach & Sauermann, 2010; Ta et al., 2024), various studies suggest that common determinants exist for doctorate holders' careers across (Western) countries, despite differing labour market conditions (Goldan et al., 2023). Our data come from a multiorganisation sample of 1,678 recent PhD

graduates¹ from universities in eight European countries across all research fields. Finally, building on the literature review, our model includes a comprehensive list of potential factors related to the different stages of doctoral training (before, during, and after), as well as preferences for job attributes and personal characteristics, to explore how these factors simultaneously affect career paths.

Although the scope of doctoral training has broadened from preparing future ‘academic successors’ to training ‘versatile experts’ with a broad range of competences (Enders, 2005; Gu et al., 2018), an important challenge remains: many doctoral education systems are still primarily designed to prepare doctorate holders for academic careers (Gardner & Doore, 2020).² Doctorate holders working outside academia, particularly in less developed economies, often find themselves overqualified for their jobs yet lacking certain professional skills (Yudkevich et al., 2020). The increasing competition in academia, combined with the lack of preparation for careers outside academia, makes it difficult for doctorate holders to plan their career prospects (Jaksztat & Gross, 2024). Evidence on the factors that influence the career pathways of doctorate holders can inform policymakers and universities seeking to better equip doctoral candidates with appropriate training and career guidance. This will ultimately maximize the value of doctoral training, both in terms of graduates’ career aspirations and their contributions to knowledge and innovation ecosystems.

Literature review

The literature has identified various determinants of doctorate holders’ career pathways, which can be grouped according to the different stages of PhD training: before, during and after completing the doctoral programme. Additionally, personal preferences and characteristics are discussed.

Before the doctoral programme: initial career motivations for pursuing a PhD

The motivations for pursuing a PhD are diverse, ranging from personal interest in research, family influences, and encouragement from lecturers to aspirations for specific career goals (Guerin et al., 2015). Pursuing a specific career path can be a significant motivating factor for starting a PhD and may influence one’s choice of post-PhD career. Some individuals start a PhD with the goal of becoming a professor, others aim to conduct research in industry or the public sector, while some pursue a PhD to enhance their overall career prospects and opportunities. Studies have examined the preferences of doctoral researchers and graduates for academic versus nonacademic careers, and how these preferences evolve over time (Li & Horta, 2021; Mangematin, 2000; Sauermann & Roach, 2012; Seo et al., 2021). However, few studies have explored how these initial career-related motivations are linked to actual employment paths (Fox & Stephan, 2001).

¹ In this study, we use the terms ‘PhD’ and ‘doctorate holder’ interchangeably, referring to the highest-level academic qualification in any scientific field.

² In the U.S., there are many professional doctorate degrees in addition to PhD degrees (e.g., Doctor of Education, Doctor of Business Administration, or Doctor of Nursing Practice), which focus on applying knowledge within professional practice. In European countries, with the exception of the UK, the emergence of professional doctorates is a relatively recent development.

During the doctoral programme

Among the factors identified in the literature as determinants of PhD career paths during the doctoral programme are the research field, the role of the doctoral supervisor, PhD funding, and collaboration during the PhD. The research field of the doctorate has been shown to influence graduates' choice of employment sector, as it is linked to the demand for specific or applied knowledge and skills within different sectors (Goldan et al., 2023). Doctorate holders in STEM fields are more likely to be employed in research jobs in the private sector, whereas graduates from social sciences and humanities (with the exception of fields such as law or economics) are more likely to work in academic or public sectors (Goldan et al., 2023; Passaretta et al., 2019; Seo et al., 2021; Waaijer, 2017). Bartsch et al. (2024) also reported significant variations within various STEM subfields, with PhD graduates in mechanical engineering being most often employed outside academia.

With respect to doctoral training, as part of the European University Association-led 'Salzbourg process' and the reform of doctoral education, universities are incorporating transferable skills training into doctoral programmes to better prepare doctorate graduates for a broader range of careers outside of academia (Hasgall & Paneoasu, 2022; Hasgall et al., 2019). However, there appears to be a lag in implementing this policy in practice: while more than 86% of EU researchers consider transferable skills important for career progression and recruitment, only 32% report having received such training during their doctoral programme (Janger et al., 2020). There is also a lack of empirical data on the impact of transferable skills training on actual employment outcomes and career trajectories. The role of the doctoral supervisor has been shown to be important in shaping the career choices of doctoral researchers, primarily orienting them toward academia (Goldan et al., 2023; Gu et al., 2018; Mangematin, 2000; Sauermann & Roach, 2012; Seo et al., 2021). Greater satisfaction with doctoral supervisors' mentoring and support increases the likelihood of doctorate graduates securing tenure-track academic positions (German et al., 2018). Combined with a supervisor's focus on basic research, greater support from the supervisor increases doctorate holders' chances of working in academia (Carriero et al., 2023). In addition to supervisor support, it is important to explore whether satisfaction with other emerging components of doctoral programmes, such as career support services or transferable skills training, influences career paths.

The effects of funding, specifically public grants or scholarships, on scientific production and career paths have been recognized in the literature (Bloch et al., 2014; Goldan et al., 2023; Horta et al., 2016; Yudkevich et al., 2020). Similarly, regarding the relevance of private funding, Marini (2022), using a sample of Italian postdoctoral researchers, demonstrated that those with postdoctoral projects funded by private companies were more likely to pursue careers in nonacademic sectors. Finally, exposure to a specific sector during the PhD makes a difference by allowing individuals to gain relevant knowledge and build professional networks. Bartsch et al. (2024) demonstrate that work experience in a specific sector during doctoral training – whether at a university or in the private sector – increases the likelihood of doctorate holders' subsequent employment in those sectors. Collaboration with the private sector during the PhD has been shown to significantly influence the choice of a career trajectory in the private sector (Mangematin, 2000; Mortier et al., 2020). From the employer's perspective, cooperation with universities has been shown to encourage firms to recruit doctorate holders in order to develop these relationships (Garcia-Quevedo et al., 2012).

Post-PhD factors

Once doctoral training is completed, postdoctoral opportunities facilitate integration in the scholarly community, improving PhD graduates' chances of securing tenure-track positions (Akerlind, 2005; Horta, 2009). With regard to nonacademic careers, Hayter and Parker (2019) demonstrated that several factors associated with postdoctoral positions hinder post-docs' career transitions, including a lack of requisite skills and limited support from principal investigators for nonacademic career paths. Postdoctoral researchers, often referred to as 'academic precariats' due to the prevalence of temporary contracts (OECD, 2021), frequently leave academia because of limited career prospects (Waijjer, 2017). Similarly, labour market conditions can influence PhD graduates' career trajectories, with knowledge-intensive economies expected to have a higher demand for doctorate holders in nonacademic sectors (Hnatkova et al., 2022). Höhle (2024) confirmed that doctorate holders in temporary positions within knowledge-intensive economies are more likely to leave academia due to the combined effect of job insecurity and attractive nonacademic opportunities. On the supply side, Bloch et al. (2015) demonstrated that a higher number of PhD graduates in specific fields increases the likelihood that doctorate holders in those fields will pursue careers outside academia. The time since PhD completion also influences career choices: the proportion of individuals pursuing academic careers decreases over time following PhD completion (Bebiroglu et al., 2019).

Indeed, researcher mobility is another important factor that can influence career trajectories. Mobility is considered an essential component of scientific knowledge exchange and has been reported to have a positive impact, such as higher citation rates (OECD, 2021) and improved wages and education-job matching (Caparros-Ruiz, 2019). International mobility is considered crucial for academic career progression, such as for networking and skill development. More than one-third of researchers working in higher education institutions experience long-term mobility after completing their PhDs (Janger et al., 2020). However, mobility has been reported to have little effect on job opportunities outside academia and salary progression (*ibid.*). Therefore, post-PhD mobility may be associated with greater chances of working in academia, as demonstrated for doctorate holders in Belgium (Bebiroglu et al., 2019). However, Marini's (2022) model showed that post-PhD mobility did not predict the sector of employment for Italian doctorate holders.

Preferences for job attributes and personal characteristics

Preferences for job attributes

Preferences for specific job attributes can influence the career path choices of doctorate holders. The literature distinguishes between intrinsic motivation, related to a passion for research, referred to as "a taste for science," and extrinsic motivation, related to rewards such as income and job security, referred to as "taste for salary" (Carriero et al., 2023; Goldan et al., 2023). A weaker "taste for science" and a stronger "taste for salary" were shown to predict a preference for careers in the industry sector over academic sector research careers (Roach & Sauerman, 2010; Carriero et al., 2023). Bloch et al. (2015) reported that preferences for job attributes such as creativity and independence (i.e., a stronger "taste for science") were positively associated with jobs in R&D, regardless of the sector of employment. Preferences for salary or job security increased the likelihood

of working in R&D in the private and other public sectors, whereas preferences for family-work balance decreased the probability of working in the business sector, whether in R&D positions or not.

Personal characteristics

Research findings on the impact of gender on career choice have been mixed and may depend on the national context, as well as whether factors such as research field and parenthood are controlled for. Marini (2022) demonstrated that women are more often employed in academia than men, while men are more frequently employed in industry than women. Goldan et al. (2023) reported that, while women were less likely to work in private sector research, they were more likely to work in public sector research and nonresearch jobs, and private sector nonresearch jobs. Waaijer et al. (2017) found no compelling evidence of gender differences in post-PhD career destinations; rather, the differences were related to the underrepresentation of women in specific research fields, such as engineering and the natural sciences. Bartsch et al. (2024) demonstrated that, for STEM PhD graduates in Germany, there were no gender differences in their employment sector after graduation. However, differences emerged when considering parenthood: women with children were more likely to work in academia, whereas men and women without children exhibited similar career patterns.

Therefore, it is important to better understand the specific career obstacles faced by parents, both women and men, as the available literature presents mixed findings. While job insecurity and high pressure may drive some parents out of academia, the perceived flexibility of academic jobs may also serve as an attractive factor for them. Grönlund (2020) demonstrated that, in the Swedish context, family concerns were a prominent reason for leaving academia for both women and men, particularly due to job insecurity. Stefanova and Latu (2022) found that both female and male parents in the UK were significantly less likely to be hired in academia compared to nonparents. Finally, the age of doctorate holders has been shown to relate differently to various career paths, with younger doctorate holders being more likely to work in business research jobs (Bloch et al., 2015; Goldan et al., 2023).

Materials and methods

Sample and survey methodology

This study is based on data collected through an online survey of doctorate holders who obtained their PhD between 2016 and 2020 from eight European universities as part of the EU-funded DocEnhance project³: Arctic University of Norway, Technical University of Munich (Germany), Maastricht University (the Netherlands), NOVA University Lisbon (Portugal), Matej Bel University (Slovakia), University of Alcalá (Spain), University of Sassari (Italy) and University of Chemistry and Technology Prague (Czech Republic).⁴

³ CAREER TRACKING—The DocEnhance Website.

⁴ Original data collection includes the University of Thessaloniki (Greece) but owing to the low number of available contact data for PhD graduates and the low response rate (28 valid answers), these data were excluded from the analysis presented here.

Each university distributed the survey via email to all PhD holders who graduated between 2016 and 2020. The survey questions cover doctoral training, skills developed during the doctorate, employment situation, and the added value of the doctorate. The complete questionnaire can be found in Boman et al. (2021). The survey employs a census-like approach without specific statistical sampling. The survey was open from 9 March to 16 April 2021⁵ and collected 2,189 responses, representing 23% of the target population. The response rates by university ranged from 32 to 11% and are presented in Annex 1.

Variables

Dependent variable: sector of employment and engagement in research

Our main dependent variable, job position, identifies the current sector of employment for doctorate holders and their engagement in research activities within their current job. It consists of six nonoverlapping categories: 1) a research position in academia (i.e., universities and/or research organisations); 2) a nonresearch position in academia; 3) a research position in the business sector (including industry, services, and other); 4) a nonresearch position in the business sector; 5) a research position in other sectors (i.e., outside academia and the business sector – government, healthcare, nonhigher education, private not-for-profit sector and other sectors); and 6) a nonresearch position in other sectors. This variable defines the working sample used in our study, which includes 1,678 individuals who provided information about their sector of employment and their engagement in research.⁶ The majority of doctorate holders working in academia are engaged in research (37%), whereas 3% are in nonresearch positions. For other sectors, the split between research and nonresearch positions is fairly even: 17% versus 21% for the private sector, and 11% versus 10% for the public, health and third sectors, respectively. The largest share of doctorate holders in research positions outside academia works in the private sector.

Independent variables

The first set of variables relates to motivations for pursuing a doctorate, specifically to work: 1) as a researcher in academia, 2) as a researcher outside academia, 3) as a highly skilled expert and to diversify career opportunities, 4) for personal accomplishment, and 5) out of interest in the research topic. In addition to the initial motivations for pursuing a PhD, prior job experience is also considered, as it can influence the choice of career path.

In relation to doctoral training, we explore the impact of several key elements: the research field of the doctorate (social science and humanities—SSci&Hum, natural and agricultural sciences—Nat&AgriSci, engineering and technology—Eng&Tech, and medical and health sciences—Med&HSci); training in transferable skills (with a value of one if the respondent has received training during their PhD); satisfaction with doctoral training, measured on a five-point scale (1 = very dissatisfied, 5 = very satisfied), across six elements (doctoral supervision, research training, transferable skills training, university services, support for pursuing an academic, and support for pursuing a nonacademic career); as well

⁵ The last year of the data collection was 2020, as the latest year for which the contact details of the PhD holders were available was 2020, before the COVID-19 pandemic.

⁶ See Annex 1 for information about the number of answers from each university in the working sample.

as sources of funding and collaboration during the PhD. To capture different sources of funding, we created three dummy variables: each takes a value of one if the respondent received funding from 1) public sources, 2) private sources, or 3) a self-funded position, and zero otherwise. External collaboration during the PhD is measured as a categorical variable with three categories: 0=no collaboration, 1=collaboration with an academic institution, and 2=collaboration with a nonacademic institution.

Taking a postdoctoral position after completing the PhD is a dummy variable that takes a value of one if the respondent held one or more postdoctoral positions at a university or research-performing organization after obtaining their doctorate. The number of years since PhD completion (at the time of the survey) is a dummy variable that takes a value of zero if the respondent is a recent graduate (i.e., 1 or 2 years between graduation and the time of the survey) and one if the number of years is 3, 4, or 5. Mobility is a dummy variable that takes a value of one if the respondent lived or worked outside their country of citizenship for 3 months or more after completing their doctorate.

'Labour market conditions' is a dummy variable that takes a value of one if the doctorate holder graduated from a university located in a region with an innovation performance score classified as 'leader or strong', and zero, if their university is in a region with 'moderate or emerging' innovation performance.,⁷⁸

The questionnaire asked PhD holders to rate, on a scale of 1 ("very unimportant") to 5 ("very important"), the importance of various reasons for taking their current main position: 1) to take the next step in my desired career path, 2) to improve/gain new skills, 3) to address intellectual challenges, 4) autonomy and responsibility, 5) salary, 6) job security/stability, 7) work/life balance, and 8) family/personal reasons. As these preferences may be related to one another, we conduct an exploratory factor analysis and then determine how the different preference profiles influence the choice of sector and research involvement.

We perform factor analysis using the principal component method with *varimax rotation*⁹ to identify the main groups of preferences. The number of factors to extract was based on Kaiser's criterion, which identified two factors with eigenvalues greater than one (Hair et al., 1998) to summarize the eight preference categories. Eigenvalues are used as criteria to define the number of factors selected because they measure the amount of common variance in the observed variables that a factor explains. Values greater than one help identify the factors that explain more variance than a single observed variable. To check the factors' internal reliability, we calculated the Cronbach's alpha coefficient. The coefficients for both groups are greater than 0.6, which is considered a satisfactory value (*ibid.*). Table 1 presents the results of the factor analysis. Factor loadings greater than 0.4 are highlighted in **bold**. Two distinct factors are identified, which we label intrinsic and extrinsic preferences.

⁷ Based on the European Regional Innovation Scoreboard 2023, NOVA University Lisbon, the University of Sassari, and Matej Bel University are located in 'moderate/emerging' innovation regions, whereas all others are located in 'leader/strong' innovation regions (see Annex 2).

⁸ This variable helps control for the fact that there are more PhD holders working in the business sector (both in research and nonresearch activities) in 'leader/strong' innovation regions than in 'moderate/emerging' innovation regions. There are no significant differences in the locations of PhD holders working in academia or other sectors.

⁹ Varimax rotation is selected because it simplifies the interpretation of the factor analysis results. After rotation, each original variable is associated with one (or a small number of) factors. In other words, Varimax rotation helps identify the factor on which each variable loads. This is important in our case, as we aim to reduce the correlation between factors resulting from the factor analysis, enabling us to use them as independent variables in our regression models.

Table 1 Results of the factor analysis: doctorate holders' reasons for taking their current main position

Variables	Intrinsic preferences	Extrinsic preferences
Intellectual challenge	0.7345	0.0821
Improve/gain skills	0.7236	0.0623
Next step in desired career	0.6262	0.0263
Autonomy and responsibility	0.6082	0.2143
Job security/stability	0.0752	0.6738
Work/life balance	0.1162	0.6589
Salary	0.2265	0.5106
Family/personal reasons	-0.0568	0.4349
Eigenvalue	1.899	1.395
Cronbach alpha	0.779	0.674

Intrinsic preferences include intellectual challenge, improving or gaining skills, taking the next step in one's desired career, and autonomy and responsibility. Extrinsic preferences include job security, work/life balance, salary, and family or personal reasons for taking a job. The variables are calculated as the average of the subitems within each factor.

Age at PhD start is calculated by subtracting the year of birth from the year in which respondents began their doctoral training programme (formal admission). Gender is a dummy variable that takes a value of one if the respondent is female. Having children is a categorical variable with three categories: 0=no children, 1=one child, and 2=more than one child.

A detailed description of the variables is provided in Annex 3. The correlation matrix presented in Annex 4 shows that there are no multicollinearity issues among the independent variables listed above. Our final sample includes 1,678 respondents with no missing data for the dependent variable or any of the variables of interest. The sample consists of early career researchers who are gender-balanced and distributed across various research fields. All descriptive statistics are provided in Annex 5.

Results and discussion

We conduct a multinomial regression analysis based on a six-category dependent variable, with standard errors clustered by university. We select the category "other nonacademic sector (outside the business sector and academia) and nonresearch-based position" as the reference category. The model estimates the probability of being employed in each of the other five career paths relative to the nonresearch position outside the academic and business sectors.

The results of the multinomial regression are presented in Table 2. Overall, the model explains 30.4% of the variability in the data.¹⁰ *Career-related* motivations for obtaining

¹⁰ Using a stepwise regression model approach, where variables are introduced in blocks, the results suggest that post-PhD factors (pseudo R²: 0.1272) and factors related to the doctoral programme (pseudo R²: 0.1214) have the most significant impact, compared to initial motivations for undertaking a PhD and prior job experience (pseudo R²: 0.029), as well as preferences for the current job attributes and personal characteristics (pseudo R²: 0.0754).

Table 2 Determinants of the career pathways of doctorate holders: results of multinomial regression

Determinants of the career pathways of doctorate holders	Academic research	Academic nonresearch	Business research	Business nonresearch	Other nonacademic research
1) Initial motivations for undertaking a PhD and other job experience					
PhD motivation: to work as researcher in academia	0.566*** [0.13]	0.362** [0.15]	-0.741*** [0.13]	-0.452*** [0.15]	-0.511** [0.22]
PhD motivation: to work as researcher outside academia	-0.281 [0.23]	-0.669*** [0.17]	0.662** [0.32]	-0.205 [0.37]	0.762*** [0.19]
PhD motivation: to diversify career opportunities	-0.248 [0.30]	0.587* [0.33]	0.183 [0.18]	0.434** [0.20]	0.059 [0.15]
PhD motivation: for personal accomplishment	-0.593*** [0.19]	-0.61 [0.43]	-0.101 [0.17]	-0.158 [0.19]	-0.451** [0.23]
PhD motivation: out of interest in research topic	0.009 [0.16]	-0.460* [0.27]	0.476 [0.35]	-0.173 [0.23]	0.43 [0.31]
Job before or during doctoral training	0.614** [0.30]	-0.126 [0.51]	0.357 [0.28]	0.278 [0.44]	0.617 [0.41]
2) Factors related to doctoral programme/training					
PhD research field: Engineering and technology	0.902*** [0.25]	-0.535 [0.45]	2.544*** [0.46]	1.877*** [0.47]	0.078 [0.37]
PhD research field: Natural and Agricultural sciences	0.155 [0.28]	-0.982** [0.42]	1.680*** [0.34]	0.944*** [0.30]	-0.354 [0.39]
PhD research field: Medical and Health sciences	-0.943*** [0.29]	-2.571*** [0.56]	-0.359 [0.55]	-1.359*** [0.31]	0.452 [0.47]
PhD funding from public sources	0.661* [0.34]	0.259 [0.29]	0.321 [0.20]	0.119 [0.34]	-0.833** [0.35]
PhD funding from private sources	0.445 [0.41]	1.739*** [0.58]	0.730** [0.37]	0.205 [0.48]	0.311 [0.68]
Self-funded PhD	-0.041 [0.40]	-0.907 [0.83]	0.156 [0.43]	0.418 [0.40]	0.664 [0.54]
Collaboration with an academic organization during PhD	0.453 [0.32]	0.33 [0.36]	0.134 [0.30]	0.34 [0.34]	0.08 [0.57]
Collaboration with a nonacademic organization during PhD	0.774* [0.46]	-0.034 [0.64]	0.901** [0.36]	0.684* [0.36]	0.751 [0.57]
Receiving transferable skills training during PhD	0.182 [0.27]	-0.68 [0.49]	0.318 [0.29]	0.291 [0.29]	0.41 [0.33]
Satisfaction with research training	0.221** [0.11]	-0.029 [0.21]	0.427*** [0.10]	0.308*** [0.08]	0.379*** [0.15]
Satisfaction with transferable skills training	-0.168* [0.09]	0.454* [0.25]	0.06 [0.08]	-0.073 [0.11]	-0.015 [0.17]
Satisfaction with university services	-0.073 [0.12]	0.129 [0.25]	-0.346*** [0.09]	-0.169 [0.13]	-0.248*** [0.08]
Satisfaction with doctoral supervision	0.049 [0.12]	-0.09 [0.11]	-0.215** [0.11]	-0.124 [0.11]	-0.034 [0.11]
Satisfaction with support for academic career	0.251** [0.10]	0.1 [0.18]	0.011 [0.15]	0.073 [0.11]	0.238 [0.15]
Satisfaction with support for nonacademic career	0.04 [0.10]	0.145 [0.17]	-0.037 [0.12]	0.07 [0.11]	-0.066 [0.14]

Table 2 (continued)

Determinants of the career pathways of doctorate holders	Academic research	Academic nonresearch	Business research	Business nonresearch	Other nonacademic research
3) Post-PhD factors					
Taking a postdoctoral position	2.714*** [0.34]	1.525*** [0.26]	0.18 [0.20]	-0.357 [0.25]	1.353*** [0.30]
Number of years since doctorate completion	-0.785*** [0.27]	-1.201*** [0.45]	-0.094 [0.20]	-0.019 [0.24]	-0.289 [0.26]
Mobility of 3 months or more after PhD completion	0.607* [0.32]	0.116 [0.37]	0.738*** [0.28]	0.178 [0.18]	0.444 [0.48]
Labour market conditions	0.292 [0.38]	1.171 [0.76]	1.413*** [0.52]	1.275*** [0.46]	0.195 [0.39]
4) Doctorate holders' preferences for current job attributes and personal characteristics					
Intrinsic preferences	1.008*** [0.12]	-0.108 [0.23]	0.792*** [0.12]	0.561*** [0.11]	0.525*** [0.21]
Extrinsic preferences	-0.361*** [0.12]	0.108 [0.30]	-0.044 [0.12]	0.009 [0.09]	0.017 [0.16]
Age at PhD start	0.042* [0.02]	0.054*** [0.02]	-0.039 [0.04]	-0.088*** [0.02]	0.012 [0.01]
Gender	-0.498*** [0.15]	-0.037 [0.17]	-1.112*** [0.27]	-0.971*** [0.21]	-0.263 [0.17]
Having one child	0.065 [0.16]	-0.072 [0.38]	-0.422*** [0.20]	-0.274* [0.16]	0.565*** [0.28]
Having more than one child	0.896* [0.48]	0.244 [0.82]	1.148*** [0.36]	0.08 [0.41]	0.849*** [0.20]
Constant	-5.198*** [1.16]	-4.915*** [1.13]	-4.001*** [0.56]	-0.54 [1.31]	-4.206*** [1.52]
Log-likelihood	-1393.421				
Df	4				
Pseudo R2	0.3035				
Observations	1274				

Standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

a PhD are strongly positively correlated with the corresponding job positions upon PhD completion and have a greater impact than other motivations for pursuing a PhD. Individuals initially motivated by a research career in academia are more likely to pursue that path, both as researchers and nonresearchers, and less likely to pursue careers in other sectors. Those planning a research career outside academia are more likely to work as researchers in business and other nonacademic sectors.¹¹ Among other motivations, individuals who pursued their PhD for personal accomplishment were less likely to pursue research careers in academia and other nonacademic sectors. Those primarily driven by an interest in research topics were less likely to work as nonresearchers in academia.

Consistent with the literature (Bloch et al., 2015; Goldan et al., 2023), business careers (in research or nonresearch) are more likely to attract doctorate holders with degrees in Eng&Tech and Agri&NatSci than those with degrees in SSci&Hum. Doctorate holders in Eng&Tech are also more likely to work in academic research positions compared to those with degrees in SSci&Hum, which seems to contradict the literature (Goldan et al., 2023; Passaretta et al., 2019; Waaijer, 2017). Doctorate holders in Med&HSci are less likely to work in academia and nonresearch jobs in the business sector compared to those with degrees in SSci&Hum. Several factors related to doctoral training are strongly associated with the choice of career path. Private funding for the doctorate is one of the strongest predictors of pursuing a research career in the business sector and holding a nonresearch position in academia. Doctorate holders with public funding are more likely to work as researchers in academia, while those without public funding are more likely to pursue research roles in nonacademic sectors outside the business sector. Collaboration with non-academic organisations during the doctorate strongly predicts a career in the business sector, both in research and nonresearch positions, as well as an academic research career, thus contributing to the literature on the topic (Mangematin, 2000; Mortier et al., 2020).

Several elements of satisfaction with doctoral training significantly impact career paths. Doctorate holders who were more satisfied with their research training during their PhD were more likely to pursue a research career across all sectors, as well as a nonresearch career in the business sector. Those who were more satisfied with the support for an academic career during their PhD are more likely to work as researchers in academia. Dissatisfaction with doctoral supervision or university services increases the likelihood of working in the business sector. These results align with findings highlighting the importance of doctoral supervisor support, particularly for academic careers (Carriero et al., 2023; Goldan et al., 2023). Finally, higher satisfaction with transferable skills training increases the likelihood of working in nonresearch positions at universities and, inversely, decreases the chances of working as academic researchers. Interestingly, receiving training in transferable skills (which nearly 70% of doctorate holders received) did not show a positive relationship with career paths beyond academia, despite the rationale behind offering such training to enhance doctorate holders' employability outside academia. This may be due to the fact that most training courses undertaken by doctorate holders focus on broader academic competencies rather than generic transferable skills like project management or communication (Boman et al., 2021).

Among the post-PhD factors, taking a postdoctoral position is the strongest predictor for pursuing academic research careers, consistent with the literature on the topic (Akerlind, 2005; Horta, 2009). Additionally, it is the strongest predictor for research careers in

¹¹ Notably, 56% of PhD holders initially motivated to work in academia are actually employed in this sector, whereas 67% of those motivated to work outside academia have pursued careers in nonacademic sectors.

nonacademic sectors other than the business sector. The importance of postdoctoral experience is also notable for nonresearchers in academia. The results also show that the longer the time since completing the degree, the more likely doctorate holders are to leave academia, which aligns with the literature (Bebiroglu et al., 2019; Waaijer, 2017). This is true for both those in research and nonresearch positions in academia. Long-term international mobility after completing the doctorate is positively associated with research careers in both academia and the business sector. Thus, international mobility should be considered important not only for academic research careers (Bebiroglu et al., 2019) but also for research careers outside academia. With respect to labour market conditions, doctorate holders who graduated from universities in regions with stronger innovation performance were more likely to work in the business sector, both in research and nonresearch roles.

We find that individual preferences for job attributes are important determinants of PhD careers, which confirms the existing literature (Bloch et al., 2015; Carreiro et al., 2023; Goldan et al., 2023). Those with stronger intrinsic preferences (e.g., for intellectual challenge and autonomy) are more likely to pursue research positions *across all sectors*, as well as nonresearch positions in the business sector. In addition, those motivated more by salary or job security (i.e., extrinsic preferences) are less likely to pursue an academic research career. Personal characteristics such as age, gender, or having children also impact career path choices. The younger respondents were when starting their PhD, the more likely they were to work in nonresearch business sector jobs; the opposite was true for academia. Gender is one of the strongest predictors of career paths in the business sector, with men being more likely to work in the business sector, both in research and nonresearch roles, as well as more likely to work as researchers in academia, compared to women. Having more than one child is one of the strongest predictors of pursuing a research career, regardless of the sector of employment. Additionally, parents with one child are less likely to work in research and nonresearch roles in the business sector.¹²

Limitations of the study

This study has several limitations. First, it is important to note that the population under study consists of early-career doctorate holders, specifically those who are between one and five years after completing their PhD at the time of the survey. The cross-sectional nature of the data limits our ability to analyse the evolution of career pathways over a longer time span. Second, the survey responses are representative of the population of doctorate holders from four out of the eight universities, meaning the results should be interpreted with caution. Finally, our list of factors influencing doctorate holders' career paths does not include variables related to academic performance during the doctorate or subjective career prospects, which have been shown to impact career trajectories (Goldan et al., 2023; Waaijer, 2017). However, the dataset does not include this information.

¹² When an interaction term between gender and children is introduced in the regression model (results available upon request), the results suggest that men with more than one child are more likely to work in research in the business sector, but no other clear patterns were observed.

Conclusions and recommendations

This study aimed to examine the interplay of a comprehensive set of factors related to doctoral training, personal characteristics of doctorate holders, and their individual preferences, all of which impact the likelihood of pursuing various job positions, combining sector of employment and involvement in research. Our findings show that over half of doctorate holders transition to nonacademic sectors within the early years after graduation, and the likelihood of leaving academia increases over time, even though many were initially motivated by academic research careers during their PhD. While most doctorate holders in academia occupy research positions, the distribution between research and nonresearch roles is more even in other sectors, with the private sector having the largest share of doctorate holders in research positions outside academia. Additionally, the business sector attracts more doctorate holders in regions with higher innovation performance. This finding supports the expectation that, despite the greater number of doctorate holders, the demand for their skills outside academia is likely to rise in the future, especially in developed knowledge economies (Jaksztat & Gross, 2024).

Different sets of determinants influence each career path explored in the study. For *academic research careers*, key factors include taking a postdoctoral position, having intrinsic preferences for intellectual challenge and autonomy (with weaker extrinsic preferences for salary and job security), holding a PhD in Eng&Tech, and having more than one child. They are also more likely to have received public funding for their PhD, to be male, and to have been motivated by an academic research career at the start of their PhD. For *research careers in the business sector*, the most important factors are having a degree in Eng&Tech and Agri&NatSci, obtaining a PhD from a university located in a region with strong innovation performance, having more than one child, being male, and collaborating with nonacademic partners during their PhD. Other important factors include receiving private funding for the PhD, having preferences for intellectual challenge and autonomy, and being mobile after completing the PhD. For *research careers in other nonacademic sectors*, the key factors include taking a postdoctoral position, having more than one child, *not* receiving public funding for PhD, and being motivated to pursue a researcher role outside academia when starting the doctorate. Working as a *researcher* across all sectors is strongly (positively) associated with having more than one child, supporting the finding of Bartsch et al. (2024) that women with children are more likely to work in academia compared to men or women without children. We interpret these findings to suggest that research careers across all sectors may offer more flexibility for parents compared to nonresearch jobs. In addition, intrinsic motivation and satisfaction with research training during the PhD emerge as common factors associated with pursuing a research career in all sectors.

For *nonresearch positions in the business sector*, key factors include having a degree in Eng&Tech or Nat&AgriSci, obtaining a PhD from a university in a region with strong innovation performance, being male, collaborating with nonacademic partners during the PhD, and having the motivation to diversify career opportunities when starting the PhD (rather than focusing on academic research). For *nonresearch jobs in academia* – a group of doctorate holders that is currently understudied in the literature – the most important factors were having private funding for the PhD, taking a postdoctoral position, and being in the early years following PhD completion. Their motivation for pursuing a doctorate seems to be primarily linked to their appreciation of academia, as well as the desire for more diverse career possibilities. This career path of professional staff

in academia warrants further exploration in future studies. Recent research has focused on conceptualizing and optimizing the roles of university professional staff in the ecosystem of academic knowledge production (de Jong & del Junco, 2023).

With respect to current debates on the transition of doctorate holders to nonacademic jobs, our findings suggest that research careers outside academia should not solely be viewed as “a forced choice”. A quarter of doctorate holders initially pursued their doctoral degree with the specific motivation to work as *researchers outside academia, not in academic research*. Most of these individuals ended up working in nonacademic research after completing their PhD. This finding suggests that doctoral holders view doctoral training as valuable for pursuing research careers outside academia. Furthermore, doctorate holders working as *researchers* across all sectors, not just in academia, are intrinsically motivated by job attributes such as intellectual challenges and autonomy, consistent with the findings of Bloch et al. (2015). Extrinsic preferences for salary did not significantly (positively) impact career paths in the business sector, as seen in Bloch et al. (2015) and Carreiro et al. (2023); instead, they negatively impacted the choice of an academic career path. This finding complements previous research, such as Cruz-Castro and Sanz-Menéndez (2005), which highlights the relatively low importance of economic factors in driving doctorate holders into private sector jobs compared to other preferences. Therefore, employers outside academia should focus on offering intellectual challenges and autonomy to attract and retain doctorate holders. Additionally, universities must improve career prospects for their researchers to retain top talent and prevent the loss of skilled academics (Waijjer, 2017). More efforts need to be made to encourage women to pursue research careers, both in academia and beyond.

Our results indicate that more can be done to provide career support for doctoral researchers, particularly in facilitating transitions to nonacademic careers, which aligns with OECD recommendations (2023). While support for an academic career increases the likelihood of pursuing an academic research career, support for nonacademic careers does not have a significant (positive) impact on any of the career paths. This suggests that while academic career support may be well integrated into doctoral training, support tailored to nonacademic career pathways might need further development to effectively influence career decisions post-PhD. Career support should not fall under the unique responsibility of doctoral supervisors, as they are more likely to orient doctoral researchers toward careers in academia and may be less familiar with alternative career paths (Bartsch et al., 2024; Gu et al., 2018; Seo et al., 2021). Doctoral researchers should also receive support from specialized career advisors and PhD alumni networks. Considering the importance of career-related motivations for future careers, doctoral training should be tailored to doctorate holders’ future career plans and provide opportunities to acquire relevant skills. To facilitate the transition to nonacademic sectors, transferable skills training should focus not only on academic competencies (e.g., related to publications or conferences) but also on broader transferable skills relevant for both academic and nonacademic jobs (e.g., project management or communication skills).

While collaboration with the private sector is a strong predictor of working in that sector, the number of doctorate holders in the study who collaborated with a nonacademic organization during their PhD is low. Policymakers and universities must provide more opportunities and incentives for collaboration with nonacademic partners during the doctorate (e.g., through industrial or collaborative doctorates) and offer more structured work experience for doctoral researchers (e.g., through joint projects). O’Shea and Jungblut (2023) recommend that doctoral programmes include structured, embedded industry internships or similar arrangements for other nonacademic sectors. Finally, attention must

be given to postdoctoral positions: while they are crucial for academic careers, they may be of less value for those aiming for broader industry or nonacademic roles. Studies show that taking a postdoctoral position can be perceived as hindering doctorate holders' transition to nonacademic sectors (Hayter & Parker, 2019). The high share of doctorate holders moving into postdoctoral positions can be explained by a lack of information on real tenure prospects and insufficient preparation for alternative careers (Schillebeeckx et al., 2013). Thus, collecting evidence of actual employment trends for doctorate holders is essential for helping universities better align doctoral training with the individual career goals of doctorate holders and their employment realities.

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Authors contributions All authors contributed to the conceptualization and design of the study. Julia Boman was responsible for the initial conceptualization and drafting of the manuscript, with feedback from the other authors on previous versions. She also led the material preparation and data collection as part of the DocEnhance project. Statistical analysis was conducted by Mabel Sanchez Barrioluengo, with input from all authors. All authors contributed to the review and editing process. All authors read and approved the final manuscript.

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Declarations

Competing interests The authors have no competing interests to declare that are relevant to the content of this article.

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