Beyond the PhD: Skill profiles in academic, non-academic and inter-sectoral early career paths

MANCHESTER INSTITUTE
OF INNOVATION RESEARCH

Beyond the PhD: Skill Profiles in Academic, Non-Academic and Inter-Sectoral Early Career Paths

BY

MABEL SÁNCHEZ-BARRIOLUENGO,
CORNELIA LAWSON, CAROLINA CAÑIBANO

MIOIR WORKING PAPER SERIES NO. 2026/01

MANCHESTER 1824
The University of Manchester

Beyond the PhD: skill profiles in academic, non-academic and inter-sectoral early career paths

Mabel Sánchez-Barrioluengo[a], Cornelia Lawson[a], Carolina Cañibano[b]

[a] Manchester Institute of Innovation Research (MIoIR). University of Manchester
[b] INGENIO, CSIC-Universitat Politècnica de València

Abstract: At a time when European science and innovation policy is seeking to better support research talent in navigating increasingly diverse post-PhD careers, we suggest that skill requirements vary substantially across employment sectors. We examine PhD holders' self-perceived transferable skills to identify the distinct skill profiles that characterise career paths in academic, non-academic and inter-sectoral settings. Building on a survey of PhD holders in Europe, we find that while research, commercialisation, and communication skills are perceived as more relevant for those working in academia, cognitive and managerial skills dominate in private sector careers. In addition, skill requirements of inter-sectoral careers emerge between the academic and non-academic sector with managerial, research and commercialisation skills considered relevant, independently of whether the combination of sectors is sequential (mixed careers) or simultaneous (hybrid careers). These findings have important implications for the design and development of doctoral education policies and programmes, as well as of policies targeting inter-sectoral mobility and the employment and attraction of research talent.

Keywords: PhD holders; Career paths; Skill intelligence; Skill relevance; Inter-sectoral careers; Competence frameworks

1. Introduction

The rapid expansion of doctoral education worldwide and its implications for researchers' careers is raising questions for science and innovation policy. A 2025 Nature commentary captured this unease by asking "*How many PhDs does the world need?*" (Kwon, 2025, p.1), a question that ultimately reflects less the concern about the sheer number of doctoral graduates but the changing realities of the labour market for new graduates. The recognition that PhD holders work increasingly outside academia has dominated the scientific literature for a while, including implications for research training. Inter-sectoral careers have therefore started to be widely recognised and promoted in PhD training frameworks (European Commission, 2025).

Research careers and the skills they entail serve not only as the foundation of personal and professional development but also as the locus of organisational knowledge exchange as researchers acquire competences and traverse the research and innovation landscape, including across sectors and countries. This is reflected in EU policy, which perceives doctoral education as a cross cutting domain linking the European Higher Education Area and the European Research Area (Marti & Peneoasu, 2025), with research careers contributing towards building bridges across organisations and geographical spaces. This process requires transferable skills to enable researchers to apply their competences in different environments. Acknowledging this need, skill development has become a crucial dimension in the design of European science and innovation policy (European Commission, 2025), with the "European Skills Agenda for sustainable competitiveness, social fairness and resilience" setting out to define "the core skills that researchers need for a successful career within and outside academia, also to foster mobility of scientists across Europe" (European Commission 2020; 11).

Despite this clear policy rationale, doctoral educators and university policymakers encounter significant difficulties in developing training programmes that adequately address the skills needed for increasingly diversified career paths that doctoral students might wish to pursue. In an era where doctoral graduates vastly outnumber available jobs in academia (Kwon, 2025), recent empirical evidence demonstrates that the majority of PhD graduates now transition to roles outside the university walls (Lawson & Lopes-Bento, 2024; Hancock, 2023; McAlpine et al., 2021) and that the private sector has emerged as a significant employer of PhD holders in science and engineering (Lee et al., 2010; Stephan, 2015; Sauermann & Roach, 2016; Denton et al., 2022).[1] Yet, doctoral education programmes remain primarily designed to prepare PhD holders for an academic career (Gardner & Doore, 2020, OJEU, 2023) and consequently face substantial challenges in meeting the needs of a wider employment market.

Improving 'skills intelligence', defined as the empirical understanding of skills and the development of evidence regarding their characteristics and trends, has been highlighted in recent policy reports as essential for effective and targeted policymaking (European Commission, 2025). Since Lee et al. (2010) found that the perceived utility of skills acquired from doctoral education differ by occupation type and sector of employment, questions regarding the specific skills sets required of researchers and PhD holders working in diverse employment sectors remain largely under-explored. To date, most of the literature on research careers is concerned with careers in

[1] In the EU, in 2023, 56% of researchers were employed by the business and enterprise sector compared to 32% working in the higher education sector. (Source of the data: Eurostat, 2025; R&D statistics, R&D personel: R&D personnel and researchers by sector of performance, educational attainment level and sex).

academia and public research organisations (PROs) (Broström, 2019; Cañibano et al., 2019; Graddy-Reed et al, 2021; Wang & Shibayama, 2022), with few studies focusing on mobility out of academia (Teelken et al., 2023; Lawson & Lopes-Bento, 2024), career transitions from non-academic sectors to universities (Garcia-Chavez et al., 2023), and mixed or hybrid careers (Cañibano et al., 2019; Lam, 2020; Lam, 2018). The relatively scarce evidence and recognition of alternative career paths, as well as the skills they need, is particularly problematic in the case of early career researchers as it makes difficult for them to effectively design training or career plans.

The contribution of the paper is twofold. First, by asking the question "*how and to what extent do skill requirements of PhD holders vary between different career trajectories?",* the paper contributes to the scientific literature on research careers and education-job match by addressing the nexus between skill requirements and career paths. Second, it timely provides empirical evidence that can inform the ongoing policy efforts to improve skills intelligence, to better monitor research careers at the global level and to develop new tools supporting research and innovation talent in their design of doctoral training and professional career plans. Empirically, our approach distinguishes the diversity of post-PhD career trajectories, recognising not only the traditional academic and non-academic employment sectors but also boundary spanning professionals in inter-sectoral (mixed and hybrid) careers. We identify differences in the skills PhD holders consider relevant for their current job and career paths. To do so, we use information from a survey of 1,432 PhD holders who completed the doctoral programme between 2016 and 2021 in eight different European universities. Results suggest that managerial skills dominate in non-academic sectors, while research and commercialisation as well as communication skills are perceived as more relevant by PhD holders working in academia. Importantly, specific skill requirements are observed for inter-sectoral careers spanning across the academic and non-academic sector. In these careers, managerial, research and commercialisation skills are considered relevant, independently of whether the combination of sectors is sequential (mixed careers) or simultaneous (hybrid careers).

2. PhD careers and skills

2.1. Career paths: navigating a changing landscape

Ultimately, the purpose of PhD training should be to equip researchers with the best skillset to find and solve complex research problems in specific institutional or organisational contexts, to navigate the career they choose to follow, and to develop their skillset in line with the evolution of their careers and the problems they face. This should take into consideration a number of factors which include institutional conditions and job opportunities in the labour market, as much as personal preferences and circumstances. Research careers are "work lives lived through the performance of scientific research" (Cañibano et al., 2019, p.19). They are typically categorised according to sector of employment and the type of research performing organisation in which they take place, distinguishing mainly between the academic and industrial sectors (e.g. Conti & Visentin, 2015). This distinction allows to position careers within the institutional and organisational contexts that shape them. Most of the literature on research careers has focused on the study of careers in the academic sector, including those working in universities and public research institutions (see e.g. Broström, 2019; Cañibano et al., 2019; Graddy-Reed et al, 2021; Wang & Shibayama, 2022). However, with increasing numbers of PhD graduates working outside academia (McAlpine et al., 2021; Kwon, 2025) and decreasing chances of obtaining a permanent position in academic research jobs (Teelken & Van

der Weijden, 2018), there is raising awareness of alternative career paths amongst early-career cohorts. Several studies have investigated the profiles of PhD holders pursuing different careers (e.g. Boman et al., 2025; Carriero et al., 2024; Conti & Visentin, 2015; Hayter & Parker, 2019), education-job match and job satisfaction of PhD holders in different sectors (Bender & Heywood, 2011; Di Paolo & Mañé, 2016; Lawson & Lopes-Bento, 2024; Sabharwal, 2011) and the specificities of careers at the frontier between academia and industry, notably in university collaborative research centres (Bozeman & Boardman, 2004, 2013, 2014, Gaughan, 2009, Gaughan & Corley, 2010).

Independently of where research careers start out or where they are located at a particular point in time, there is agreement in the literature that career pathways after PhD completion have multiplied and diversified over the last couple of decades and that the weight of single organisation - single industry careers is declining, giving space instead to a rise of careers that are considered "boundaryless" (Arthur & Rousseau 1996), and sometimes spanning various sectors and organisations, either simultaneously (referred to as "hybrid careers") or subsequently ("mixed careers") (Cañibano et al., 2019). These inter-sectoral careers combining academic and non-academic career trajectories have always existed but the growth of project-based employment among other factors, has contributed to their increasing prominence (Lam, 2020; Lam, 2018).

This new scenario, characterised by career diversification and higher inter-sectoral mobility of researchers, opens up new opportunities for knowledge brokerage and valorisation (Lam, 2018; Gluckman et al., 2021), for translational research and innovation (Nelson et al., 2011) and for a better integration of research and innovation systems, especially in Europe (Hristo et al., 2016). Yet, it also creates the challenge of providing researchers with the competences and skills to enter and navigate this new landscape. The concrete risks of this new scenario are connected to over-education (with doctorates not required for the role) and over-skilling (no opportunity to use doctoral skills) (POCARIM, 2015; Di Paolo & Mañé, 2016; Bender & Heywood, 2011), resulting in lower job satisfaction, lack of recognition and problems in transferring skills during transitions from the university to other workplaces (Lawson & Lopes-Bento, 2024; Galimberti, 2023).

2.2. PhD training and skill requirements

The above considerations highlight the importance of generic skills that can be useful across different organisational and job contexts. While a PhD has become a requisite for entering an academic career, and the majority of early career researchers studying for a PhD are motivated by a desire for an academic job (Roach & Sauermann, 2010; Hayter & Parker, 2019; Ganguli et al. 2022; Lawson & Lopes-Bento, 2024), an increasing share of PhD holders will leave academia (Auriol et al., 2013; Stephan, 2015; Kwon, 2025). For these non-academic careers transferable skills are vital, as highlighted in the 2019 MORE4 study[2], where 86% of respondents regarded transferable skills as positive factors for career progression.

In fact, the ten Salzburg Principles, established in 2005 within the Bologna Process as the basis of the reforms for doctoral education in the EU, included the "promotion of innovative structures: to meet the challenge of interdisciplinary training and the development of transferable skills" (Principle 8)[3]. However, while in theory doctoral graduates should develop generic skills, PhD programmes are generally geared towards training the next generation of academic researchers

[2] MORE4 study: https://euraxess.ec.europa.eu/sites/default/files/policy_library/more4_final_report.pdf
[3] Salzburg 2005 – Conclusions and Recommendations: https://www.eua.eu/publications/positions/salzburg-2005-conclusions-and-recommendations.html

(Nerad & Cerny, 2000). For example, according to the MORE4 study, the share of EU researchers receiving transferable skills training during the PhD was only 32% in 2019. Inevitably, the increasing emphasis on research excellence and insufficient training in generic skills leaves PhD researchers discouraged and unprepared for non-academic and alternative career paths (Hayter & Parker, 2019; Buenstorf et al., 2023).

What exactly are the skills that are needed and currently missing? Previous surveys of firm employers and of PhD graduates highlighted the relative lesser relevance of specialist research skills compared to generic skills (de Grande et al., 2014; Hayter & Parker, 2019; Kyvik & Olsen, 2012; Lee et al., 2010; Zellner, 2003). Employers in particular have lamented that PhDs lack leadership or team working experience, and associated communication and management skills (Hayter & Parker, 2019). They also value technical knowledge more than research skills per se (de Grande et al., 2014). Some prior research clarifies the skill needs with regard to research and non-research careers. For instance, research and analysis skills are highly valued by employers and students in research careers (Diamond et al., 2014; Zellner, 2003), while management skills are more critical in non-research careers (Lee et al., 2010; Sinche et al., 2017). Yet, in all these studies the majority of skill needs and gaps is shared across sectors and occupation types (McAlpine, 2020).

Thus, while PhDs will learn specialist skills specific to their domain, other skills may be neglected, acting as barriers to future careers. For instance, Blume-Kohout & Adhikari (2016) argue that PhD fellowships, where students work on their own independent project, may allow students to excessively focus on their own research and the development of associated research skills, at the detriment of generic skills. Instead, students that are required to take on research assistance posts or part-time teaching to finance their studies may have a greater level of hands-on experience such as project- and team-work (Blume-Kohout & Adhikari, 2016), which may enable them to develop more generic, transferable skills (Broström, 2019) that are valued by employers also outside academia (Nerad & Cerny, 2000; Kyvik & Olsen, 2012). Other 'extra-curricular' activities that have the potential to fill gaps in PhD development include work placements and public engagement (Bryan & Guccione, 2018; Mills & James, 2020). Here, students have early opportunities to work across sectors, something that again has been recognised as critical for developing generic skills (Germain-Alamartine et al. 2021) and can smooth career transition into non-academic research employment (Hottenrott and Lawson 2017; Marini, 2022).

In response to various skill needs, recent years have seen a diversification of PhD training with the development of more collaborative or industrial PhDs that offer degree programmes that cross disciplinary and sector boundaries (Sarrico, 2022). These aim to "create great researchers but also great entrepreneurs, create experts able to work across many different disciplines, build the in-depth knowledge of a research degree, and also develop a breadth of generic 'transferable' skills" (Balaban, 2020, p.325). While such programmes are seen as a solution to the current lack of transferable skill training, they also risk overburdening doctoral programmes or to prioritise generic skills at the detriment of specialist research skills (Mills & James, 2020), where doctoral education risks losing its distinctiveness (Balaban, 2020). In this context it thus becomes particularly critical to understand the skill profiles that benefit different career paths to help inform a balanced approach towards skill training during the PhD.

In what follows, we test empirically two propositions that emerge from the above discussion. First, there is some intuition on skills relevance in single-sector career paths. They consistently point at cognitive and managerial skills as highly important for non-academic (or industry) careers while

research skills are given less weight (see McAlpine, 2020 for a review). Academic careers, instead, require research and cognitive skills, while managerial skills are needed to a lesser degree (Lee et al., 2010). Second, inter-sectoral careers, which span different sectors such as academia and industry, present a particular challenge due to the need to adjust to different work context, a process that requires adaptation and learning (Lam, 2018). Tensions may arise when navigating different worlds, to the extent that skill requirements of one or more role cannot be met (Lam, 2020). Researchers who successfully manage these tensions likely become adept at skill transfer and learn to maintain skill consistency when embarking on new roles (Lam, 2018). This will likely reflect in broader skill-relevance compared to single-sector careers due to the need to construct a mixed or hybrid skill identity.

3. Skills intelligence

In the introduction we already pointed out that recent European policy documents highlight the need to better understand and track the skills that researchers need to follow different career paths (European Commission, 2020, 2025). The categorisation or typification of skills and competences emerges as a first necessary step to track their development over time and investigate the contexts where they are needed. Previous policy frameworks associated different research career stages with certain competence and skill profiles. This was the case of the European Framework for Research careers published by the European Commission in 2011. The framework associated research skills, such as the acquisition of cognitive (i.e. critical thinking, analytic skills) and research competences (i.e. conducting research, writing skills) to the initial phases of the career, and generic skills, such as competences required for the management of people, resources and projects along with impact generation, to the latest part of the career (European Commission, 2011). However, with the diversification of career pathways, along with the high rates of geographical, sectorial and disciplinary mobility, researchers may need and acquire new competences at any point in their career. A senior researcher may need to be trained in a new research method as much as a junior researcher needs to understand intellectual property management.

Available research competence frameworks, some of which have now been in place for decades, were initially developed as a tool for researchers and research performing organisations to manage research training and careers, allowing their users to identify and categorise relevant competences and to make plans for their acquisition and development according to career objectives. We call the reader's attention to some of these tools, starting with the European Competence Framework for Researchers (known as "Research Comp"[4]), which was introduced by the European Commission in late 2022. The framework classifies competencies into seven main groups and foresees four levels of competence development, starting at "foundational" and progressing towards "advanced". Competences are no longer associated to specific career stages in this new framework, neither are specific competences linked to career track types. A self-assessment tool[5] based on this framework has also been made available.

[4] ResearchComp: The European Competence Framework for Researchers: https://research-and-innovation.ec.europa.eu/jobs-research/researchcomp-european-competence-framework-researchers_en, Accessed: 6 Feb 2026.
[5] ResearchComp Self-Assessment Tool: https://projects.research-and-innovation.ec.europa.eu/en/jobs-research/researchcomp-european-competence-framework-researchers/self-assessment-tool; Accessed: 6 Feb 2026

Other examples are Vitae's Researcher Development Framework (RDF)[6] or MyIDP Individual Development Plan[7] developed by the American Association for the Advancement of Science. Both these resources are designed to support successful research career planning and are structured around the identification and self-assessment of individual skills and competences. MyIDP also matches self-assessed skills to a list of 20 possible careers paths, according to expert knowledge regarding the competence typical profile in each of those paths. MyIDP is structured around 7 competence groups whilst Vitae's RDF categorises skills into 5 larger groups that are further subdivided.

While these classifications differ, the three competence frameworks introduced here make a broad distinction between the skills and capacity to conduct research (cognitive, scientific, methodological, subject knowledge skills); the capacity to interact and work with others; to manage oneself and manage work and others; and to communicate and engage with society. However, none of these frameworks is currently accompanied or complemented by information regarding the specific skills-sets that different career trajectories may require, which could substantially support self-assessment, career planning and the design and customisation of doctoral training. It is precisely this reason that encouraged the survey on transferrable skills conducted by the European Science Foundation, which constitutes the empirical basis for this study (Boman et al., 2021). As will be highlighted later, the results of this research are relevant for potential future developments of available competence frameworks and for encouraging their use.

4. Data source and variables

4.1. Data source

In this study, we build on a unique set of ad hoc data collected by the 'PhD graduate tracking survey', conducted within the DocEnhance project in 2021 with the purpose to improve transferable skills intelligence (Boman et al., 2021). It is a multi-organisation survey of doctorate holders in eight European universities: Arctic University of Norway (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 the University of Chemistry and Technology Prague (Czech Republic).[8] The survey included seven sections, covering 1) doctoral education, 2) skills training, 3) first employment, 4) current employment, 5) & 6) mobility, and 7) demographic information, and took 10-20 minutes to complete.

The target population of the survey were doctorate holders who obtained their degrees between 2016 and 2020. Each university distributed the survey via email to all PhD holders who graduated in that period. The complete questionnaire and detailed methodology can be found in Boman et al. (2021). The anonymous survey was open to PhD alumni across the participating universities from March to April 2021 and collected 2,189 valid responses representing a 23%

[6] The Vitae Researcher Development Framework: https://www.vitae.ac.uk/researchers-professional-development/about-the-vitae-researcher-development-framework/developing-the-vitae-researcher-development-framework/; Accessed: 6 Feb 2026

[7] MyIDP Individual Development Plan: https://myidp.sciencecareers.org/; Accessed: 6 Feb 2026

[8] Original data collection includes also the University of Thessaloniki (Greece) but, due to the low response rate (28 valid answers) it was excluded from the analysis presented here.

response rate.[9] Of these, 400 were dropped as they did not indicate an active employment status, 5 were excluded as they declared an age lower than 22 years old at the time of the survey, and 352 have missing values for the main variables used in the analysis (described in the following section), resulting in a working sample of 1,432 respondents used for the analysis in this study.

4.2. Variables

This section presents the main variables used in our analysis including career trajectories and skills as well as a set of control variables related to the PhD programme and doctoral holders' characteristics.

PhD holders current employment and career path

We build two measures that represent the main independent variables in this study: current employment and career path of PhD holders. First, *current employment* is a static measure that provides information on the sector where the PhD holders are employed at the time of the survey. It is based on the question: *Please indicate the sector which best describes your current main employment.* In particular, we compute a dummy variable (*non-academic job*) with the value 1 if the PhD holder works in a non-academic job (business sector, public administration, healthcare, non-higher education, private not-for-profit sector and other sectors) and 0 if they work in academia (universities and/or public research organisations). Subsequently, and because a large proportion of our respondents are employed in the business sector (39%) including industry and services, we further distinguish between business sector vs other sectors.

Second, in order to capture a more dynamic characterisation of the PhD holders' work experience that allows to differentiate career profiles, we compute the variable *career path*[10] that tracks back and compares the PhD holder's current sector of employment with previous post-PhD job experiences. In particular, we distinguish four non-overlapping categories: a) PhD holders who are currently employed in academia and have not had any previous work experience or, if any, have only worked in universities or public research organisations (*only academic*); b) PhD holders who are currently employed in a non-academic job and have not had any previous work experience or, if any, only in the business sector, public administration, healthcare, non-higher education, private not-for-profit sector or any other sector different from academia (*only non-academic*); c) inter-sectoral mobility of PhD holders who alternate from academic to non-academic jobs (or vice versa) subsequently (*mixed*); and d) inter-sectoral mobility via part-time jobs of PhD holders who alternate between academic and non-academic jobs simultaneously (*hybrid*).

Skills

Our dependent variables are the skills relevant for the current job, based on answers to "*To what extent are the following skills important in your current main job*?". A set of twenty-four skills

[9] Tests checking non-response bias were performed using information of the two e-mail reminders sent to the target population. Respondents were split in 3 categories depending on when they answered the survey (before or after the first reminder, or after the second reminder) and their responses for the key variables of this study compared. Results presented in Annex I suggest that the frequency of the employment/career path and the average skills do not vary indicating that the responses of those who answered the survey at the first invitation and those who answered later are the same and that we have avoided problems of non-response bias.

[10] In order to build this variable, the following questions from the questionnaire were used: *How many other employers did you have before your current employment and after obtaining your doctorate (including postdoctoral positions with other employers)?; Before your current employment and after obtaining your doctorate, in which sector(s) have you worked?*; and *In which organisations have you ever combined positions at the same time*? The working sample for this variable is 1,431 because one respondent was excluded for reporting multiple post-PhD roles without specifying employment sectors.

were presented (see Table 1) and each rated using a 5-points Likert scale from 1= "not at all important" to 5= "extremely important". We perform a factor analysis based on principal components with Kaiser normalisation to identify the main groups of skills. The number of factors to extract was based on Kaiser's criteria, which identified four factors with eigenvalues greater than one (Hair et al., 1998). In order to check the factors' internal reliability, we calculate the Cronbach-alpha index and the coefficients for all groups are close to or greater than 0.7, which is considered satisfactory (Hair *et al.*, 1998). Table 1 shows the results of the factor analysis and how the skills are allocated in each group. Based on the results of the factor analysis four variables are computed, which group the twenty-four skills into four categories: cognitive skills, managerial skills, research and commercialisation skills, and communication skills. To compute the four dependent variables, we rely on the predictions of the factor loadings resulting from the factor analysis, which take into consideration the weighted composite of the items in the calculation.[11] However, for the descriptive analysis we compute the four factors based on the average of the relevant items (values remain between 1 and 5) to facilitate interpretation.

[Insert Table 1 about here]

As our dependent variables are based on respondents' self-perceptions, it is possible that a person is not aware of the importance of a specific skill at work simply because the skill has never been acquired or used. To take this into consideration, for each skill needed at work, we control for the perception of the relevance of the same skill at the time of PhD completion. This perception could influence the subsequent acquisition (and in our case perceptions) of skills needed (Siegel, 2020) at work. We are able to establish this link as respondents were asked "*How would you rate your research skills and other academic competences at the time you completed your doctorate*?". The set of twenty-four skills was also presented and each one rated using a 5-points Likert scale from 1= "not at all important" to 5= "extremely important". We apply the same cluster analysis technique resulting in four factors, namely *managerial skills at PhD* (Cronbach-alpha=0.85), *cognitive skills at PhD* (0.82), *research and commercialisation skills at PhD* (Cronbach alpha=0.71) and *communication skills at PhD* (Cronbach-alpha=0.68) (see Annex II).[12] We compute the factor scores of these four variables as the prediction of the factor loadings resulting from the factor analysis.

Due to the parallelism between the measurement of skills in current employment and during the PhD, the variables measuring skills acquired at PhD completion can be considered a proxy for a *lagged* dependent variable. This approach helps control for unobserved individual-specific heterogeneity and initial conditions. It can also correct for any self-selection into careers that meet acquired skills profiles.

Profile of PhD holders

A second set of controls relates to the profile of PhD holders, which may relate to skill attainment and perception. We take into consideration the *gender* (0=Female, 1=Male) and whether graduates have or do not have *children* (0=No, 1=Yes). In addition, we look at the age of the PhD

[11] Results remain mainly unaltered if we compute factor scores as the average of the items included in each factor.
[12] Although the cluster results are identical in the self-perception of skills acquired at the completion of the PhD programme and those needed at work, factor loadings differ within each cluster. We computed an alternative measure of the skills acquired at the end of the PhD programme following the same allocation of items within factors as in the case of the skills needed at work. Results (available upon request) remain as those presented here but the goodness of fit of the model representing the variability of the data explained by the factors included in the regression model (R-square) is smaller.

holder at the start of the PhD (*age PhD started*) that is computed as the difference between the formal admission into the doctoral training programme and the year of birth. We also include the number of years since the PhD holder completed the doctoral programme (*years since completion*) that is calculated as the difference between the year of data collection (2021) and the year in which the doctoral holder completed the PhD programme. This last variable helps to control for individuals' past work experience.

Other controls

In order to account for the fact that the skill needs could be related to factors beyond the sector of employment or PhD, we control for four additional variables. First, regardless of the sector of employment the involvement in research activities is an important task that will require the expertise and competences acquired during the PhD (Boman et al., 2025; Diamond et al., 2014). Although research activities are mainly related to academic jobs, these could also be very important in other sectors (e.g. pharmaceutical). For this reason, we include a variable with the value 1 if the PhD holder is currently involved in research activities in the job or 0 otherwise (*Involvement in research*). Second, we take into account certain external factors, such as labour market demand (Conti & Visentin, 2015; Ganguli et al., 2022) that could affect skill perceptions. For this, we compute a dummy variable taking the value 1 if the PhD holder has experienced inter-sectoral mobility due to the lack of opportunities (*SecMob_lack of opportunities*) and 0 otherwise.[13] Additionally, we take into consideration potential personal ties controlling for the fact that the current job is located in the same country where the PhD was completed (*match job-PhD*) and the fact that the PhD holder is working in their country of citizenship (*match job-citizenship)* as a proxy to capture the mobility of students that return back home once they completed the PhD, as this could impact education-job match (Lawson & Lopes-Bento, 2024). In the first case, a dummy variable captures with the value 1 if the location of the university where the PhD holder completed the doctoral programme is the same as the country where they currently live and 0 otherwise. For the latest, the matching exercise returns code 1 if the PhD holder currently lives in their citizenship country (the questionnaire allows to include up to three countries of citizenship).

With all analysis variables being collected in the same survey, there is a risk of common method bias. This was considered in the design of the survey. Specifically, questions relating to skills obtained during training were surveyed in section 2 and thus far apart and in different contexts from the dependent variable (section 4) to ensure that respondents did not connect the two questions and the measures do not suffer from 'consistency motif' or respondents applying 'implicit theories' to these items (Podsakoff et al., 2003, 2012). The employment sector variables were however collected close to the dependent variable and while this helped create a context for the responses, it also risks a priming effect driving socially desirable responses and correlations. To counter this we guaranteed anonymity to our respondents, which should reduce respondents' concerns regarding right and wrong answers and thus reduce social desirability that may have been triggered, and we ensured methodological separation, that is, used different response modes for independent and dependent variables, which helps reduce the salience of any contextual clues (Podsakoff et al., 2003, 2012).

[13] This variable takes the value 1 if a respondent selected "It was the only way to enter the labour market" to the question "Which were the reasons to change sectors?" OR "No full-time job available" to the question "Which were the reasons to combine positions in different sectors at the same time?". Those who had other reasons for inter-sectoral mobility or that have not done any inter-sectoral mobility at all has been assigned to the category 0.

The correlation matrix is presented in Annex IV and identifies no multicollinearity problems among the variables. We additionally examined the variance inflator factor (VIF), which is the inverse of the tolerance statistic values. We observe that VIFs results are below the value 10, which is usually used as a rule of thumb to determine that there are no multicollinearity problems (Field, 2013).

4.3. Descriptive statistics

Table 2 presents the results of the descriptive statistics. The sample includes almost 60% of respondents currently working in non-academic jobs compared to 40% working in universities and public research institutions. Among those working outside academia, the majority work in the private sector (39% compared to 21% working in other sectors). Career trajectories of PhD holders show a good proportion having only followed a non-academic path (48%) compared to those that have worked only in academic jobs (32%). In addition to these more traditional career paths we observe PhD holders working across different sectors, either subsequently (mixed – 9%) or simultaneously (hybrid - 10%).

The perception of the skills needed at the job highlights the importance of managerial skills (4.30 out of 5) compared to other lower-rated skills. Among the other three sets of skills, communication skills rate higher (3.76) compared to research and commercialisation skills (3.54) and cognitive skills (3.51). This contrasts with the perception of skills acquired at the end of the PhD, where cognitive skills rank first (4.25) compared to research and commercialisation skills and managerial skills that received the lowest score (3.23 and 3.68 respectively).

In terms of PhD programme measures, we see that the majority (88%) had some type of funding during the doctoral training. PhD holders were more satisfied with the training and mentoring delivered by the programme (3.96 out of 5) than with the university supporting options available (3.45). Motivations to do a PhD are related to future career expectations to work in academia (38.1%), while less than 12% were motivated to work in non-academic jobs at the time they started the PhD. Indeed, only 8.5% developed a PhD co-supervised by non-academic actors and almost 24% of those who embarked on an inter-sectoral career did so due to the lack of opportunities otherwise.[14]

On average, PhD holders started enrolling in the PhD at almost 29 years of age, although this varies substantially between 22 and 58 years old. Due to the definition of the target population for the survey, the sample is composed of early career researchers with between 1 and 5 years of post-PhD experience and 2.9 years on average. The sample includes 58% male PhD holders and 42% women. Almost forty one percent of respondents have children. Currently, 76% are working in the same country where they completed the PhD programme and 62% are located in their country of citizenship.

[Insert Table 2 about here]

[14] It is worth noting that lack of opportunities is not the main reason for inter-sectoral mobility even when we take into consideration only those that have had more than 2 jobs because approximately 1 out of 4 respondents involved in inter-sectoral mobility selected that this was the only way to enter the labour market or that no full-time jobs were available. Note that Table 2 reports 9% as per variable construction to be used in regression models and according the information provided in footnote 13.

4.4. Skills

The self-perception of skills needed at work is one of the key relevant variables for this analysis. In Table 3 we identify some differences in the perception of skills[15] taking into consideration different characteristics of the PhD holders: current employment and career path, gender and field of research.

Respondents working in academia at the time of the survey reported higher values of the perceived importance of skills at their current job compared to those working in non-academic sectors. In particular, significant differences are reported for communication skills (3.93 for academics compared to and 3.65 for non-academics), with an even higher gap in the case of research and commercialisation skills (3.93 vs 3.29). Similar patterns are reported when looking at longer career paths. This is in line with Tzanakou (2012) (cited in Bryan & Guccione, 2018) who found that graduates in academic roles reported a greater utility for direct skills and knowledge gained than graduates in roles outside academia.

We check for differences in skills across three additional PhD holders characteristics: gender, involvement in research activities and field of study. Female PhD holders report higher values of skills relevance in the current job compared to their male counterparts, with significant differences for all types of skills. Similarly, there are significant difference in all skills for those working in research vs. not. Surprisingly, those involved in research report higher values for cognitive, managerial and communication skills while they score lower the importance of research and commercialisation skills at work. By field differences in the relevance of skills perceived at the current job are only significant for cognitive and communication skills. In particular, PhD holders in the NMA field scored cognitive skills lower compared to those in SSH and Engineering (3.44 vs 3.59 and 3.56) while those in SSH considered communication skills more relevant in the current job compared to those in other fields (3.95 vs 3.69 and 3.76).

[Insert Table 3 about here]

5. Results

Table 4 presents the results of four seemingly unrelated regression models that analyse how different types of employment relate to perceptions of the importance of skills needed for the job. This method allows for correlations between the error terms of each equation, as we can expect that skills are connected, and each PhD holder will balance differently their abilities and skills at the job. In Model 1, we decompose PhD holders' current employment into two categories (academic vs non-academic) while Model 2 presents a more fine grained comparison of PhD holders currently working in academia (ref. category), with those working in the private sector or in other sectors. In all models we include a PhD skill variable, capturing the acquisition of the relevant skill during the PhD, to control for unobserved individual-specific heterogeneity and initial conditions. In all models the skills obtained during the PhD are positively correlated with skills that are of importance in current job, suggesting some matching of skills with career profiles. Our results thus corroborate that by controlling for the relevance of skills at PhD completion, we account for the possibility—suggested by Siegel (2020)—that current self-perceptions of skills at work are shaped by prior acquisition and awareness.

[15] Significance of results remain when we use the prediction of the factor loadings to compute the factor scores.

The left panel (Model 1) in Table 4 suggests that PhD holders working outside academia perceive managerial skills as particularly important in their current job compared to those working in academia. In contrast, their perception of the importance of research and commercialisation skills, and communication skills is negative and significant, meaning that these sets of skills are perceived as key competencies for those working in universities and public research institutions (i.e. academic jobs). This is confirmed by the results provided in the right panel (Model 2) reporting more detailed differences between academia, private sector and other sectors. Specifically, they confirm that PhD holders working in the private or other sectors perceive both research and commercialisation skills as well as communication skills as less important, while managerial skills are more relevant when compared with the perception of skills reported by academics. Some differences are evident in the case of cognitive skills where PhD holders in the private sector present a positive and significant result when compared to academics, while this coefficient is negative for other sectors. In addition, we perform a Wald test to compare the coefficients (Mullahy, 2015) for private and other sectors and results indicate that the coefficients of cognitive and managerial skills are significantly different for PhD holders in the private sector compared to other sectors (chi2(1)=26.26; p=0.000 and chi2(1)=7.19; p=0.007 respectively). This means that cognitive skills and managerial skills are perceived as particularly important by PhD holders currently working in the private sector when compared to other sectors.

[Insert Table 4 about here]

Table 5 represents the results for the relationship between career paths and self-perception of skills. We see no difference in the perception of cognitive skills between different pathways.

PhD holders following a non-academic path only perceive managerial skills as more important than those following an academic path only. The same is true for those in a mixed or hybrid career path when compared with academic only. However, there are no significant differences between those in non-academic, mixed or hybrid career paths (chi2(1)=0.68, p=0.41; chi2(1)=0.93, p=0.33; chi2(1)=0.01, p=0.92) with regard to managerial skills.

In contrast, research and commercialisation skills are perceived as more relevant by respondents in academic only trajectories compared to those in other paths. In this case, respondents with mixed (chi2(1)=12, p=0.00) or hybrid career paths (chi2(1)=10.30, p=0.00) perceive these skills as significantly more important than those in the non-academic only path, while there are no significant differences between those in mixed or hybrid career paths (chi2(1)=0.08; p=0.77).

Finally, communication skills are perceived as more important by respondents following an academic only path when compared with those in a non-academic only path and in a mixed one (although the latest is only significant at 10%). In this case there are also no significant differences when comparing non-academic only, mixed and hybrid careers.

This result across skill types also suggest that PhD holders pursuing hybrid and mixed careers, consider the importance of different skills equally, with no statistically significant difference between the two groups. This suggests the existence of a set of relevant skills for inter-sectoral careers, independently of whether the combination of sectors is sequential or simultaneous.[16]

[16] We tested the robustness of our results to specific university sample size. Specifically, respondents from the Technical University of Munich represent 51% of the sample. To make sure our results are not representing the specific

[Insert Table 5 about here]

All models include control variables which offer some additional insights. Women perceive most skills as less important in their current job compared to men. Research content of a job relates positively to research and commercialisation skills as could be expected. Those moving out of academia due to lack of opportunities, are more likely to highlight the relative unimportance of research and commercialisation skills in their current work. Those that work in the same country as their PhD make lesser use of research and commercialisation skills but more managerial use, which suggests that international mobility may be an enabler of education-job match. Those that work in their country of citizenship assign lesser importance to communication skills. Other variables, such as motivation for pursuing a PhD or funding are not found to be relevant for skill-use in different sectors.

6. Discussion and Conclusions

The increasing number of PhD graduates leaving academia for careers in other sectors requires the development of transferable skills that enable them to effectively apply their competences in different environments (European Commission, 2020, 2025). In this study we shed light on the transferable skill-sets that characterise different career paths pursued by doctorate graduates in Europe. The results contribute to European skills intelligence and are consequential for higher education and research and innovation policies, as well as for the development of tools that may support early career researchers in the design of training and career plans (European Commission, 2020, 2025).

At a descriptive level, we found evidence of a skill-gap (de Grande et al., 2014; Sinche et al., 2017) in that the skills that are perceived as relevant on the job, differ from those that have been acquired during the PhD. Specifically, managerial skills are considered highly important in the current job, but were less developed during PhD training, whilst cognitive skills, which most respondents consider as highly developed by the end of the PhD, are of lesser importance for the current job. This mismatch highlights the acknowledged necessity to (re)define the skills that researchers need to embark on successful careers within and across sectors, and to revise doctoral education programmes as employer and graduate needs evolve. There is room for doctoral education to improve the provision of transferable skills, especially of managerial skills, as they are highly important in their future careers regardless of sector (Hayter & Parker, 2019; Lee et al., 2010; Sinche et al., 2017).

We further provided evidence that the skill-sets considered most relevant on the job vary across employment sectors and career types (Lee et al., 2010). Specifically, our results suggest three skill-set profiles. First, a profile that distinguishes careers in the private sector, for which cognitive and managerial skills are relatively more important. Second, a profile for careers pursued primarily in the academic sector for which research, commercialisation and communication skills are comparatively more relevant. Third, a profile that considers the particularities of inter-sectoral careers (Cañibano et al., 2019; Lam, 2020), independently of whether employment sectors are combined simultaneously (hybrid) or subsequently (mixed). In these careers, managerial skills are perceived as

characteristics of the German market, we replicated the same models excluding answers from this university. Results are robust and available upon request.

more important than in academic only careers, while research and commercialisation skills are considered more relevant than for careers that unfold in a single non-academic sector.

These results improve our empirical knowledge about the competences and skills PhD holders require in different career trajectories, and provide grounds for improved tailoring of doctoral training and career support, that meets the aspirations of doctoral students and labour market conditions. The results also shed light on the specificities of inter-sectoral careers, which have become a key objective of European Research Area policies.[17] Our study provides evidence that careers that cross employment sectors require a broader portfolio of transferable skills compared to those that develop according to a more traditional single-sector or single-organisation pattern. Equipping doctoral students for inter-sectoral careers implies paying attention to the adequate provision of managerial skills on top of the more traditional provision of cognitive and research skills. Equipping PhD holders with a balanced set of skills will make them adapt at transferring knowledge between roles and sectors (Lam, 2018).

Our results are relevant for further development of competence frameworks such as those described in section 3 of the paper, including the European Competence Framework for Researchers (ResearchComp). Competence self-assessment tools for researchers could incorporate information regarding skill-sets that are necessary in different career paths and employment sectors, which is currently lacking. This information would allow researchers to better plan their training and to make career choices accordingly, with improved knowledge regarding their potential skills strengths and needs in line with their career choices and options. In addition, by shedding light on specific skills requirements in different sectors and careers, the study may also inform the ongoing development of the Research and Innovation Careers Observatory (ReICO)[18], led jointly by the European Commission and the OECD. ReICO will progressively collect additional data across OECD countries on R&I talent development, labour market and geographical circulation. The further collection of data on skills seems particularly relevant considering the gaps identified in this study and the association between relevant skill-sets and career pathways.

We must nevertheless highlight some limitations of this research. First, results are based on self-reported perceptions of skills needs. Further research could complement this analysis with employers' perspective, to give a more holistic view of the supply and demand of skills in the different sectors. Second, the use of cross-sectional data provides only a snapshot in time. Although we have included a dynamic perspective of the career path by taking into account the employment sector of subsequent jobs, we cannot track changes in skill profiles over a researcher's career. Finally, the anonymised nature of the data limits the ability to link the survey responses with other datasets to create a richer, more complete picture of researchers' career trajectories, or to make the link with the outcomes of their work and skills such as publications or patents.

Acknowledgement

Data used in this research has been collected through the DocEnhance project (grant agreement no. 872483) under an European Union`s Horizon 2020 Science with and for Society programme. Mabel Sanchez Barrioluengo acknowledges the European Science Foundation for the use of the DocEnhance dataset under consultancy agreement (Ref. 2021-03A).

[17] European Research Area Platform: https://european-research-area.ec.europa.eu/; Accessed: 6 Feb 2026.
[18] Research and Innovation Careers Observatory (ReICO): https://www.oecd.org/en/networks/research-and-innovation-careers-observatory.html; Accessed: 6 Feb 2026.

References:

Arthur, M. B., & Rousseau, D. M. (1996). *The boundaryless career: A new employment principle for a new organizational era*. Oxford: Oxford University Press.

Auriol, L., Misu, M., & Freeman, R. A. (2013). *Careers of doctorate holders: Analysis of labour market and mobility indicators*. OECD: Paris.

Balaban, C. (2020). Diversifying the missions and expectations of doctoral education: Are we losing the distinctive 'added value' of the PhD?. In *Structural and institutional transformations in doctoral education: Social, political and student expectations* (pp. 325-345). Cham: Springer International Publishing.

Blume-Kohout, M. E., & Adhikari, D. (2016). Training the scientific workforce: Does funding mechanism matter? *Research Policy*, *45*(6), 1291–1303.

Boman, J., Beeson, H., Sanchez Barrioluengo, M. & Rusitoru, M. (2021). *What comes after a PhD? Findings from the DocEnhance survey of doctorate holders on their employment situation, skills match and the value of the doctorate*. European Science Foundation, Strasbourg. Available at: https://docenhance.eu/career-tracking/; Accessed: 6 Feb 2026

Boman, J., Sanchez Barrioluengo, M. & van der Weijden, I. (2025). Determinants of the career pathways of doctorate holders: Evidence from eight European universities. *Higher Education* (Forthcoming).

Bozeman, B., & Boardman, C. (2004). The NSF engineering research centers and the university–industry research revolution: A brief history featuring an interview with Erich Bloch. *Journal of Technology Transfer*, 29: 365–375.

Bozeman, B., & Boardman, C. (2013). Academic faculty in university research centers: Neither capitalism's slaves nor teaching fugitives. *The Journal of Higher Education*, 84(1): 88–120.

Bozeman, B., & Boardman, C. (2014). *Research Collaboration and Team Science. A state of the art and review agenda.* Springer Briefs in Entrepreneurship and Innovation. International Publishing.

Broström, A. (2019). Academic breeding grounds: Home department conditions and early career performance of academic researchers. *Research Policy*, 48(7), 1647-1665.

Bryan, B. & Guccione, K. (2018). Was it worth it? A qualitative exploration into graduate perceptions of doctoral value, *Higher Education Research & Development*, 37:6, 1124-1140.

Buenstorf, G., Koenig, J. & Otto, A. (2023). Expansion of doctoral training and doctorate recipients' labour market outcomes: evidence from German register data, *Studies in Higher Educatio*n, 48:8, 1216-1242.

Cañibano, C., Woolley, R., Iversen, E., Hinze, S., Hornbostel, S., & Tesch, J. (2019). A conceptual framework for studying science research careers. *Journal of Technology Transfer*, 44: 1964-1992.

Carriero, R., Coda Zabetta, M., Geuna, A., & Tomatis, F. (2024). Investigating PhDs' early career occupational outcomes in Italy: individual motivations, role of supervisor and gender differences. *Higher Education*, 87(5), 1375-1392.

Conti, A. & Visentin, V. 2015 A revealed preference analysis of PhD students' choices overemployment outcomes. *Research Policy* 44: 1931-1947

De Grande, H., De Boyser, K., Vandevelde, K., & Van Rossem, R. (2014). From Academia to Industry: Are Doctorate Holders Ready? *Journal of the Knowledge Economy*, *5*(3), 538–561.

Denton, M., Borrego, M., & Knight, D. B. (2022). US postdoctoral careers in life sciences, physical sciences and engineering: Government, industry, and academia. *PLoS One*, 17(2), e0263185.

Diamond, A., Ball, C., Vorley, T., Hughes, T., Moreton, R., Howe, P., & Nathwani, T. (2014). *The impact of doctoral careers.* Leicester: CFE Research.

Di Paolo, A., & Mañé, F. (2016). Misusing our talent? Overeducation, overskilling and skill underutilisation among Spanish PhD graduates. *The Economic and Labour Relations Review*, 27(4), 432-452.

European Commission (2011). Towards a european framework for research careers. Brussels. https://euraxess.ec.europa.eu/sites/default/files/policy_library/towards_a_european_framework_for_research_careers_final.pdf (Accessed 6 February 2026)
European Commission (2020). European Skills Agenda for sustainable competitiveness, social fairness and resilience. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Brussels, 1.7.2020 COM(2020) 274 final.
European Commission (2025). The Union of Skills. Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions. Brussels, 5.3.2025 COM(2025) 90 final.
Field, A. (2013). *Discovering Statistics using IBM SPSS Statistics*. (4th ed.). SAGE Publications.
Garcia-Chavez, C. Howoldt, D. Hoyer, P. Karaulova, M., Kroll, H. and Schubert, T. (2023) Understanding career transitions of applied researchers to universities: evidence from Germany. *Science and Public Policy* 00, 1-19
Gardner, S. K., & Doore, S. A. 2020. Doctoral Student Socialization and Professional Pathways. In *Socialization in Higher Education and the Early Career*, edited by J. C. Weidman and L. DeAngelo, 113–27. New York: Springer.
Galimberti, A. (2023): PhD graduates' professional transitions and academic habitus. The role of tacit knowledge, *Studies in Higher Education*, 48(10), 1563–1575.
Ganguli, I., Gaulé, P., & Čugalj, D. V. (2022). Chasing the academic dream: Biased beliefs and scientific labor markets. *Journal of Economic Behavior & Organization*, 202, 17-33.
Gaughan, M. (2009). Using the curriculum vitae for policy research: An evaluation of National Institutes of Health center and training support on career trajectories. *Research Evaluation*, 18(2): 117–124.
Gaughan, M., & Corley, E. (2010). Industrial involvement of science and engineering faculty at U.S. research universities: The impacts of gender and university research center affiliation on industrial activities. *Technovation*, 30: 215–222.
Germain-Alamartine, E., Ahoba-Sam, R., Moghadam-Saman, S., & Evers, G. (2021). Doctoral graduates' transition to industry: networks as a mechanism? Cases from Norway, Sweden and the UK. *Studies in Higher Education*, *46*(12), 2680–2695.
Gerpott, T. J., Domsch, M., & Keller, R. T. (1988). Career orientations in different countries and companies: An empirical investigation of West German, British and US industrial R&D professionals. *Journal of Management*, 25(5): 439–462.
Gluckman, P.; Bardsley, A. and Kaiser, M. (2021) Brokerage at the science-policy interface: from conceptual framework to practical guidance. *Humanities and Social Science Communications*, 8(1), 84.
Graddy-Reed, A., Lanahan, L., & D'Agostino, J. (2021). Training across the academy: The impact of R&D funding on graduate students. *Research Policy*, 50(5), 104224
Hair, J., Anderson, R., Tatham, R. and Black, W. (1998). *Multivariate data analysis* (5ª Edition). Prentice Hall. New Jersey.
Hancock, S. (2023). Knowledge or science-based economy? The employment of UK PhD graduates in research roles beyond academia. *Studies in Higher Education*, 48(10), 1523-1537.
Hayter, C. S., & Parker, M. A. (2019). Factors that influence the transition of university postdocs to non-academic scientific careers: An exploratory study. *Research Policy*, 48(3), 556-570.
Hottenrott, H., and C. Lawson. 2017. "Flying the Nest: How the Home Department Shapes Researchers' Career Paths." *Studies in Higher Education* 42 (6): 1091–1109.
Hristo, H.; Slavcheva, M.; Jonkers, K. and Szkuta, K. (2016) Intersectoral mobility and knowledge transfer. Preliminary evidence of the impact of intersectoral mobility policy instruments. JRC Science for Policy Report. European Commission. doi:10.2791/041776
Kyvik, S., & Olsen, T. B. (2012). The relevance of doctoral training in different labour markets. *Journal of Education and Work*, *25*(2), 205-224.

Kwon, D. (2025). How many PhDs does the world need? Doctoral graduates vastly outnumber jobs in academia. *Nature*, 643, 3.
Lam, A. (2018) Boundary-crossing careers and the 'third space of hybridity': Career actors as knowledge brokers between creative arts and academia. *Environment and Planning A*, 50(8), 1716-1741.
Lam, A. (2020). Hybrids, identity and knowledge boundaries: Creative artists between academic and practitioner communities. *Human Relations*, 73(6), 837-863.
Lawson, C., & Lopes-Bento, C. (2024). Miss or match? The impact of PhD training on job market satisfaction. *Research Policy*, 53(3), 104945.
Lee, H.F., Miozzo, M. & Laredo, P. (2010) Career patterns and competences of PhDs in science and engineering in the knowledge economy: The case of graduates from a UK research-based university. *Research Policy*, 39: 869-881.
Marini, G. 2022. "The Employment Destination of PhD-Holders in Italy: Non-Academic Funded Projects as Drivers of Successful Segmentation." *European Journal of Education* 57 (2): 289–305.
Marti, S. and Peneoasu, A.M. (2025) Doctoral education in Europe today: enhanced structures and practices for the European knowledge society. 2025 Survey report I. European University Association, Council for Doctoral Education.
McAlpine, L. (2020). Views on the usefulness of the PhD outside academia: What do we know and need to know? In: Cardoso et al. (eds.), *Structural and institutional transformations in doctoral education: Social, political and student expectations*, 241-274.
McAlpine, L., I. Skakni, and K. Inouye. 2021. PhD Careers beyond the Traditional: Integrating Individual and Structural Factors for a Richer Account. *European Journal of Higher Education* 11 (4): 365–85.
Mills, D., & James, D. (2020). Reconceptualising organisational collaborations in social science doctoral education. *Higher Education*, 79(5), 791-809.
Mullahy, J. (2015). Multivariate fractional regression estimation of econometric share models. *Journal of Econometric Methods*, 4(1), 71-100.
Nelson, R., Buterbaugh, K., Perl, M., & Gelijns, A. (2011). How medical know-how progresses. *Research Policy*, 40(10), 1339–1344.
Nerad, M., & Cerny, J. (2000). From rumors to facts: Career outcomes of English PhDs. *ADE Bulletin*, 43–55.
Official Journal of the European Union – OJEU (2023) Council Recommendation of 18 December 2023 on a European framework to attract and retain research, innovation and entrepreneurial talents in Europe (C/2023/1640).
Pelz, D. C., & Andrews, F. M. (1976). *Scientists in organizations*. Ann Arbor: University of Michigan.
POCARIM (2015) Mapping the Population, Careers, Mobilities and Impacts of Advanced Research Degree Graduates in the Social Sciences and Humanities (POCARIM) Final Report. January 2015. European Policybrief, https://www.researchgate.net/publication/321075974_POCARIM_FINAL_REPORT; Accessed: 6 Feb 2026.
Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: a critical review of the literature and recommended remedies. *Journal of applied psychology*, 88(5), 879-903.
Podsakoff, P. M., MacKenzie, S. B., & Podsakoff, N. P. (2012). Sources of method bias in social science research and recommendations on how to control it. *Annual review of psychology*, 63(1), 539-569.
Roach, M., & Sauermann, H. (2010). A taste for science? PhD scientists' academic orientation and self-selection into research careers in industry. *Research policy*, *39*(3), 422-434.
Sabharwal, M. (2011). Job satisfaction patterns of scientists and engineers by status of birth. *Research Policy*, 40(6), 853-863.
Sarrico, C. S. (2022). The expansion of doctoral education and the changing nature and purpose of the doctorate. *Higher Education*, *84*(6), 1299-1315

Sauermann, H., & Roach, M. (2016). Why pursue the postdoc path?. *Science*, *352*(6286), 663-664.
Siegel, S. (2020) Skill and expertise in perception. In: Ellen Fridland & Carlotta Pavese (eds.), *The Routledge Handbook of Philosophy of Skill and Expertise*. New York, NY: Routledge, 306-313.
Sinche, M., Layton, R. L., Brandt, P. D., O'Connell, A. B., Hall, J. D., Freeman, A. M., ... & Brennwald, P. J. (2017). An evidence-based evaluation of transferable skills and job satisfaction for science PhDs. *PloS one*, *12*(9), e0185023.
Stephan, P. (2015). *How economics shapes science*. Harvard University Press.
Teelken, C., Andreasen, K. E., Galimberti, A., & Rasmussen, A. (2023). An international exploration of post-PhD careers. Discussing the issues of employability and intersectorial mobility. *Studies in Higher Education*, 48(10), 1519-1522.
Teelken, C., and van der Weijden, I. (2018). The Employment Situations and Career Prospects of Postdoctoral Researchers. *Employee Relations* 40 (2), 396–411.
Tzanakou, C. (2012). *Beyond the PhD: The significance of boundaries in the early careers of highly qualified Greek scientists and engineers* (Doctoral dissertation). University of Warwick.
Wang, J., & Shibayama, S. (2022). Mentorship and creativity: Effects of mentor creativity and mentoring style. *Research Policy*, *51*(3), 104451.
Zellner, C. (2003). The economic effects of basic research: evidence for embodied knowledge transfer via scientists' migration. *Research Policy*, *32*(10), 1881–1895.

Table 1. Results of the factor analysis for the importance of skills in PhD holders' current job

	Cognitive skills	Managerial skills	Research and Commercia-lisation skills	Communication skills	Unique-ness
Problem-Solving	**0.7772**	0.0182	0.2708	-0.0024	0.3223
Flexibility	**0.7109**	0.2169	0.0198	0.164	0.4203
Personal Effectiveness	**0.6965**	0.2708	0.0626	0.1518	0.4145
Resilience	**0.6615**	0.1994	0.0601	0.1916	0.4823
Critical-Analytical Thinking	**0.6453**	-0.011	0.4666	-0.0037	0.3657
Creativity	**0.5724**	0.1839	0.3476	0.1585	0.4926
Team Working	**0.4913**	0.3536	-0.0095	0.1623	0.6072
Effective Communication	**0.4823**	0.2944	0.0134	0.4006	0.52
Project Management	**0.4642**	0.4624	0.1326	0.0766	0.5473
Entrepreneurship	0.0346	**0.7461**	0.1032	0.0521	0.4287
Negotiation	0.2952	**0.6899**	-0.0292	0.0968	0.4267
Self-Branding	0.2316	**0.6796**	0.172	0.1548	0.4309
Networking	0.3192	**0.6489**	0.1429	0.2082	0.4133
Career Management	0.2958	**0.5355**	0.276	0.1296	0.5328
Data Stewardship	0.1515	**0.4793**	0.4185	0.1705	0.5432
Methodology	0.2548	-0.0098	**0.7949**	0.0126	0.303
Research Ethics and Integrity	0.0446	0.1461	**0.7291**	0.2393	0.3879
Subject Knowledge	0.2426	0.0037	**0.7157**	0.0861	0.4214
Research Valorisation, Engagement and Innovation	0.0075	0.4247	**0.6375**	0.0915	0.4048
Intellectual Property	-0.0843	0.422	**0.5539**	0.1171	0.4943
Teaching/Mentoring/Supervision	0.1475	0.166	**0.4229**	0.2919	0.6866
Intercultural Skills	0.1677	0.2895	0.1508	**0.7668**	0.2773
Languages	0.1884	-0.002	0.2438	**0.7474**	0.3465
Digital Communication	0.17	0.4192	0.1797	**0.4801**	0.5326
Eigenvalue	4.06717	3.71896	3.43245	1.97892	
Cronbach alpha	0.8583	0.8176	0.8044	0.6822	

Note: results in bold indicate the factor where each item is computed.

Table 2. Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max	Freq.	Percent
Cognitive skills	3.51	0.80	1	5		
Managerial skills	4.30	0.55	1	5		
Research and commercialisation skills	3.54	0.88	1	5		
Communication skills	3.76	0.85	1	5		
Current employment						
Academic					576	40.22%
Non-academic					856	59.78%
Business sector					558	38.97%
Other sectors					298	20.81%
Career path						
Only academic					454	31.73%
Only non-academic					692	48.36%
Mixed					135	9.43%
Hybrid					150	10.48%
Cognitive skills at PhD	4.25	0.52	1.67	5		
Managerial skills at PhD	3.68	0.61	1.22	5		
Research and commerc. skills at PhD	3.23	0.77	1	5		
Communication skills at PhD	3.98	0.61	1	5		
MotPhD						
Work in academia					546	38.13%
Work outside academia					169	11.80%
Work in and out academia					178	12.43%
Other					539	37.64%
Funding	0.88	0.32	0	1		
Training & mentoring	3.96	0.96	1	5		
University support	3.45	0.97	1	5		
Co-supervision	0.09	0.28	0	1		
Gender: male	0.58	0.49	0	1		
Children	0.39	0.49	0	1		
Age PhD started	28.64	5.84	22	58		
Years since completion	2.85	1.35	1	5		
Involved in Research	0.66	0.47	0	1		
SecMob_lack of opportunities	0.09	0.28	0	1		
Match job-PhD	0.76	0.43	0	1		
Match job-citizenship	0.62	0.48	0	1		
Field						
SSH					307	21.44%
NMA					747	52.16%
Eng.					378	26.40%

Note: All skills variables are computed using averages of the factor included in each group. Obs: 1,432

Table 3. Self-perception of skills needed at the current job by PhD holders' characteristics (N=1,432)

	Cognitive skills	Managerial skills	Research and Commercialisation skills	Communication skills
Current employment				
Academic	3.54	4.33	3.93	3.93
Non-academic	3.48	4.28	3.29	3.65
P-value	*0.211*	*0.126*	*0.000*	*0.000*
Career path				
Only academic	3.51	4.33	3.92	3.92
Only non-academic	3.47	4.26	3.25	3.64
Mixed	3.55	4.33	3.60	3.77
Hybrid	3.62	4.32	3.71	3.85
P-value	*0.181*	*0.189*	*0.000*	*0.000*
Gender				
Female	3.59	4.34	3.59	3.84
Male	3.44	4.26	3.51	3.71
P-value	*0.000*	*0.000*	*0.092*	*0.003*
Involved in Research				
No	3.36	4.22	2.94	3.57
Yes	3.58	4.34	3.86	3.86
P-value	*0.000*	*0.000*	*0.000*	*0.003*
Field				
SSH	3.59	4.32	3.57	3.95
Natural, medical, agriculture (NMA)	3.44	4.29	3.56	3.69
Engineering	3.56	4.30	3.50	3.76
P-value	*0.006*	*0.702*	*0.500*	*0.000*

Note: Skills variables measured as means from 1-5 Likert scales as result of the factor analysis. P-value based on t-test for current employment and gender and ANOVA for career path and field.

Table 4. Regression analysis: relationship between current employment and skills at work

	M1				M2			
	Cognitive skills	Managerial skills	Research and Comm. skills	Comunni-cation skills	Cognitive skills	Managerial skills	Research and Comm. skills	Comunni-cation skills
Current employment (ref: academic)								
Non-academic	0.09	**0.316*** **	**-0.443*** **	**-0.196*** **				
	[0.06]	**[0.06]**	**[0.05]**	**[0.06]**				
Private sector					**0.254*** **	**0.400*** **	**-0.408*** **	**-0.152** **
					[0.07]	**[0.07]**	**[0.06]**	**[0.07]**
Other sectors					**-0.127***	**0.204*** **	**-0.491*** **	**-0.255*** **
					[0.08]	**[0.07]**	**[0.06]**	**[0.08]**
Motivation PhD:								
Work outside academia	-0.089	-0.015	0.104	0.03	-0.129	-0.036	0.096	0.019
	[0.09]	[0.09]	[0.07]	[0.09]	[0.09]	[0.09]	[0.07]	[0.09]
Work in and out academia	-0.043	-0.058	0.062	0.088	-0.039	-0.055	0.062	0.09
	[0.08]	[0.08]	[0.07]	[0.08]	[0.08]	[0.08]	[0.07]	[0.08]
Other	0.02	-0.081	-0.048	0.017	0.003	-0.089	-0.05	0.013
	[0.06]	[0.06]	[0.05]	[0.06]	[0.06]	[0.06]	[0.05]	[0.06]
Funding	-0.036	0.027	0.024	0.064	-0.101	-0.008	0.009	0.046
	[0.08]	[0.08]	[0.07]	[0.08]	[0.08]	[0.08]	[0.07]	[0.08]
Training & mentoring	**0.062***	0.042	**0.048***	-0.031	0.058*	0.038	**0.047***	-0.033
	[0.03]	[0.03]	**[0.03]**	[0.03]	[0.03]	[0.03]	**[0.03]**	[0.03]
University support	-0.01	0.041	0.025	0.023	-0.011	0.041	0.024	0.024
	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]
Co-supervision	-0.007	0.162*	0.004	0.095	-0.048	0.14	-0.007	0.083
	[0.09]	[0.09]	[0.08]	[0.09]	[0.09]	[0.09]	[0.08]	[0.09]
Gender: male	**-0.14*** **	**-0.131** **	-0.001	**-0.209*** **	**-0.18*** **	**-0.149*** **	-0.01	**-0.219*** **
	[0.05]	**[0.05]**	[0.04]	**[0.05]**	**[0.05]**	**[0.05]**	[0.04]	**[0.05]**
Children	-0.103*	-0.016	-0.037	-0.055	-0.097*	-0.013	-0.036	-0.053
	[0.05]	[0.05]	[0.05]	[0.05]	[0.05]	[0.05]	[0.05]	[0.05]
Age PhD started	**-0.01*** **	**0.016*** **	0.002	**0.014*** **	**-0.010** **	**0.017*** **	0.002	**0.015*** **
	[0.00]	[0.00]	[0.00]	**[0.00]**	**[0.00]**	**[0.00]**	[0.00]	**[0.00]**
Years since completion	**0.066*** **	-0.005	0.025	**0.035***	**0.066*** **	-0.005	0.026	**0.035***
	[0.02]	[0.02]	[0.02]	**[0.02]**	**[0.02]**	[0.02]	[0.02]	**[0.02]**
Involved in Research	0.005	0.096	**0.803*** **	-0.018	0.032	0.109*	**0.808*** **	-0.011
	[0.06]	[0.06]	**[0.05]**	[0.06]	[0.06]	[0.06]	**[0.05]**	[0.06]
SecMob_lack of opportunities	-0.141	-0.065	-0.107	0.092	-0.144	-0.067	-0.108	0.09
	[0.09]	[0.09]	[0.07]	[0.09]	[0.09]	[0.09]	[0.07]	[0.09]
Match job-PhD	-0.114	**0.175** **	**-0.134** **	-0.024	**-0.131***	**0.167** **	**-0.138** **	-0.028
	[0.07]	**[0.07]**	**[0.06]**	[0.07]	**[0.07]**	**[0.07]**	**[0.06]**	[0.07]
Match job-citizenship	0.118*	-0.077	0.008	**-0.209*** **	**0.135** **	-0.068	0.012	**-0.205*** **
	[0.07]	[0.06]	[0.05]	**[0.07]**	**[0.06]**	[0.06]	[0.05]	**[0.07]**
Personal skills at PhD	**0.312*** **				**0.299*** **			
	[0.03]				**[0.03]**			
Managerial skills at PhD		**0.313*** **				**0.317*** **		
		[0.03]				**[0.03]**		
Research and engag. skills at PhD			**0.197*** **				**0.201*** **	
			[0.02]				**[0.02]**	
Communication skills at PhD				**0.243*** **				**0.240*** **
				[0.03]				**[0.03]**
Field	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.085	**-0.915*** **	**-0.632*** **	0.054	0.104	**-0.898*** **	**-0.618*** **	0.061
	[0.23]	**[0.23]**	**[0.20]**	[0.23]	[0.23]	**[0.23]**	**[0.20]**	[0.23]
R-squared	0.1326	0.162	0.3799	0.1204	0.148	0.1657	0.3808	0.1218
RMSE	0.936373	0.916544	0.77567	0.937027	0.928	0.914	0.778	0.935
chi2	219.16	284.01	882.55	195.72	249.71	293.6	886.66	198.17
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Observations	1,432	1,432	1,432	1,432	1,432	1,432	1,432	1,432

Note: Significant results are in bold. Robust standard errors in parantheses. * p-value<0.1; ** p-value<0.05; *** p-value<0.01

Table 5. Regression analysis: relationship between career paths and skills at work

	Cognitive skills	Managerial skills	Research and Engag. skills	Comunnication skills
Career path (ref: only academic):				
Only non-academic	0.056	**0.315*** **	**-0.447*** **	**-0.151** **
	[0.07]	**[0.07]**	**[0.06]**	**[0.07]**
Mixed	0.009	**0.239** **	**-0.176** **	**-0.170* **
	[0.10]	**[0.10]**	**[0.08]**	**[0.10]**
Hybrid	0.071	**0.229** **	**-0.203*** **	-0.097
	[0.09]	**[0.09]**	**[0.08]**	[0.09]
Motivation PhD:				
Work outside academia	-0.074	0.008	0.081	-0.001
	[0.09]	[0.08]	[0.07]	[0.09]
Work in and out academia	-0.037	-0.054	0.053	0.071
	[0.08]	[0.08]	[0.07]	[0.08]
Other	0.029	-0.069	-0.057	0.001
	[0.06]	[0.06]	[0.05]	[0.06]
Funding	-0.043	0.011	0.039	0.079
	[0.08]	[0.08]	[0.07]	[0.08]
Training & mentoring	0.063*	0.047	0.044*	-0.03
	[0.03]	[0.03]	[0.03]	[0.03]
University support	-0.013	0.036	0.032	0.028
	[0.03]	[0.03]	[0.03]	[0.03]
Co-supervision	-0.008	0.151*	0.025	0.096
	[0.09]	[0.09]	[0.08]	[0.09]
Gender: male	**-0.139*** **	**-0.125** **	-0.01	**-0.213*** **
	[0.05]	**[0.05]**	[0.04]	**[0.05]**
Children	**-0.101* **	-0.012	-0.046	-0.056
	[0.05]	[0.05]	[0.05]	[0.05]
Age PhD started	**-0.014*** **	**0.015*** **	0.003	**0.014*** **
	[0.00]	**[0.00]**	[0.00]	**[0.00]**
Years since completion	0.067***	-0.005	0.021	0.036*
	[0.02]	[0.02]	[0.02]	[0.02]
Involved in Research	-0.015	0.068	**0.835*** **	0.013
	[0.06]	[0.06]	**[0.05]**	[0.06]
SecMob_lack of opportunities	-0.142	-0.076	**-0.153* **	0.106
	[0.09]	[0.09]	**[0.08]**	[0.09]
Match job-PhD	-0.11	**0.177** **	**-0.136** **	-0.03
	[0.07]	**[0.07]**	**[0.06]**	[0.07]
Match job-citizenship	**0.121* **	-0.08	0.007	**-0.210*** **
	[0.07]	[0.06]	[0.05]	**[0.07]**
Personal skills at PhD	**0.315*** **			
	[0.03]			
Managerial skills at PhD		**0.308*** **		
		[0.03]		
Research and engag. skills at PhD			**0.196*** **	
			[0.02]	
Communication skills at PhD				**0.241*** **
				[0.03]
Field	Yes	Yes	Yes	Yes
Constant	0.117	**-0.892*** **	**-0.663*** **	0.000
	[0.23]	**[0.23]**	**[0.20]**	[0.23]
R-squared	0.13	0.16	0.38	0.12
RMSE	0.937	0.918	0.778	0.938
chi2	218.42	277.7	867.69	189.62
p-value	0.000	0.000	0.000	0.000
Observations	1,431	1,431	1,431	1,431

Note: Significant results are in bold. Robust standard errors in parantheses. * p-value<0.1; ** p-value<0.05; *** p-value<0.01

Annex I. Tests for non-response bias

	Before reminder	After 1st reminder	After 2nd reminder	Tests
Academic	221 (40.9%)	181 (40.0%)	167 (38.8%)	Pearson chi2(4) = 4.5393 P-value = 0.338
Private Sector	195 (36.1%)	180 (39.7%)	182 (42.2%)	
Other	124 (23.0%)	92 (20.3%)	82 (19.0%)	
Only academic	171 (31.7%)	146 (32.2%)	132 (30.7%)	Pearson chi2(6) = 2.3482 P-value = 0.885
Only non-academic	270 (50.0%)	215 (47.5%)	206 (47.9%)	
Mixed	48 (8.9%)	46 (10.1%)	51 (11.9%)	
Hybrid	51 (9.4%)	46 (10.1%)	51 (11.9%)	
Cognitive skills	3.47	3.52	3.54	ANOVA = 0.47 P-value = 0.625
Managerial skills	4.30	4.29	4.31	ANOVA = 0.95 P-value = 0.389
Research and commercialisation skills	3.55	3.57	3.51	ANOVA = 0.35 P-value = 0.706
Communication skills	3.79	3.76	3.74	ANOVA = 0.44 P-value = 0.439

Note: Values of the four skills factors are computed based on the average of the relevant items to facilitate interpretation.

Annex II. Factor analysis for the self-perception of skills acquired at the completion of the PhD program

	Mana-gerial skills	Cognitive skills	Research and Commer-cialisation skills	Commu-nication skills	Unique-ness
Career Management	**0.6963**	0.0969	0.2334	0.1077	0.4397
Project Management	**0.6814**	0.2167	0.0822	0.1363	0.4634
Personal Effectiveness	**0.6198**	0.411	0.0037	0.0077	0.4468
Networking	**0.5962**	0.0659	0.2968	0.2535	0.4878
Entrepreneurship	**0.5793**	-0.0787	0.4704	-0.0362	0.4356
Negotiation	**0.54**	0.0492	0.3169	0.3194	0.5035
Self-Branding	**0.5211**	0.0506	0.3657	0.2642	0.5223
Data Stewardship	**0.515**	0.0871	0.3961	0.0763	0.5645
Resilience	**0.4547**	0.4484	-0.0395	0.0965	0.5814
Team working	**0.4444**	0.1564	0.0743	0.3232	0.6681
Problem-Solving	0.1658	**0.7794**	0.08	0.1221	0.3438
Critical-Analytical Thinking	0.0775	**0.7493**	0.1203	0.1557	0.3938
Methodology	0.0295	**0.6637**	0.2088	0.1404	0.4953
Subject Knowledge	0.0081	**0.6515**	0.2027	0.2372	0.4782
Creativity	0.242	**0.5935**	0.2329	0.0576	0.5316
Flexibility	0.4498	**0.5344**	-0.0153	0.1007	0.5017
Research Valorisation, Engagement and Innovation	0.2471	0.1817	**0.7244**	0.0007	0.3812
Intellectual Property	0.2126	0.0685	**0.7235**	-0.059	0.4232
Teaching/Mentoring/Supervision	0.1101	0.3118	**0.5513**	0.2313	0.5333
Research Ethics and Integrity	0.0752	0.2926	**0.5374**	0.1834	0.5863
Languages	0.0274	0.2378	-0.0827	**0.7679**	0.3462
Intercultural Skills	0.2057	0.1018	0.0671	**0.7048**	0.446
Effective Communication	0.3111	0.2854	0.1839	**0.5557**	0.4791
Digital Communication	0.2437	0.142	0.3437	**0.4361**	0.6122
Eigenvalue	3.87571	3.53465	2.73293	2.19186	
Cronbach alpha	0.8507	0.8158	0.7096	0.6825	

Note: results in bold indicate the factor where each item is computed.

Annex III. Results of the factor analysis for satisfaction with the PhD program

	Training & Mentoring	University Support	Uniquenes s
Quality of research training	**0.7055**	0.2747	0.4269
Quality of transferable skills training	**0.5921**	0.3338	0.5380
Supervision provided by the supervisor(s)	**0.5575**	0.3148	0.5901
Support to pursue an academic career	0.3323	**0.5959**	0.5344
Support to pursue a non-academic career	0.2253	**0.5939**	0.5965
Services for doctoral candidates at your university	0.3811	**0.4777**	0.6266
Eigenvalue	1.4654	1.2221	
Cronbach alpha	0.7548	0.7048	

Note: results in bold indicate the factor where each item is computed.

Annex IV. Correlation matrix

Variables	VIF	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Current emp._Academic		1										
(2) Current emp._Private sector	0.17	-0.655***	1									
(3) Current emp._Other	0.24	-0.421***	-0.410***	1								
(4) Career path_Only academic		0.831***	-0.545***	-0.349***	1							
(5) Career path_Only non-academic	0.15	-0.794***	0.562***	0.284***	-0.660***	1						
(6) Career path_Mixed	0.54	0.018	0.031	-0.059**	-0.220***	-0.312***	1					
(7) Career path_Hybrid	0.51	0.017	-0.119***	0.123***	-0.233***	-0.331***	-0.110***	1				
(8) Cognitive skills		-0.036	0.137***	-0.121***	-0.01	0.012	0.007	-0.011	1			
(9) Cognitive skills		-0.115***	0.102***	0.017	-0.134***	0.086***	0.02	0.043*	0	1		
(10) Research and commer. Skills		0.430***	-0.296***	-0.164***	0.362***	-0.375***	0.013	0.049*	-0.003	0	1	
(11) Communication skills		0.140***	-0.080***	-0.073***	0.111***	-0.117***	-0.013	0.034	0.01	-0.006	0.012	1
(12) Cognitive skills at PhD	0.92	0.019	0.076***	-0.114***	0.042	-0.057**	0.03	0.001	0.320***	-0.042	0.153***	0.03
(13) Managerial skills at PhD	0.91	0.028	-0.061**	0.039	-0.025	-0.046*	0.041	0.073***	0.151***	0.336***	0.052**	0.059**
(14) Res. and comm. skills at PhD	0.78	0.047*	-0.107***	0.072***	0.011	-0.044*	-0.038	0.092***	-0.165***	0.247***	0.248***	0.047*
(15) Communication skills at PhD	0.95	0.046*	0.041	-0.104***	0.082***	-0.076***	0.003	-0.003	0.094***	-0.066**	0.009	0.244***
(16) Mot_PhD_Work in aca.		0.294***	-0.223***	-0.087***	0.237***	-0.282***	0.061**	0.041	0.013	-0.02	0.116***	0.025
(17) Mot_PhD_Work out aca.	0.76	-0.185***	0.196***	-0.012	-0.142***	0.170***	-0.044*	-0.019	-0.016	0.037	-0.004	-0.031
(18) Mot_PhD_Work in&out aca.	0.83	0.036	-0.049*	0.015	0.036	-0.041	0.002	0.01	-0.011	-0.028	0.073***	0.032
(19) Mot_PhD_Other	0.72	-0.196***	0.127***	0.085***	-0.167***	0.197***	-0.034	-0.035	0.006	0.015	-0.163***	-0.027
(20) Funding	0.89	0.100***	0.104***	-0.246***	0.076***	-0.077***	0.029	-0.017	0.017	-0.037	0.009	0.033
(21) Training & mentoring	0.63	0.101***	-0.045*	-0.067**	0.089***	-0.102***	0.043*	-0.011	0.105***	0.093***	0.175***	0.016
(22) University support	0.60	0.089***	-0.004	-0.103***	0.065**	-0.058**	0.01	-0.013	0.037	0.091***	0.156***	0.021
(23) Co-supervision	0.92	-0.113***	0.187***	-0.089***	-0.117***	0.145***	-0.039	-0.023	0.013	0.068**	-0.025	-0.003
(24) Gender	0.88	-0.073***	0.189***	-0.139***	-0.058**	0.058**	0.000	-0.007	-0.048*	-0.073***	0.011	-0.108***
(25) Children	0.85	-0.028	-0.036	0.077***	-0.057**	-0.018	0.029	0.089***	-0.082***	0.057**	0.024	-0.002
(26) Age PhD started	0.74	0.071***	-0.225***	0.185***	0.011	-0.089***	-0.011	0.138***	-0.105***	0.127***	0.102***	0.078***
(27) Years since completion	0.92	-0.058**	0.018	0.049*	-0.092***	-0.018	0.132***	0.043*	0.094***	-0.004	-0.002	0.045*
(28) Involved in research	0.72	0.473***	-0.365***	-0.132***	0.395***	-0.407***	0.000	0.063**	-0.016	-0.012	0.532***	0.061**
(29) SecMob_lack of opportunities	0.85	-0.013	-0.021	0.041	-0.116***	-0.163***	0.220***	0.232***	-0.032	-0.011	-0.043*	0.041
(30) Match job-PhD	0.60	-0.220***	0.171***	0.060**	-0.204***	0.203***	0.001	-0.023	-0.01	0.065**	-0.192***	-0.096***
(31) Match job-citizenship	0.60	-0.205***	0.114***	0.111***	-0.200***	0.182***	0.024	-0.016	0.037	0.019	-0.162***	-0.132***
(32) Field_SSH		0.109***	-0.219***	0.130***	0.036	-0.126***	0.012	0.139***	-0.03	0.055**	0.000	0.135***
(33) Field_NMA	0.54	0.033	-0.089***	0.067**	0.087***	-0.034	-0.007	-0.070***	0.032	-0.124***	0.058**	-0.069***
(34) Field_Eng	0.48	-0.139***	0.304***	-0.198***	-0.133***	0.156***	-0.004	-0.050*	-0.009	0.088***	-0.066**	-0.047*

Correlation matrix (continued)

Variables	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)
(12) Cognitive skills at PhD	1											
(13) Managerial skills at PhD	0.033	1										
(14) Res. and comm. skills at PhD	-0.028	-0.001	1									
(15) Communication skills at PhD	0.001	-0.025	0.025	1								
(16) Mot_PhD_Work in aca.	0.062**	-0.025	0.048*	-0.007	1							
(17) Mot_PhD_Work out aca.	0.022	-0.008	-0.023	0.002	-0.287***	1						
(18) Mot_PhD_Work in&out aca.	0.005	-0.02	0.049*	0.033	-0.296***	-0.138***	1					
(19) Mot_PhD_Other	-0.080***	0.044*	-0.067**	-0.017	-0.610***	-0.284***	-0.293***	1				
(20) Funding	0.063**	-0.069***	-0.063**	0.071***	0.045*	-0.008	0.019	-0.053**	1			
(21) Training & mentoring	0.189***	0.152***	0.233***	0.062**	0.037	-0.025	0.069***	-0.068***	-0.024	1		
(22) University support	0.085***	0.130***	0.328***	0.092***	0.037	-0.008	0.001	-0.033	0.034	0.553***	1	
(23) Co-supervision	0.03	0.013	0.056**	0.022	-0.116***	0.113***	-0.009	0.047*	0.01	0.003	0.051*	1
(24) Gender	0.043*	-0.123***	0.111***	0.016	0.012	0.029	0.04	-0.058**	0.048*	0.039	0.121***	0.069***
(25) Children	-0.063**	0.076***	0.089***	-0.044*	-0.011	0.056**	-0.082***	0.03	-0.066**	0.000	0.052*	0.031
(26) Age PhD started	-0.073***	0.157***	0.223***	-0.089***	0.003	-0.039	-0.027	0.041	-0.220***	0.053**	0.009	-0.087***
(27) Years since completion	0.048*	-0.019	-0.059**	0.003	0.031	-0.011	-0.045*	0.007	-0.003	0.069***	-0.012	0.006
(28) Involved in research	0.043*	0.037	0.090***	0.011	0.103***	0.012	0.061**	-0.153***	-0.015	0.092***	0.042	-0.029
(29) SecMob_lack of opportunities	0.031	0.002	0.009	-0.02	0.051*	-0.03	0.032	-0.053**	-0.017	-0.003	-0.096***	-0.051*
(30) Match job-PhD	-0.024	-0.037	-0.007	-0.026	-0.078***	0.022	-0.063**	0.106***	0.000	-0.067**	-0.047*	0.077***
(31) Match job-citizenship	0.000	-0.025	-0.039	-0.038	-0.072***	0.017	-0.065**	0.105***	-0.028	-0.068***	-0.015	0.057**
(32) Field_SSH	-0.01	0.044*	0.116***	0.01	0.084***	-0.117***	-0.021	0.009	-0.01	-0.003	-0.055**	-0.098***
(33) Field_NMA	0.001	-0.047*	-0.154***	0.019	-0.051*	0.004	0.073***	0.000	-0.093***	0.054**	-0.039	-0.078***
(34) Field_Eng	0.008	0.012	0.066**	-0.031	-0.02	0.105***	-0.062**	-0.007	0.115***	-0.059**	0.095***	0.180***

THE MANCHESTER INSTITUTE OF INNOVATION RESEARCH IS A CENTRE OF EXCELLENCE IN THE FIELD OF INNOVATION STUDIES.

MANCHESTER INSTITUTE OF INNOVATION RESEARCH

Alliance Manchester Business School
The University of Manchester
Booth Street West
Manchester M15 9PB

http://www.mioir.manchester.ac.uk