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Does intersectoral collaboration during the PhD play a role for careers after the PhD?

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INTRODUCTION

Many PhD holders build either an academic career or a non-academic career (ECOOM-brief 25). Only a minority combines the two career paths. The academic career path has a clear trajectory: most PhD holders are first postdoctoral researchers before being employed as professors (ECOOM-brief 39). PhD holders who move into the non-academic labor market are primarily employed in the private sector with research and development (R&D) activities, in government, and in the private sector without R&D activities (ECOOM-brief 42). But what factors determine where PhD holders go to work? What could possibly influence PhD holders' career paths? Previous studies show that several factors can influence postdoctoral careers. For example, individual factors (e.g., PhD candidates' interest to work in non-academic sectors after obtaining one's PhD degree - ECOOM Brief 36; Roach & Sauermann, 2017) play a role, but also factors related to PhD candidates' supervisors (e.g., whether they provide career support; Hayter & Parker, 2019; ECOOM Brief 46) and the organizational and policy environment (e.g., the establishment of Doctoral Schools at Flemish universities). In this ECOOM brief, we examine whether the employment sector of PhD holders (inside vs. outside the university) is related to whether they collaborate during the doctoral program. Collaboration can potentially pave the way to a future job in a particular sector or with a particular employer (Borrel-Damian et al., 2010; Müller & Kaltenbrunner, 2019). We consider the following research questions:

1. *What are the sectors of collaboration during the PhD track?*
2. *Are there differences in collaboration according to science cluster?*
3. *Is there a relationship between intersectoral collaboration during the PhD track and intersectoral mobility after obtaining the PhD?*
4. *Does the relationship between intersectoral collaboration and intersectoral mobility differ according to science cluster?*
5. *Does the relationship between intersectoral collaboration and intersectoral mobility differ according to sector?*

ANSWERS BASED ON THE PHD CAREER SURVEY

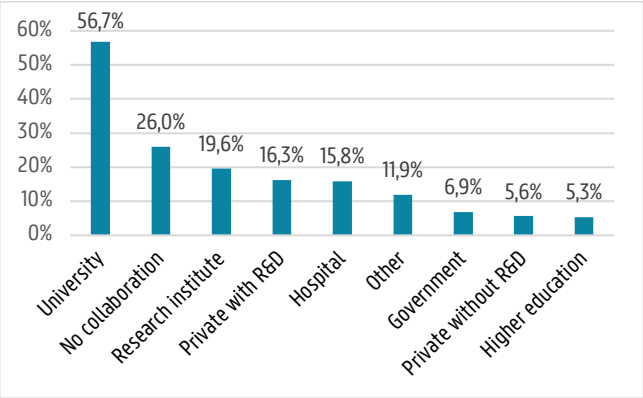
We answer the above questions based on the PhD Career Survey conducted by ECOOM-UGent in 2017. For a detailed discussion we refer to ECOOM-brief 25. For a visual overview we refer to the website https://www.phdcareersflanders.com/en/. In short: the PhD Career Survey maps the career paths of PhD holders who obtained their PhD at one of the Flemish universities. In what follows we analyze the answers of PhD holders for whom the first job after obtaining the PhD is a non-academic job (N = 1535). We asked these PhD holders the following question, "What sector(s) did you collaborate with during your doctorate?" Building on ECOOM-brief 42, we distinguished eight sectors PhD holders may have collaborated with during their PhD: (1) university, (2) hospital; (3) research institute; (4) higher education excluding university; (5) government; (6) private sector with research and development (R&D) activities; (7) private sector without R&D activities; (8) other (including freelance, non-profit organization and research institutes). PhD holders could indicate multiple sectors as answers.

WHAT ARE THE SECTORS OF COLLABORATION DURING THE PHD TRACK?

Figure 1 shows the percentages of PhD holders who collaborated with people or companies within a specific sector during their PhD track. Just over a quarter of PhD holders did not collaborate during their PhD trajectory (26.0%). More than half of the PhD holders collaborated with the university during their PhD program (56.7%). The top three sectors to collaborate with are closed by research institutes (19.6%). This is followed by the private sector with R&D activities (16.3%), hospital (15.8%), other sectors (11.9%), government (6.9%), private sector without R&D activities (5.6%) and higher education (5.3%). Looking at the number of sectors with which PhD holders collaborated during their PhD track, one in three collaborated with one sector (34.2%) and about one in four collaborated with two sectors (24.3%). 9.8%

collaborated with three sectors and 5.8% collaborated with four sectors or more.

Figure 1: Percentage of PhD holders who collaborated with a particular sector during their PhD track (N = 2985).



ARE THERE DIFFERENCES IN COLLABORATION ACCORDING TO SCIENCE CLUSTER?

Based on Figure 2, we see differences according to science cluster. For the **applied sciences**, a high proportion collaborated with the university (62.1%) and the private sector with R&D activities (34.1%). Collaboration with a research institute completes the top 3 (28.6%). In the **exact sciences**, approximately one in five did not collaborate during the PhD (21.5%). The majority of PhD holders collaborated with the university (64.6%). Moreover, nearly one in three PhD holders in the exact sciences collaborated with a research institute (30.0%). In the **social sciences**, the largest proportion of PhD holders collaborated with the university (46.6%). Just over 1 in 3 did not collaborate during the PhD track (35.5%). The top 3 is completed by collaborations with other sectors (18.0%). In **humanities**, nearly half did not collaborate during their PhD track (49.1%). Of those who collaborated, the majority primarily did so with the university (43.1%). The top three is closed by collaborations with other sectors (13.4%). Finally, in the **(bio-)medical sciences**, the majority has collaborated with the university (60.3%) and the hospital (47.3%) during their PhD track. Almost one in five collaborated with a research institute (19.0%).

IS THERE A RELATIONSHIP BETWEEN INTERSECTORAL COLLABORATION DURING THE PHD TRACK AND INTERSECTORAL MOBILITY AFTER OBTAINING THE PHD?

We explore this question by categorizing future employment into two groups: (1) employment at a university and (2) employment outside the university (=intersectoral mobility). Collaboration is also categorized into two categories: (1) no collaboration or only collaboration with the university and (2) collaboration with a sector other than the university (=intersectoral collaboration). Looking at Table 1, we initially examine the PhD holders who stayed at the university. Within this group, 54.8% had no intersectoral collaboration, while 45.2% of these PhD holders engaged in intersectoral collaboration. Subsequently, we investigate the group of PhD holders who transitioned from the university to the labor market outside academia. Among these, 42.0% had no collaboration or solely collaborated with a university, whereas 58.0% engaged in intersectoral collaboration. A chi-square test indicates that these differences are significant (X^2=48.50, p<0.001; Cramer's V=.13).

Table 1. Share of PhD holders employed at the university vs. outside the university according to the type of collaboration undertaken during the PhD. ($N_{university}$=1441, $N_{outside\ of\ university}$=1536)

	Employed in a first job after the PhD – university	Employed in a first job after the PhD – outside of university
No collaboration or only collaboration with the university.	54.8%*	42.0%*.
Intersectoral collaboration.	45.2%*	58.0%*

(*) significance based on Chi²-test, n*=p<0.05

DOES THE RELATIONSHIP BETWEEN INTERSECTORAL COLLABORATION AND INTERSECTORAL MOBILITY DIFFER ACCORDING TO SCIENCE CLUSTER?

To address this question, we refer to Table 2, which displays the percentages for both collaboration categories (no collaboration or solely with a university vs. intersectoral collaboration) based on science clusters and employment type (at a university vs. outside the university). Post-hoc tests with a stricter significance level of p<.01 show an association between employment type and collaboration during the PhD track for PhD holders in the humanities (X^2=12.80, p<0.001; Cramer's V=.17, N=431) and applied sciences (X^2=11.89, p<0.001; Cramer's V=.13, N=758). We compare two groups within both science clusters: PhD holders who remain at the university and those who leave university. Initially, focusing on those who did not partake in intersectoral collaboration during the PhD track, we notice a higher proportion among those who stay at the university after the doctorate (85.3% humanities; 43.1% applied sciences) compared to those who leave the university (28.5% humanities; 30.9% applied sciences). Subsequently, focusing on those who engaged in intersectoral collaboration during the PhD track, we observe a higher proportion of PhD holders who have departed from the university and worked intersectorally (28.9% humanities; 69.1% applied sciences) compared to those who remained at the university (14.7% humanities; 56.9% applied sciences).

DOES THE RELATIONSHIP BETWEEN INTERSECTORAL COLLABORATION AND INTERSECTORAL MOBILITY DIFFER ACCORDING TO A SPECIFIC SECTOR?

Table 3 demonstrates the association between the initial employment sector after obtaining the PhD and the sector(s) with which collaboration occurred during the PhD. In comparison to PhD holders who left university, those who remained at the university exhibited

less involvement in collaborations with a hospital, research institute, and the private sector engaged in R&D activities. Additionally, we observe that among PhD holders who did not engage in collaborations during their PhD, a higher proportion chose to remain at the university compared to those who left. No significant differences were observed concerning collaborations with the university, higher education, government, private sectors without R&D activities, and other sectors.

Table 3. Proportion of PhD holders employed in a specific sector according to collaboration during the PhD ($N_{university}$=1441, $N_{outside\ of\ university}$=1536).

Collaborated during the PhD with…	Employed in a first job after the PhD – university	Employed in a first job after the PhD – outside of university
No collaboration	28.9%*	23.4%*
University	58.4%	55.1%
Hospital	14.4%*	17.2%*
Research institute	15.2%*	23.7%*
Higher education	5.5%	4.9%
Government	6.0%	7.7%
Private with R&D	13.1%*	19.4%*
Private without R&D	5.8%	5.5%
Other sectors	11.7%	12.1%

(*) significance based on Chi²-test, n*=p<0.05

SUMMARY AND CONCLUSION

What sectors do PhD candidates collaborate with during their PhD track? Do these collaborations possibly influence their later career paths? And are there differences depending on the science cluster in which the PhD was obtained? This ECOOM-brief focuses on the link between intersectoral mobility and intersectoral collaboration during the PhD. Looking at the sectors PhD holders collaborated with during their PhD track, more than half collaborated with a university. This sector was the most popular for collaboration during the PhD track across all science clusters except humanities. Collaborating with the university is unsurprisingly popular due to various supportive programs, such as shared research projects, research groups, co-supervisors from other institutions, joint PhDs, etc. Additionally, supervisors often leverage their academic networks to establish joint research projects, and attending conferences aids in building academic networks that foster collaborations. Initiatives promoting intersectoral collaborations, such as VLAIO Baekeland mandates, TETRA projects, the Industrial Research Fund (IOF), and the Mobility Fund, encourage intersectoral mobility among PhD candidates and postdocs.

Approximately one in four PhD holders did not collaborate during their PhD track, missing opportunities to develop skills relevant to both academic and non-academic careers (e.g., teamwork, communication, and leadership). Non-academic employers tend to perceive PhD holders with collaborative experience as better prepared for the non-academic job market (Borrell-Damian et al., 2010). These skills are increasingly valued in academia, emphasizing collaboration, leadership, and coaching within research (Coalition for Advancing Research Assessment, 2022).

The proportion of PhD holders who did not collaborate is notably higher in the humanities and social sciences. It is possible that researchers in these fields have fewer opportunities for collaboration compared to other science clusters. For instance, PhD candidates in the applied sciences may collaborate with private companies due to their expertise aligning with these companies' needs. Conversely, humanities and social sciences candidates might have less apparent connections between their expertise and industry needs, leading to fewer collaborations (Santos, Veloso, & Urze., 2020; also see Figure 2).

The higher proportion of humanities and social sciences PhD holders who did not collaborate during their PhD may be linked to future employment. In ECOOM-brief 25, a smaller proportion of PhD holders in these clusters left the university immediately after obtaining their PhD compared to other clusters. Consistently, this ECOOM-brief supports a link between intersectoral mobility and collaboration. PhD holders who leave the university are more likely to have engaged in intersectoral collaboration, suggesting that such collaboration during the PhD may facilitate intersectoral mobility. Collaborating allows PhD candidates to gain sector-specific experience, acclimate to work environments quicker, build networks for job opportunities, and challenge negative stereotypes held by non-academic employers about PhD holders (Stassen et al., 2016; Skakni, Inouye, & McAlpine, 2021).

This link between intersectoral mobility and collaboration is particularly notable for PhD holders in the humanities and applied sciences. This finding complements the observations in ECOOM-brief 25, where PhD holders in the humanities show smaller proportions in immediate post-PhD university departures ("early switchers") compared to other career paths. Conversely, applied sciences PhD holders exhibit larger proportions in early switchers compared to other paths.

Moreover, collaborating with various sectors potentially facilitates intersectoral mobility after obtaining the PhD. Collaborations with hospitals, research institutes, and private sectors engaged in R&D activities can stimulate intersectoral mobility. PhD holders not collaborating during their PhD are more likely to secure a first job at a university after obtaining the PhD.

This ECOOM-brief emphasizes collaborations as a means to transition from earning a PhD to entering the job market, although collaborations are just one method to connect with diverse career paths. Other strategies, like job shadowing and mentoring projects, can also contribute to this transition.

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Figure 2. Share of PhD holders according to collaboration during their PhD track and science cluster (*N* = 2985)

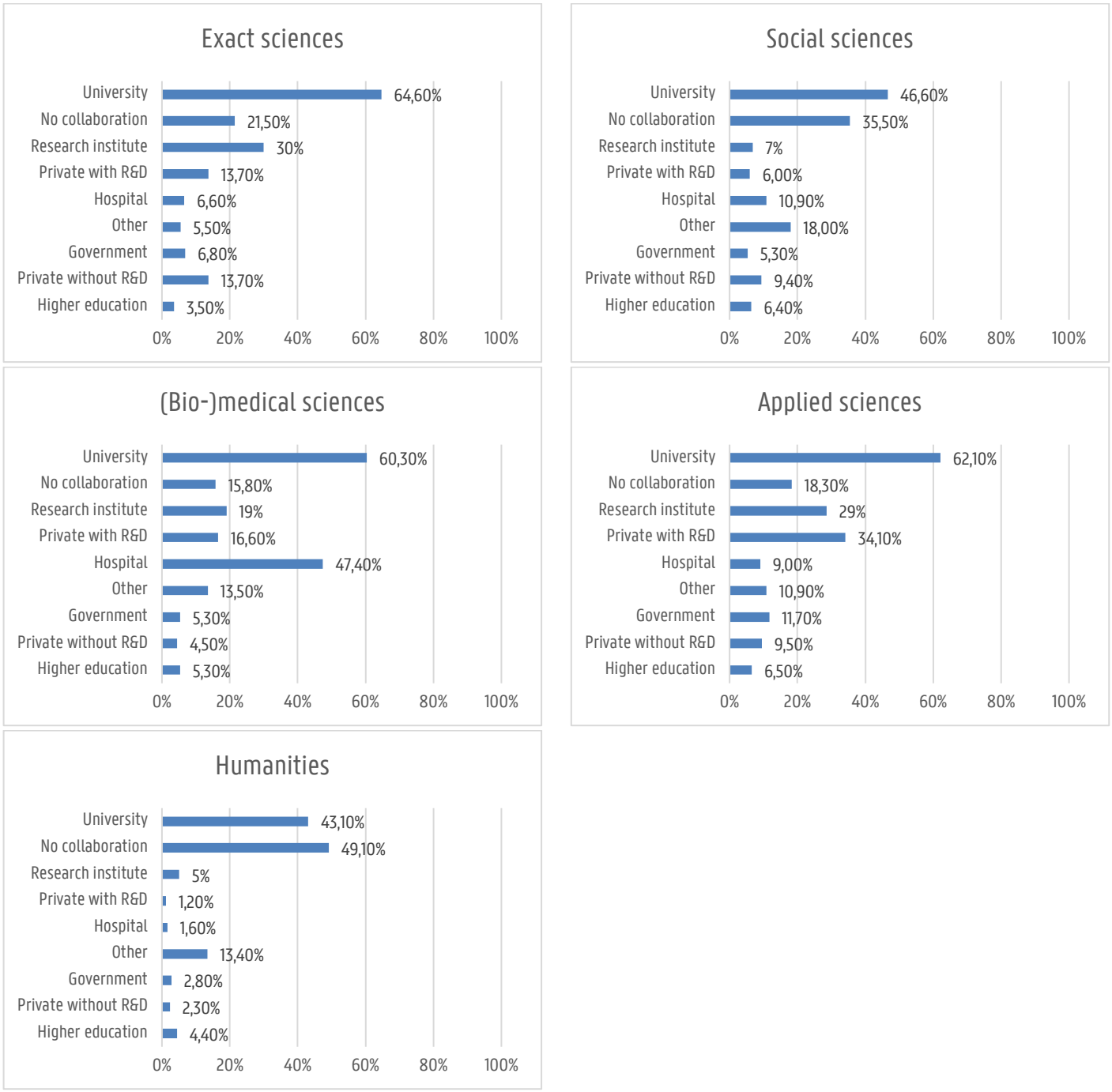

Table 2. Share of PhD holders according to whether they collaborate intersectorally, science cluster and sector of subsequent employment. Percentages are calculated on the number of PhD holders in the sector of future employment. Percentages with an asterisk differ significantly from each other.

	Exact sciences		**(Bio-)medical sciences**		**Humanities**		**Social sciences**		**Applied sciences**		**Total**	
	University	*Outside of university*	*University*	*Outside of university*	*University*	*Outside of university*	*University*	*Outside of university*	*University*	*Outside of university*	*University*	*Outside of university*
Collaboration No collaboration or only with a university.	57.1%	49.4%	31.8%	28.5%	85.3%*	71.1%*	58.2%	52.3%	43.1%*	30.9%*	54.7%	42.0%
Intersectoral collaboration	42.9%	50.6%	68.2%	71.5%	14.7%*	28.9%*	41.8%	47.7%	56.9%*	69.1%*	45.3%	58.0%
Total	289	346	264	355	258	173	318	214	311	447	1440	1535