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The cross-employment of PhDs across the university sector boundary: an analysis of Finnish register data

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Abstract

Tacit knowledge flows can be facilitated by employment transitions, such as for example the transitions of PhDs from university employment to industry. There are however barriers to transitions into and out of university employment, and as a consequence, such transitions are relatively rare. PhDs can circumvent the barriers to permanent transitions by simultaneous secondary employment relationships. Though we know that such cross-employment exists, we do not know how common it de facto is. In this paper, we use a nine-year panel of daily-level employment microdata on the full population of Finnish PhDs to show that about 30% of university-employed PhDs are cross-employed outside of universities. This is a substantial share, and its magnitude alone suggests a central but underappreciated role for cross-employment in contemporary knowledge production and dissemination. We furthermore find that similar numbers of non-university-employed PhDs are cross-employed at universities as university PhDs are cross-employed outside of universities, and that many cross-employment relationships are in non-technical fields, and with public sector organizations. This illustrates the importance of understanding the nature of knowledge flows other than the unidirectional flows of technical knowledge from universities to industrial firms.

Keywords Cross-employment · PhD mobility · Knowledge transfer · University-industry interaction · Public sector · Precariousness

Introduction

Universities are central to the production of scientific knowledge — knowledge which is then disseminated in codified form through patents and publications, and in tacit form through the outflows of graduates and researchers. Centralized forms of knowledge production and

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dissemination have however increasingly been complemented with and replaced by new, more distributed forms (cf. e.g. Carayannis and Campbell, 2012; Gibbons et al. 1994), in which knowledge is often produced in the context of its application.

The emergence of new forms of knowledge production and dissemination raises questions on how to measure the associated knowledge flows. Patents, publications, and profits are relatively easy to observe, but much knowledge is never patented, published, or commercialized. Tacit knowledge dissemination can be proxied by the labor flows of employees from employer to employer, but also in this literature, most studies concern labor flows specifically from universities to industrial firms (cf. e.g. Fernández-Zubieta et al. 2015b).

It is sometimes easy to forget that the vast majority of activities in an advanced economy take place in other sectors than industry. Knowledge can furthermore flow not only *from* universities, but also *to* them. And the barriers researchers face in more permanently entering or exiting university employment create incentives for organizations to effect tacit knowledge flows through other, arguably understudied means. Our preoccupation with commercializable knowledge and with permanent university-to-industry labor flows therefore puts us at risk of underestimating and underappreciating the breadth of knowledge production and dissemination, and the role that universities play in it.

We propose to study tacit knowledge dissemination by looking not at permanent labor flows, but rather at individuals' simultaneous cross-employment with employers in other sectors (Campbell & Carayannis, 2013). Like permanent labor flows, cross-employment allows tacit knowledge to flow between organizations through their shared employees, while at the same time allowing employees to retain their main employment relationship within their own sector. Cross-employment also shares the property with permanent employment flows that it can be observed in linked employer-employee data (cf. e.g. Abowd and Kramarz, 1999), suggesting that it should be possible to use existing data to study cross-employment in different countries and settings.

In this particular paper, we use a nine-year panel of daily-level, full-population linked employer-employee microdata to trace the cross-employment relationships of all PhDs residing in Finland. We find that about 30% of university-employed PhDs are cross-employed outside of the university sector, and that similar numbers of non-university-employed PhDs are cross-employed at a university. This in and of itself already suggests that cross-employment is a phenomenon worth studying further in its own right. It also shows that Finnish universities are strongly networked with other organizations through the PhDs they employ, and suggests that cross-employment may more generally be important to our conceptual understanding of how distributed knowledge production and dissemination occurs in contemporary society.

We study both the background of cross-employed PhDs, and the types of organizations they are cross-employed at, and find that cross-employment relationships are often in fields not traditionally studied in the literature, such as for example the humanities, the social sciences, education, and health and welfare, and that more senior researchers are more likely to be cross-employed. We also find that cross-employment relationships are often with public sector organizations rather than with industrial firms. These findings too suggest that our existing view of knowledge production and dissemination may be too skewed towards the patentable and the commercializable.

The remainder of this paper is structured as follows. We describe related literature in the next section, our data and measures in the third, and our empirical results in the fourth. The fifth section concludes.

Background

Knowledge is more important than ever. The exponential growth of research publications shows no signs of slowing down (Bornmann & Mutz, 2015), the number of PhDs keeps increasing (NCSES, 2019), and the massification of higher education previously seen in the world's advanced economies has been duplicated elsewhere, with worldwide tertiary education enrollment rates now comparable to those which advanced economies enjoyed in the 1970s (Lee & Lee, 2016). At the same time, public funders of research push for university-produced knowledge to be more directly applicable and more societally relevant (Benner & Sandström, 2000; Wang et al., 2020).

During the past thirty years, a broad range of theories and concepts have been developed to describe the central position of knowledge in postmodern society, and the changing roles of universities in it. Among these are theories of the knowledge economy (Powell & Snellman, 2004), knowledge society (Stehr, 2003), network society (Castells, 2011), and networked knowledge society (Välilä et al., 2016). These theories typically highlight universities as central knowledge institutions, educating the labor force to the high skill levels required, and conducting research for the benefit of society. Another set of theories has emerged to describe how knowledge is increasingly produced in the context of its application, and as a collaboration of different types of actors. The most well-known of these are the works of Gibbons et al. (1994, see also Nowotny et al. 2001), on the changing modes of knowledge production, and the calls by Etzkowitz and Leydesdorff (1995; 2000) to foster innovation by creating a triple helix of collaboration between universities, government, and industry. This classic work has in turn been expanded on by others to describe how society itself may be more closely linked into systems of knowledge production and dissemination (e.g. Carayannis and Campbell, 2012).

A considerable amount of effort has been put into attempts to measure universities' contributions to contemporary society. While codified forms of knowledge, like publications and patents, are relatively easy to measure, much knowledge is tacit in nature (Nonaka, 1994). Tacit knowledge is embedded in people, and as a consequence, hard to observe directly. Instead, tacit knowledge flows are often studied indirectly, among others by observing the flows of people from employer to employer. It is the tacitness of knowledge that motivates organizations to hire those who hold it in order to gain access to it (Zucker et al., 2002). An employment relationship not only all but guarantees direct personal interaction with the employee, a prerequisite for tacit knowledge transfer, but also involves a contractual formalization of the interaction, which may result both in higher levels of commitment to the knowledge transfer process, and a mitigation of appropriability risks (c.f. Bonaccorsi and Piccaluga, 1994; Miozzo et al. 2016; Thune, 2011).

The labor flows of researchers have been studied extensively, especially the flows from universities to industry, and it is well established that mobile researchers benefit the receiving organization.¹ Most notably, Herrera et al. (2010) use a survey of Spanish firms in the manufacturing sector to determine that hiring a university researcher has a positive impact on the firm's innovation input and output, measured in internal and external R&D expenditure and patent propensity respectively. Herstad et al. (2015) use a combination of survey data and linked employer-employee data, and find similar patenting benefits to inflows of university researchers in Norway. Kaiser et al. (2018) use register data on Danish firms and their employees to show that hiring a researcher with prior university research experience

¹ See for example (Fernández-Zubieta et al., 2015b) for an overview.

results in a larger increase in firms' patenting propensity than either hiring other types of researchers, or recent graduates.

The evidence on the effects of labor flows of researchers into universities is less clear, but likewise suggestive of benefits. Compared to those without it, university researchers with industry experience are generally found to draw in more external resources (Lin & Bozeman, 2006), and engage more in external research collaboration (Abreu & Grinevich, 2013; Gulbrandsen & Thune, 2017), student support and training (Gulbrandsen & Thune, 2017; Lin & Bozeman, 2006), and patenting and other formal commercialization activities (Abreu & Grinevich, 2013; Dietz & Bozeman, 2005; Gulbrandsen & Thune, 2017). This may or may not come at a cost to their basic research performance (cf. Dietz and Bozeman, 2005; Fernández-Zubieta et al., 2015a; Gulbrandsen and Thune, 2017; Lin and Bozeman, 2006). Abreu and Grinevich (2013) and Gulbrandsen and Thune (2017) furthermore show that university researchers' prior experience from public or non-profit sector work is positively associated with external research collaboration and non-commercial activities, such as public lecturing and informal advising, and negatively associated with formal commercialization activities, such as patenting and licensing research output.

Though the existing evidence points to labor flows from or to the university sector being beneficial to the receiving organization, such labor flows are comparatively small (e.g. Dietz and Bozeman, 2005), suggesting barriers to changing to or from university employment. Differing value systems, differences in working habits, and other cultural differences (Dasgupta & David, 1994; Saueremann & Stephan, 2013) may for example make employees loath to switch between sectors. Merits accrued in one sector may furthermore not be valued in the other (Musselin, 2013; Suomi et al., 2020; Tetreva & Vlckova, 2018; Vellamo et al., 2021). As a consequence, organizations may explore various methods of accessing tacit knowledge in ways that do not require the employee to either leave or enter university employment more permanently (cf. e.g. Perkmann et al. 2021).

Of particular interest to the present study is *cross-employment*: an employee's simultaneous employment at two or more different employers, in our case across the university sector boundary. Cross-employment, as introduced by Campbell and Carayannis (2013, pp. 35–36), is a way to satisfy the growing need for integrating the different knowledge and innovation modes of contemporary knowledge systems while avoiding the costs associated with more permanent career changes. Its opposite, single-employment (Campbell and Carayannis, 2013, pp. 67), may no longer be the only career model that is sensible from an organizational perspective, and increasing numbers of researchers are expected to have parallel careers inside and outside of universities. Cross-employment creates connections not only between universities and non-universities on the organizational level, but also between knowledge production and knowledge application, fostering both the creation of new knowledge and innovations, and the organizational environments that support such creative practices (Campbell and Carayannis, 2013, pp. 35–36; Campbell and Carayannis, 2016, pp. 5–7).

We propose using information on cross-employment as a complementary measure for studying the knowledge connections between university and non-university organizations in contemporary societies. Cross-employment has a number of advantages in common with existing measures of labor flows. Both can be derived from employment registers, avoiding the problems of sampling bias, recall bias, and nonresponse that survey-derived measures may have, and allowing for the compilation of population-representative statistics across all academic fields, and across all sectors of the economy (cf. e.g. Abowd and Kramarz, 1999; Figlio et al. 2016). Like more permanent labor flows, cross-employment can unearth flows of tacit knowledge that are otherwise hard to observe. An employment relationship almost necessarily indicates a connection of a certain minimum depth and value because of the

time, effort, and funds required to establish it. At the same time, permanent labor flows are comparatively rare, and may not do justice to the wealth of connections that can be observed using cross-employment relationships.

We use a nine-year panel of daily-level full-population data to trace the cross-employment relationships of all PhDs residing in Finland, almost thirty thousand PhDs in total. To our knowledge, we are the first to calculate population-representative statistics on the cross-employment of PhDs, and we contribute to the literature by showing just how common cross-employment is, at least in Finland.

Much of the existing literature is focused on the flows of technical knowledge to industry, and one may easily come away with an impression that the main economic relevance of knowledge production lies in its application by industrial firms. There is however reason to believe that if this was ever true, it no longer is. Only about one quarter to one fifth of an advanced economy can be described as industry (cf. Santacreu and Zhu, 2018), and we should question whether especially patents and publications accurately capture the structures of knowledge production and dissemination in the other four fifths. This knowledge is often not patentable, and is not necessarily either published or commercialized. In this respect, we may be particularly blindsided by the role played by the public sector. In this context, we often think of the government merely as a policy maker which funds and regulates knowledge production (cf. e.g. Etzkowitz and Leydesdorff, 1995), but the public sector at large is also a source of knowledge demand and supply of its own. This is true in the different branches of government, in the civil service, and also at public providers of goods and services, such as for example schools and hospitals.

Our comprehensive measurement of cross-employment allows us to make comparisons between different fields, and between different sectors of the economy. Our second contribution to the literature is therefore to show that much cross-employment occurs in non-technical fields, and that many cross-employment connections are with public sector rather than with private sector organizations, suggesting that it would be relevant to study contemporary knowledge flows more deeply in these domains as well. The substantial cross-employment of PhDs by universities themselves furthermore suggests that it is not only the rest of society that demands knowledge from PhDs employed at universities, but that it is also universities that demand knowledge from PhDs employed elsewhere.

For the interpretation of our results, it is necessary to ask whether any observed cross-employment is not explained by a lack of within-sector employment opportunities (cf. Brechelmacher et al. 2015) rather than by cross-sector knowledge demand. We however show that in our data, cross-employment is concentrated among employees without any registered unemployment during the year, and at the top of the academic hierarchy. This suggests that it is not a lack of PhDs' employment opportunities that explains the high incidence of cross-employment we find, but rather an intersectoral demand for their skills.

Data and measures

Our empirical analysis is based on a panel of linked employer-employee full-population administrative microdata.² The use of administrative data is common in fields like economics and sociology. There are a number of clear advantages to the use of administrative data. In

² See e.g. Abowd and Kramarz (1999) for a good description of linked employer-employee data use and e.g. Figlio et al. (2016) for a broad list of examples of the use of administrative data, as well as for a description of some of the challenges involved.

many cases, administrative data sets contain information on the entire population of individuals under study, adding to statistical power through large sample sizes while also greatly reducing concerns about selection and nonresponse. Administrative data should furthermore be expected to have much lower error rates than survey data in many domains, e.g. regarding employment histories. Among the downsides of using administrative data in research is that the data are not collected specifically for research purposes, and can thus feel unwieldy to the researcher. Researchers using administrative data often depend on local communities of other data users for support.

In the present study, we use data from Finnish registers. Given the lack of existing evidence on the prevalence of researcher cross-employment, Finland is a good context for a first study. It is a fairly typical OECD country in many respects, with for example its 12 PhDs per 1000 working age inhabitants close to the OECD average (OECD, 2019). Finnish R&D expenditure accounted for 2.7% of GDP in 2017, close to the OECD average of 2.4% (OECD, 2017b; OECD, 2022). Finnish higher education and public research institutes collaborate closely with the private sector, the latter accounting for around two-thirds of total R&D expenditure. This share too is close to the OECD average (Academy of Finland, 2022; OECD, 2022).

In Finland, the (re)use of administrative data for research purposes is regulated in law. We access our data through Statistics Finland, and Statistics Finland safeguards the security and confidentiality of the data. Other researchers can request data access on the same terms as us, and are encouraged to do so.³ The data sources we use for the present study include the Longitudinal Population Census (LPC), the Register of Completed Education and Degrees (RCED) and the Longitudinal Employment Statistics File (LESF), with information linked between the registers using exact matching on unique identifiers. Employment relationships are observed at the daily level, including multiple simultaneous employment relationships where applicable. Employment relationships link individuals to employers, on which anonymized information is also available.

In our analysis, we limit ourselves to the cross-employment of PhDs specifically. We make this choice mainly for practical reasons. The cross-employment of doctoral students is of interest in principle, but doctoral student status is imperfectly observed in our data. The university employment of other non-PhDs may be of interest too, but it is not always clear from our data what their role at the university is.

Our data cover the years 2007–2015. For each of these years, we select from the full population of Finnish residents those individuals who held a PhD at the end of the year, were less than 66 years of age at the end of the year, and were employed both on the first and on the last day of the year. This results in a sample of 29279 unique individuals in total. From the RCED, we retrieve the field in which each individual completed their PhD. We aggregate these to 1-digit ISCED 1997 levels, i.e. to Agriculture; Education; Engineering, Manufacturing and Construction; Health and Welfare; Humanities and Arts; Science; Social Sciences, Business and Law; and Services.

For each year, we categorize individuals into one of two sectors based on whether their main employment relationship at the end of the year was at a university or at a non-university. We further subdivide the group of university employees into full professors, other research and teaching staff, and PhDs in managerial or administrative positions. The reason to include the latter group is that PhDs may hold positions which are classed as managerial or administrative even when their de facto responsibilities include teaching or research. We subdivide

³ A description of the application process can be found at: https://tilastokeskus.fi/tup/mikroaineistot/hakumeneettely_en.html.

non-university employees into those employed in the public sector and those employed in the private sector.

Though our analysis could in principle be carried out on a single year of data, the use of multiple years of data reduces confidentiality concerns, and allows for more precision by smoothing out year-to-year random variation. All reported statistics pertain to yearly averages where applicable.

Table 1 shows the numbers of PhDs by employment category in our sample. From the table, we can see that the university sector and the public sector each employed an average of over seven thousand PhDs in the sample years, while the private sector employed an average of around five thousand PhDs. The fact that the public sector is a bigger employer of Finnish PhDs than the private sector in and of itself already suggests that it may be important to investigate not only the connections between universities and the private sector, but also between universities and public sector organizations.

Labor flows have commonly been conceptualized as persistent transitions from, and in some cases to university employment. We measure such more persistent flows in our data by categorizing as *switchers* PhDs whose main employment relationship was with a university at the end of the year, but who did not work for a university at the start of the year, or vice versa. Contrasting these are *cross-employed stayers*: PhDs who at the start of the year were employed in the same sector as at the end of the year, but who had a secondary employment relationship in the other sector for at least one day during the year, be it simultaneously or in rapid sequence.

Though confidentiality requirements stop us from delving too deeply into any single employment relationship in the data, it is useful to characterize the collection of relationships as a whole. The median cross-employment relationship for university-employed PhDs in the non-university sector is a little over a month in our data. A non-trivial number of these relationships is related either to research and development, or to business and other management consultancy. Many relationships are however not in either of these categories, but are instead related to the provision of health care, to the provision of education, to public administration, to the functions of the judiciary, to the activities of NGOs, to cultural and religious organizations, to the performing arts, or to museums.

The median cross-employment spell of a non-university employee at a university is a little over two weeks long. We unfortunately lack detailed information on the job tasks of these

Table 1 The employment of Finnish PhDs, main employer by end of year, yearly averages 2007–2015

	Number of PhDs
University-employed	
Full professor	2061
Other research or teaching position	5260
Managerial or administrative position	291
Total	7612
Non-university-employed	
Public sector	7488
Private sector	4833
Total	12321

hires, except that they are typically registered to be in some way related to research and/or teaching.⁴

Results

We first compare the number of PhDs who enter or exit university employment on a year-to-year basis with those that do not. As can be seen from Table 2, only 2% of PhDs employed by a university at the end of the year started out the year employed by a non-university. Likewise, only 2% of PhDs employed by a non-university by the end of the year started out employed by a university. These numbers suggest that traditional cross-sector recruitment of PhDs is rare in Finland, and perhaps by extension that the associated knowledge flows are small too. When we however look at PhDs who retain their main employment relationship within the sector, and see how many of them are cross-employed in the other sector, the picture changes. As can be seen from the table, 30% of university PhDs were cross-employed outside of the university during the year, while 21% of PhDs employed by a non-university were cross-employed by a university. In absolute numbers, the latter group is even larger than the former.

We next turn to the distribution of cross-employed PhDs over academic fields, and over public and private sector employers. Figure 1 shows proportions of university-employed PhDs cross-employed in the public and private sectors respectively in the two top panels, proportions of public sector PhDs with university cross-employment in the bottom left panel, and proportions of private sector PhDs with university cross-employment in the bottom right panel. Some patterns can be made out. Relatively few university-employed PhDs in engineering and science have cross-employment in the public sector, while relatively many do in the fields of education, in the humanities, in the social sciences, and especially in health and welfare-related fields. Even when we look at private sector cross-employment, engineering and science are the fields with the lowest proportions of cross-employed university PhDs. The bottom two panels of the figure suggest that cross-employment at a university is not uncommon among public sector PhDs of any major field, while in the private sector, PhDs in the humanities and social sciences stand out as being unusually often cross-employed at a university.

Since there is a cost associated with hiring a PhD, there is little reason to believe that from the employer side, cross-employment would not be indicative on some kind of demand for knowledge and expertise. What is not as clear is why the employee is willing to engage in cross-employment in the first place. Brechelmacher et al. (2015) hypothesize that cross-employment may be caused by precariousness, and a pessimistic reading of our results would be that many Finnish PhDs need to work two jobs or more because within-sector demand for their knowledge and expertise is lacking. On the other hand, previous evidence tends to show that more senior and more prominent researchers are more likely to engage in cross-sectoral activities (e.g. Perkmann et al. 2021; Zucker et al. 2002). We investigate the pessimistic reading of our results in two ways: by seeing if PhDs' cross-employment can be explained by their unemployment histories during the year, and specifically for university-employed PhDs whether cross-employment is more common at the bottom or rather at the top of the university hierarchy.

The top two panels of Fig. 2 show the numbers of cross-employed and non-cross-employed university PhDs without a single day of unemployment during the year, and with at least one

⁴ Anecdotally, universities may hire external employees to give lectures, or to perform specialist research tasks. The cross-employment of lecturers is for example also mentioned in Brechelmacher et al. (2015).

Table 2 Average yearly numbers of cross-employed stayers, non-cross-employed stayers, and switchers by main employment sector, 2007–2015

	Number	Sector share
University-employed		
Stayer, cross-employment	2264	30%
Stayer, no cross-employment	5223	69%
Switcher	125	2%
Non-university-employed		
Stayer, cross-employment	2622	21%
Stayer, no cross-employment	9488	77%
Switcher	211	2%

day of unemployment during the year respectively. The bottom two panels show the same numbers for non-university PhDs. As can be seen from the figure, the number of sample PhDs with any unemployment during the year is very small, suggesting that the observed cross-employment is not driven by a lack of within-sector employment opportunities. When

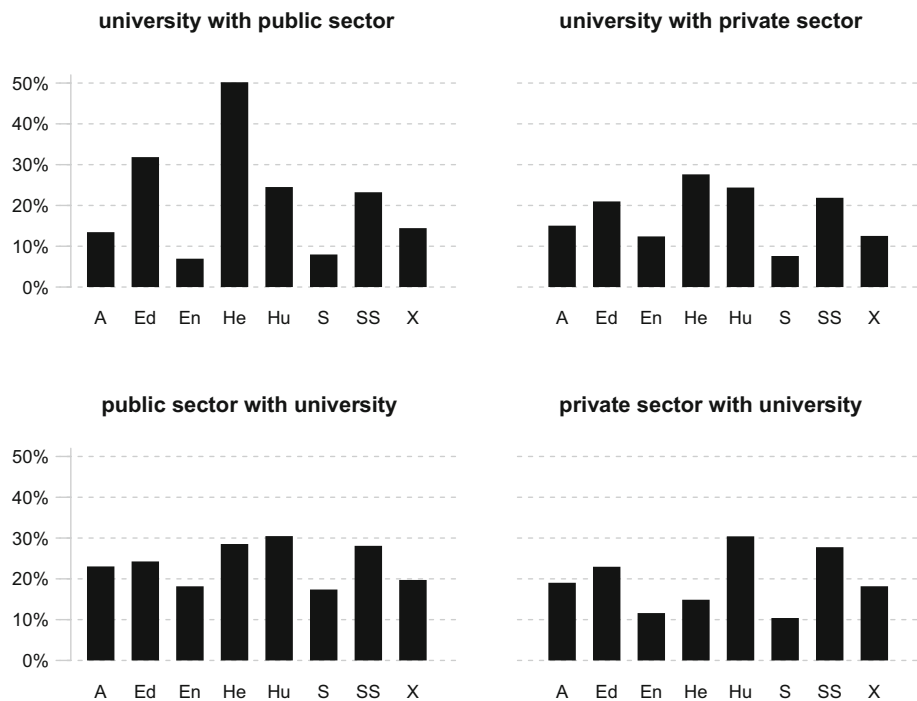


Fig. 1 Cross-employment by sector and field. Notes: The top two panels show the proportion of university-employed PhDs cross-employed in the public and private sector respectively. The bottom two panels show the proportion of PhDs employed in the public and private sectors who are cross-employed at universities. Fields are: Agriculture (A), Education (Ed), Engineering, Manufacturing and Construction (En), Health and Welfare (He), Humanities and Arts (Hu), Science (S), Social Sciences, Business and Law (SS), and Services (X). Data: 2007–2015

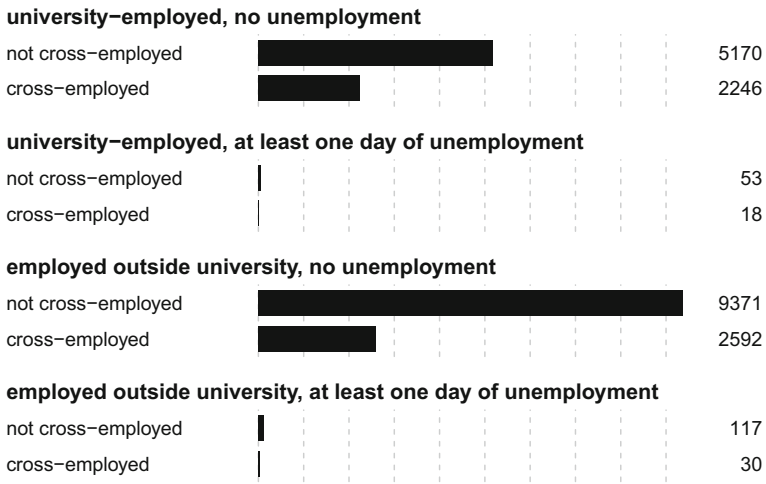


Fig. 2 Cross-employment and unemployment among sample PhDs. Notes: The figure shows the average yearly number of cross-employed and non-cross-employed stayers inside and outside of universities separately for PhDs who experienced at least one day of unemployment during the year and for those who did not. Switchers have been omitted from the figure. Very few cross-employed PhDs experience unemployment during the year, suggesting that the observed cross-employment is not well explained by a lack of within-sector employment opportunities. Data: 2007–2015

we furthermore turn to Table 3, we can see that the proportion of cross-employed among full professors is as high as 40%, while among other research and teaching staff, the same number is only about 26%. Full professors should be expected to have both reasonably high wages and high job security, and as a consequence this too suggests that precariousness does not fit well as an explanation for the cross-employment we observe.

Discussion

In this paper, we perform a comprehensive quantitative analysis of the cross-employment of Finnish PhDs. Cross-employment relationships are indicative of networks through which knowledge can flow between universities and other organizations in contemporary knowledge societies. We are able to obtain detailed cross-employment information for the full popula-

Table 3 Cross-employment among stayers across university positions. Of all university-employed PhDs, full professors are the most likely to be cross-employed by a non-university. Switchers have been omitted from the denominator. Data: 2007–2015

	Yearly number	Share cross-employed
University-employed stayers		
Full professor	2048	40%
Other research or teaching position	5155	26%
Managerial or administrative position	284	34%

tion of PhDs resident in Finland. This information is derived from government registers maintained by Statistics Finland, and is neither affected by PhDs' own views of what constitutes cross-employment, nor by any recall biases that may be present in self-reported employment histories.

The fact that an employer is willing to cross-employ a PhD is an indication of the connection created having cleared some kind of minimum threshold of usefulness and value. Prior research has found that private sector organizations benefit from hiring university researchers (Herrera et al., 2010; Herstad et al., 2015; Kaiser et al., 2018), and that labor flows into universities of researchers from private, public, and non-profit employment may increase the collaboration between universities and these other sectors (Abreu & Grinevich, 2013; Gulbrandsen & Thune, 2017). It seems plausible that cross-employment would have similar effects.

We find that as many as 30% of Finnish university-employed PhDs are cross-employed outside of the university sector, and that similar numbers of non-university-employed PhDs are cross-employed by a university in return. This suggests that Finnish universities are heavily networked with the rest of society through the labor market links of their employees, and perhaps by extension that universities remain relevant contributors also to newer, more distributed forms of knowledge production and dissemination (cf. Campbell and Carayannis, 2013; Campbell and Carayannis, 2016).

Because our data are population-representative, we can make comparisons of cross-employment rates across academic fields, and across sectors of the economy. The empirical labor flows literature is mostly focused on flows of technical knowledge to industrial firms, and theories of contemporary knowledge production and dissemination similarly abstract from most types of economic activity other than industry, or at the very least involving the production of some kind of physical artifacts. By contrast, we find that cross-employment is most common among PhDs in generally softer fields like health and welfare, education, the humanities, and the social sciences. We furthermore find that cross-employment relationships are often with public sector organizations rather than with industrial firms.

Our findings serve as a reminder that a focus on the publishable, the patentable, and the commercializable can cause us to forget about less salient kinds of knowledge. The larger part of an advanced economy is not accurately described as industry, and a focus on industry can lead us to underappreciate how universities are networked with many other parts of society, and how they for example also contribute to public sector tasks like public administration and the public provision of goods like education and health care. The large numbers of non-university-employed PhDs that are cross-employed at universities may also be an important but overlooked channel of knowledge flows. While our data do not allow us to determine which tasks universities most commonly cross-employ PhDs for, we suggest that finding this out through other means would be a worthwhile endeavor.

We do not find evidence to support that the cross-employment we observe would be driven by precariousness on the side of the PhDs themselves, but it is worth noting that this finding in and of itself is not informative of the extent to which precariousness exists in Finnish academia — or outside of it for that matter. Our sample excludes by construction both those who have not yet received their PhD, and those who never will. Furthermore, although the overall unemployment rate of PhDs is low in the sample years, some PhDs are not only not registered as employed, but are also not registered as receiving transfers such as unemployment benefits, parental allowances, or welfare payments. One potential explanation for this is that they may receive personal, tax-free grants which we do not observe. Without further information, it is however hard to form a judgment either on their circumstances, or on their well-being.

Though there are no strong reasons to believe that cross-employment would not constitute a net benefit to the organizations involved, we should also be aware that perhaps to an even larger extent than when employees change employers more permanently, their cross-employment can cause a variety of conflicts of interest. That political or commercial interests should not be allowed to influence the outcomes of academic research is relatively widely understood, but conflicts of interest can also run the other way. A university researcher may for example want to publish information against the interests of the private employer they are cross-employed by, and similarly, a university researcher cross-employed by the government may have an interest in recommending a policy that is easy to evaluate for research purposes rather than the policy they a priori expect to be the most effective. Organizations which cross-employ PhDs must be prepared to handle such conflicts of interest ahead of time.

To our knowledge, we are the first to study the cross-employment of PhDs using population-representative data, and in this sense, we do not have existing work to compare our estimates to. Linked employer-employee data is also available for other countries, and we suggest that it would be valuable to replicate our analysis on other countries' data. At the same time, Finland is a fairly typical Western European country in many respects, and until we are presented with evidence to the contrary, we do not have reasons to believe that overall cross-employment rates would be very different elsewhere.

Though Finland has many characteristics in common with other OECD countries, there are some ways in which it does stand out. As much as 25% of its working population is registered as being employed in the public sector (OECD, 2017a). This number is both lower than in other Nordic welfare states, and higher than in many other OECD countries. The high Finnish public sector employment share is partially driven by the degree to which employment in education and health care is counted towards public sector employment. Education and health care are mainly publicly provided in Finland, and one should expect that cross-employed PhDs especially in health- and education-related fields would be observed to be cross-employed with the public sector in Finland, but with the private sector in many other countries, even if they perform similar tasks for similar employers.

A separate question is whether cross-employment takes the same nature in other countries as in Finland. Previous research on cross-employment in Finland and Austria by Brechel-macher et al. (2015) for example provides some evidence that cross-employment may be seen in a more positive light in Finland than in Austria, and perhaps by extension that the nature of cross-employment itself may differ between the two countries. Finding this out, also for other countries, would be a valuable addition to our understanding of contemporary knowledge production and dissemination.

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Declarations

Conflicts of interest The authors declare that they have no conflict of interest

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