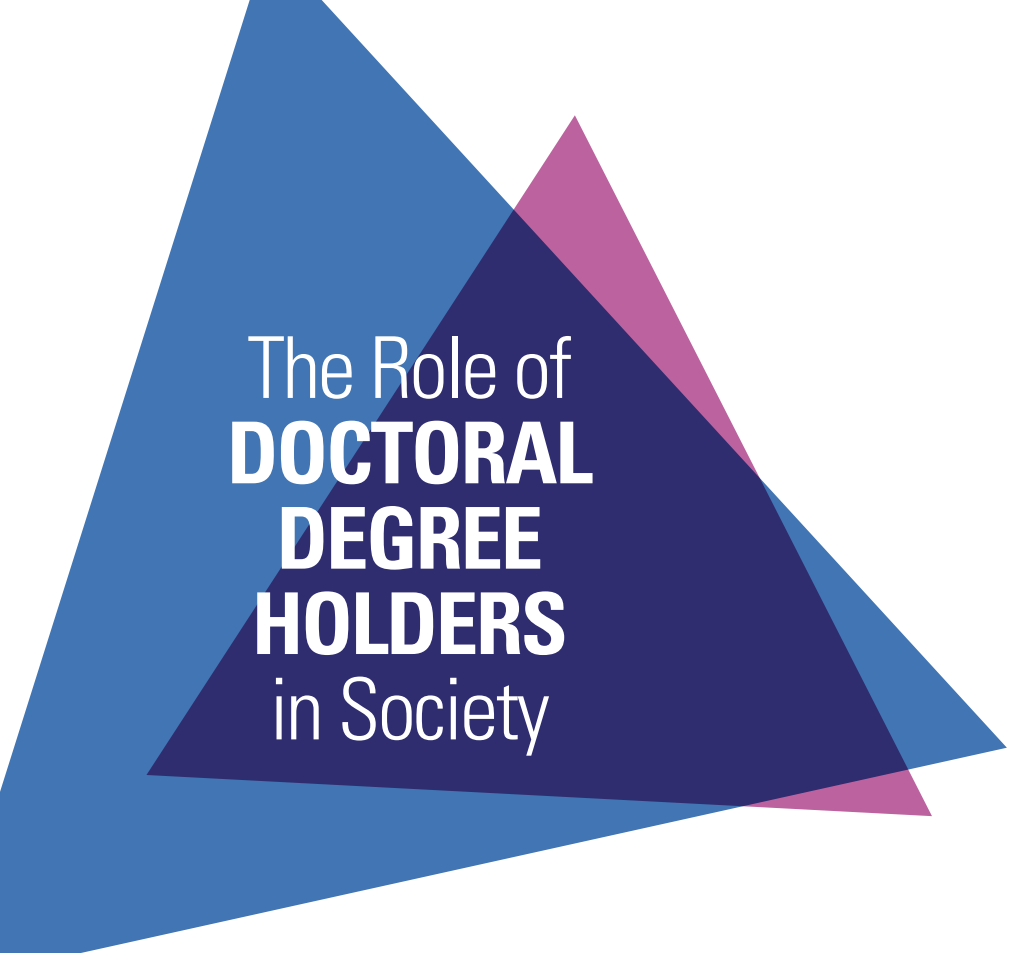


JOHANNA TÖRNROOS

The Role of
**DOCTORAL
DEGREE
HOLDERS**
in Society



ACADEMY OF FINLAND



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Summary

The broader impact of research in society is widely discussed today: the questions of how one should define, evaluate, and support it have become one of the main themes in science and innovation policy. One important route to broader impact of research is through people working outside academia who have been trained in research, e.g., have a doctoral degree. With their research-based knowledge and skills they have impact on various sectors of society.

The total number of doctoral degrees awarded annually in Finland has increased since the early 1990s. The growth has continued in the 2000s, although the speed of the growth has subsided. The growth rates vary between different research fields, and in some fields the number has even decreased during 2007–2015. In 2015 the total number of doctoral degrees awarded in Finland was 1,881.

Doctoral training is not exclusively meant for those who are pursuing an academic career. Based on statistics generated by Statistics Finland in 2013, there were about 24,300 doctoral degree holders in Finland's labour force, of which approximately 23,200 were employed. The largest employer sector for doctoral degree holders was the universities, with 37% of all employed doctoral degree holders who had gained their doctorate in 2012 or earlier. Less than 10% of the employed doctoral degree holders worked in government research institutes and little more than 25% in other parts of the public sector. The private sector accounted for little more than 25% of the employed doctoral degree holders. This includes the entrepreneurs (6% of all employed doctoral degree holders). The proportion of doctoral degree holders working in different employer sectors varies across disciplines.

To examine the role of doctoral degree holders in society the Academy of Finland conducted a survey for doctoral degree holders in four different research fields (ecology,

evolutionary biology and ecophysiology; history; materials science and technology; and medical engineering and health technologies) as part of a special theme (Broader impact of research in society) in the State of Scientific Research in Finland 2016 review. The target group of the survey consisted of Finnish residents who had been awarded a doctoral degree in one of the above mentioned fields from a Finnish university between 2005 and 2014. Potential participants were identified by gathering degree information from the universities. Altogether 566 responses were obtained, the response rate being 33%.

The careers and employment situations of doctoral degree holders are diverse. Like among all employed doctoral degree holders, also most of the respondents in the survey work outside university. Half of the respondents who reported they are currently working for an employer outside university have worked for the same or at least the same type of employer outside university already before gaining the doctorate. Little less than two-fifths of those who reported they are currently working outside university have not worked outside university prior to their doctorate. Different career paths are something to keep in mind when designing doctoral programmes. Continuing to a doctoral programme straight after the master's degree has its benefits, as the doctoral graduate can then sooner start a job that fits their researcher training. On the other hand, spending some time outside academia after the master's degree may give the doctoral candidate experience and points of view that are beneficial in their studies.

Of the respondents in the survey, 14% reported they are currently working for more than one type of employer. When a respondent is working for more than one type of employer the most common employer is a university. Doctoral degree holders may want to maintain their contacts to academia by, for example, occasionally giving lectures. Some of them may

want to continue their own research work with a personal grant. However, this may also reflect changes in working life: it is becoming increasingly common to either have multiple employers or to be engaged in entrepreneurship or freelancer work besides the daily job.

The respondents in the survey work all over Finland, although they are more concentrated in the areas with universities and research institutes. Besides working for a certain employer or for multiple employers, we also studied how doctoral degree holders view themselves in belonging to different expert communities. Examples of such communities are the scientific community, a research and development unit, or an educational community. The boundaries of such expert communities are not fixed and they exceed the boundaries between workplaces. How the respondents see their belonging to expert communities varies across the research fields and the types of employers. The concept of belonging to an expert community is subjective, of course, and two individuals working in the same kinds of tasks may see the communities to which they belong very differently.

The areas where the effects of the actions of doctoral degree holders manifest themselves can vary through the activities of the expert communities. The effects can be very local or they can appear at international or even universal level, i.e. be independent of location. A doctoral degree holder can sometimes benefit their own local community by, for example, developing their own practices, while with the same ideas introduced to a wider audience the doctoral degree holder can benefit their colleagues around the world as well. The respondents who work in a university or in a company most often reported the area where the effects manifest themselves to be international while those who work in a government research institute or other public-sector or non-profit organisation reported it to be in Finland.

Yhteenveto

A doctoral degree gives qualifications to work as a researcher or as an expert in demanding research and development tasks. Besides that, the research work carried out while pursuing the doctoral degree provides generic skills that the doctoral degree holders value in their career. Ability to piece together and solve problems and skills related to searching for, adopting and critically examining knowledge are seen very important among the respondents regardless of the research field or employer. Thus, the possible employers of doctoral degree holders should not be limited only to those relevant to the substance of their doctoral dissertation but should also extend to those that could benefit the wider spectrum of skills of these highly educated experts.

Doctoral degree holders and their expert communities do have an impact on society. While the added value of the actions of an individual doctoral degree holder for society may not be significant, the cumulative added value of research and research-based expertise is. These skilled experts influence how we interpret the surrounding world and affect decision-making, practice development and the development of new products and innovations, among other things. These are the same societal contributions that are expected of scientific research, or the roles of science in society, as discussed in the State of Scientific Research in Finland 2016 review. ▲

Tutkimuksen laajempi vaikuttavuus yhteiskunnassa puhuttaa laajalti: kysymykset tutkimuksen laajemman vaikuttavuuden määrittelystä, arvioinnista ja tukemisesta ovat nykyään yksi tiede- ja innovaatiopolitiikan tärkeistä teemoista. Akateemisen maailman ulkopuolella työskentelevät tohtorinkoulutuksen saaneet ihmiset ovat yksi tärkeä tutkimuksen vaikuttavuuden reitti. Tutkimustyöstä kumpuavalla osaamisellaan he vaikuttavat yhteiskunnan eri sektoreilla.

Suomessa suoritettujen tohtorintutkintojen lukumäärä on kasvanut 1990-luvun alkupuolelta asti. Kasvu on jatkunut 2000-luvulla vaikka ei yhtä voimakkaana kuin aiemmin. Kasvussa on vaihtelua tieteenaloittain, ja joillakin aloilla tohtorintutkintojen lukumäärä jopa laski vuosina 2007–2015. Vuonna 2015 Suomessa suoritettiin yhteensä 1 881 tohtorintutkintoa.

Tohtorinkoulutusta ei ole tarkoitettu ainoastaan akateemiselle uralle pyrkiville. Tilastokeskuksen mukaan vuonna 2013 Suomen työvoimassa oli 24 300 tohtoria, joista työllisiä oli 23 200. Tohtoreiden suurin työnantajasektori oli yliopisto, jossa työskenteli 37 % vuonna 2012 tai aiemmin tohtorintutkintonsa suorittaneista, työllisistä tohtoreista. Alle 10 % työllisistä tohtoreista työskenteli valtion tutkimuslaitoksissa ja vähän yli 25 % muissa julkisen sektorin organisaatioissa. Yksityisellä sektorilla työskenteli vähän yli 25 % työllisistä tohtoreista. Osuus sisältää yrittäjät (6 % kaikista työllisistä tohtoreista). Eri sektoreilla työskentelevien tohtoreiden osuus vaihtelee tieteenaloittain.

Selvittääkseen tohtorintutkinnon suorittaneiden roolia yhteiskunnassa Suomen Akatemia teki kyselyn neljän eri tieteenalan tohtoreille (ekologia, evoluutiobiologia ja ekofysiologia; historiatieteet; materiaalitiede ja tekniikka; lääketieteellinen tekniikka ja terveysteknologiat) osana Tieteen tila 2016 -katsauksen erityisteemaa (Tutkimuksen laajempi vaikuttavuus yhteiskunnassa). Kyselyn kohteena olivat suomalaisista yliopistoista vuosina 2005–2014 väitelleet, Suomessa asuvat

tohtorit. Vastaajat tunnistettiin keräämällä tutkintotiedot yliopistoista. Kyselyyn saatiin yhteensä 566 vastausta vastausprosentin ollessa 33.

Tohtoreiden työurat ja työtilanteet ovat monimuotoisia. Kuten kaikkien työllisten tohtoreiden osalta myös suurin osa kyselyyn vastanneista tohtoreista työskentelee yliopiston ulkopuolella. Puolet heistä, jotka vastasivat työskentelevänsä nykyään muualla kuin yliopistossa, olivat työskennelleet samalla työnantajasektorilla jo ennen tohtorintutkinnon suorittamista. Vähän alle kaksi viidesosaa heistä, jotka työskentelevät nykyään muualla kuin yliopistossa, eivät olleet työskennelleet yliopiston ulkopuolella ennen tohtorintutkinnon suorittamista. Erilaiset urapolut on tärkeää ottaa huomioon tohtorinkoulutusohjelmia suunniteltaessa. Maisterintutkinnon suorittamisen jälkeen suoraan tohtorinkoulutukseen jatkamisessa on puolensa, sillä silloin tohtori voi aloittaa nopeammin tutkijankoulutustaan vastaavissa töissä. Toisaalta yliopiston ulkopuolella työskentely voi antaa tohtorikoulutettavalle hyödyllistä kokemusta tohtoriopintoja varten.

Kyselyyn vastanneista 14 % työskentelee nykyään useammalla kuin yhdellä sektorilla. Yleensä tällöin yksi työnantajasektoreista on yliopisto. Tohtorit saattavat haluta säilyttää yhteyden akateemiseen maailmaan esimerkiksi luennoimalla satunnaisesti. Toiset heistä saattavat haluta jatkaa omaa tutkimustaan henkilökohtaisen apurahan turvin. Tämä saattaa myös heijastaa työelämän muutoksia: on yhä yleisempää työskennellä useammille työnantajille tai toimia yrittäjänä tai freelancerina päivätyön lisäksi.

Kyselyyn vastanneet tohtorit työskentelevät ympäri Suomea, joskin heistä enemmistö on keskittynyt alueille, joilla yliopistot ja tutkimuslaitokset sijaitsevat. Eri työnantajille työskentelyn lisäksi tarkastelimme myös, miten tohtorit kokevat kuuluvansa erilaisiin osaamisyyhteisöihin. Esimerkkejä tällaisista yhteisöistä ovat tiedeyhteisö, tutkimus- tai kehitys-

yksikkö ja koulutus- tai sivistisyhteisö. Osaamisyhteisöjen rajat eivät ole tarkasti määriteltyjä, ja ne ylittävät työpaikkojen rajat. Se, kuinka vastaajat näkevät kuulumisensa osaamisyhteisöihin, on tietenkin subjektiivista. Kaksi samankaltaisissa tehtävissä työskentelevää henkilöä voi kokea kuuluvansa hyvin erilaisiin yhteisöihin.

Se, missä tohtoreiden toimien vaikutukset ilmenevät, vaihtelee osaamisyhteisöjen toimien mukaan. Vaikutukset voivat olla hyvin paikallisia tai kansainvälisiä, jopa universaaleja eli paikasta riippumattomia. Tohtori voi vaikuttaa omaan paikalliseen yhteisöönsä esimerkiksi kehittämällä omia toimintatapojaan. Samojen ideoiden esitleminen laajemmalle yleisölle voi hyödyttää kollegoita ympäri maailmaa. Vastaajat, jotka työskentelevät yliopistossa tai yrityksessä, kertoivat useimmin toimionsa vaikutusalueen olevan kansainvälinen, kun taas valtion tutkimuslaitoksissa ja muissa julkisen sektorin tai kolmannen sektorin organisaatioissa työskentelevät raportoivat sen olevan Suomessa.

Tohtorin tutkinto pätevoittää toimimaan tutkijana tai tutkimustoiminnan vaativissa asiantuntijatehtävissä. Tutkinnon

suorittamiseksi tehty tutkimustyö opettaa tohtorille myös geneerisiä taitoja, joita tohtorit arvostavat työurallaan. Ongelmien hahmottamis- ja ratkaisukykyä sekä tiedon etsimiseen, omaksumiseen ja kriittiseen tarkasteluun liittyviä taitoja pidetään todella tärkeinä riippumatta tohtorintutkinnon tieteenalasta tai työnantajasta. Tohtoreiden mahdollisia työnantajia ei tule rajata ainoastaan tieteenalan kannalta relevantteihin työnantajiin, vaan laajentaa näkökulmaa myös niihin, jotka voisivat hyödyntää näiden korkeasti koulutettujen asiantuntijoiden laajempaa osaamista.

Tohtorit ja heidän osaamisyhteisönsä vaikuttavat yhteiskunnassa. Vaikka yksittäisen tohtorin toiminnan tuoma lisäarvo ei välttämättä olekaan vielä suuri, tutkimuksen ja tutkimuksesta kumpuavan osaamisen kumulatiivinen lisäarvo on. Näillä lahjakkailla asiantuntijoilla on muun muassa vaikutusta siihen, miten tulkitsemme ympäröivää maailmaa. He vaikuttavat päätöksentekoon, käytäntöjen kehittämiseen sekä uusien tuotteiden ja innovaatioiden syntyyn. Nämä ovat samoja asioita, joita tieteeltä odotetaan yhteiskunnan hyväksi. Näitä tieteen rooleja käsiteltiin myös Tieteen tila 2016 -katsauksessa. ▲

1 Introduction

The number of doctoral degrees awarded annually has increased worldwide in the past two decades (OECD 2016). This has led to a discussion about the importance of assessing the career-related utility of a doctoral degree. Furthermore, as the broader impact of research on society has gained importance over the last few years, also the discussion about the impact of doctoral degrees not only to the doctorates themselves but also to other stakeholders involved has become timely (Halse and Mowbray 2011).

Doctoral degree holders have an important role to play in the knowledge economy. Doctorate holders can, for example, promote innovations in companies, boost the credibility of organisations and connect ideas between academia and industry (Diamond et al. 2014). In addition, the process of obtaining a doctorate has impact not only on the doctoral graduates themselves but also on doctoral supervisors, being a learning process in ‘becoming a supervisor’ (Halse 2011).

Earlier, the doctorate was considered as preparation for an academic career, and a career in academia was the most wanted career path among doctorate holders in many fields (Cyranoski et al. 2011; Sauermann and Roach 2012). However, not everyone can have a career in academia so other career opportunities must be considered as well (Melin et al. 2015). Besides employment opportunities, there are also other factors that influence a doctorate holder’s pursuit of a non-academic career (Herrera and Nieto 2016).

Awareness of and knowledge about career possibilities outside academia among doctorate candidates should be enhanced (Manuela Nogueira et al. 2015). More research is needed on longer-term employment patterns and careers of doctorate holders as well as on how these meet the needs of the knowledge economy (Neumann and Tan 2011). Doctoral training develops research skills but it also provides more generic skills that are highly valued on the labour market (OECD/UNESCO 2012; Durette et al. 2016).

To examine the significance of a doctoral degree for the doctoral degree holder’s career and for society, the Academy of Finland has conducted a survey for doctoral degree holders as part of a special theme (Broader impact of research in society) in the State of Scientific Research in Finland 2016 review¹. This report presents some of the results of the survey.

In Finland, doctoral degree holders’ employment and career development have been reviewed on a regular basis. The Aarresaari network² has conducted nationwide career

monitoring for early-career doctoral degree holders since 2007; the latest report was published in 2016 (Sainio and Carver 2016). There are a lot of similarities between the study presented in this report and the studies Aarresaari has conducted, especially in the way doctoral degree holders’ careers are examined. However, Aarresaari’s target group has been doctoral degree holders 2–3 years after graduation, whereas the survey presented here extended the timespan to doctoral degree holders 2–11 years after graduation.

In this report, the focus is more on the careers of doctoral degree holders and the significance of the doctoral degree than on the employment of doctoral degree holders. Factors influencing the employment of doctoral degree holders in Finland have been studied, for example, in a report commissioned by the Finnish Ministry of Education, Science and Culture published in 2016 (Haila et al. 2016).

This report first gives a statistical overview of doctoral degrees and doctoral degree holders’ placement in working life in Finland. It then takes a deeper look at the survey data and doctoral degree holders’ careers. The report also presents the results on where the doctoral degree holders are making their contributions to society. Finally, the question of the significance of a doctoral degree is discussed. A remarkable difference between the Academy of Finland’s study and former studies as regards doctoral degree holders’ careers is that the present study does not only look at the importance of the doctoral degree for the career but also at the broader impact of research-based abilities in society.

¹ See the Academy of Finland’s website (www.aka.fi/en) » State of scientific research in Finland).

² Aarresaari is a network of Academic Career Services representing 13 Finnish universities, see www.aarresaari.net.

2 Data and methods

2.1 Statistical data

The statistical data on doctoral degrees was obtained from the Ministry of Education, Science and Culture.³ The numbers of doctoral degrees by research field were calculated from Statistics Finland data on doctoral degrees classified by education code. The research fields of doctoral degree holders were defined based on the education code (e.g. *Doctor of Philosophy, Physics* would be classified under *Physics*) and grouped into broader disciplinary groups.

The placement statistics on doctoral degree holders in this report are analysed in terms of employer sectors. The information is based on statistics from the education administration's reporting portal Vipunen on doctoral degree holders' placement in employer sectors (see Table 2.1).⁴ The classification of employer sectors in Vipunen has been modified from Statistics Finland's classification.

2.2 Survey data

The survey on the role of doctoral degree holders in society was conducted as part of a special theme, Broader impact of research in society, in the State of Scientific Research in Finland 2016 review⁵. A survey dataset on the role of doctoral degree holders in society was collected in four different research fields (ecology, evolutionary biology and ecophysiology⁶; history; materials science and technology; and medical engineering and health technologies).⁷ Potential respondents were identified by gathering degree information from relevant Finnish universities on persons who had been awarded a doctoral degree in one of the above-mentioned fields between 2005 and 2014. For practical reasons, the final target group of the survey consisted of Finnish residents: we could only contact persons with a permanent address in Finland. The survey was open from 9 May to 1 June 2016.

The survey was conducted in Finnish and in English in parallel. Altogether there were 1,723 invited participants, and we obtained a response rate of 33%. The number of responses received by research field is shown in Table 2.2. Respondents who could not be allocated to any of the four research fields are included in the analysis when all respondents are examined. The survey contained structured multiple-choice questions as well as open-ended questions. The questionnaire is available in Appendix 1 and a summary of the results is available on the Academy of Finland's website (www.aka.fi/en » State of scientific research in Finland). The data generated in the survey has been opened for broader use. The data can be found in the Aila Data Service provided by the Finnish Social Science Data Archive (<https://services.fsd.uta.fi/catalogue> » FSD3159 Survey on the Role of Doctoral Degree Holders in Society 2016).

³ The statistics as of 2005 are available through the education administration's reporting portal Vipunen (see <https://vipunen.fi/en-gb>).

⁴ The data on the placement of employed doctoral degree holders are based on material number 5.5 of the information service contract of the Finnish education administration and Statistics Finland. The population in the data includes persons aged 16–74 with a tertiary-level degree or working in expert tasks. The latest statistical year is 2013. The terms and conditions of using the placement data requires securing the data so that individuals cannot be identified. Therefore, the numbers of individuals have been rounded: if the number of individuals in a category is 1–4, the number has been rounded to three, and if the number is 5 or more, the number has been rounded to the nearest number divisible by three.

⁵ See the Academy of Finland's website (www.aka.fi/en » State of scientific research in Finland).

⁶ Later in this report this research field is referred to as ecology.

⁷ In addition to the survey for doctoral degree holders, the dataset of the special theme consisted of a survey for researchers active in the four above-mentioned research fields and focus group interviews for researchers and users or beneficiaries of knowledge.

Table 2.1.
Classification of sectors used in statistical analysis of placement of doctoral degree holders, compared to classifications in the source data.

This report	Statistics Finland's data in Vipunen
University	University
Government research institute	Research institute
Public	State Municipalities
Private	Private State-majority corporate enterprises
Entrepreneurs	Entrepreneurs
(Other or unknown)	Other or unknown

Non-profit institutions, religious communities and foundations, as a rule, are included in the private sector. University hospitals and the National Defence University are included in the public sector.

Table 2.2.
Number of responses to the survey for doctoral degree holders.

Research field	Responses
Ecology, evolutionary biology and ecophysiology	154
History	125
Materials science and technology	183
Medical engineering and health technologies	68
None of the fields above	36
In total	566

A total of 79 responses were received from persons who reported that their doctoral degree or dissertation had no relevant connection to any of the four research fields examined. Of these respondents, 43 were allocated to the research fields based on of how they described their research field in an open-ended question.

3 Overview of doctoral degree holders in Finland

This section provides an overview of doctoral degree holders in Finland based on statistical data. The disciplinary groups differ from the research fields examined through the survey because of differences in the data sources. Further information about the disciplinary groups is available in section 2, Data and methods.

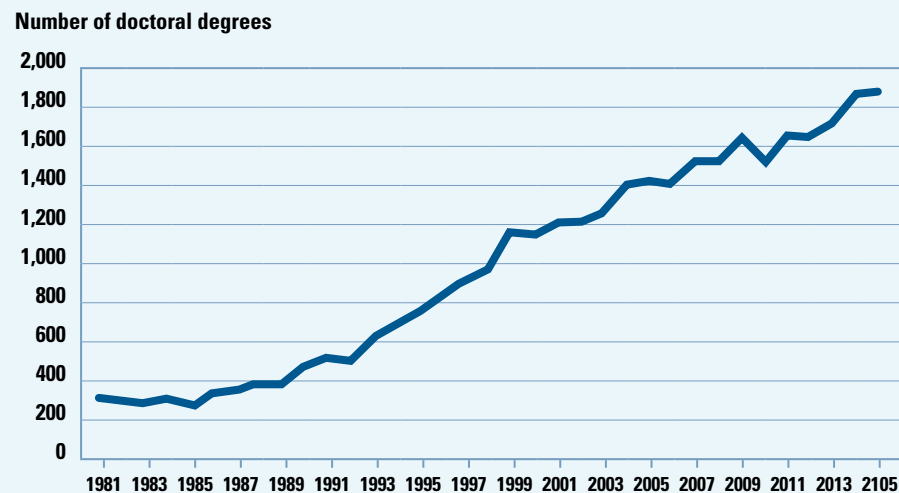
3.1 Doctoral degrees

The number of doctoral degrees awarded annually in Finland remained quite steady in the 1980s, with 340 degrees on average in 1981–1989 (see Figure 3.1). In the 1990s, there were concrete investments on research activities in Finland. This together with a positive ambiance towards research formed a basis for an increase in the number of research personnel. The number of doctoral degrees increased in the 1990s when also the performance management system in universities and national graduate schools was introduced (Academy of Finland 2003). The increase in the number of doctoral degrees in 1990s was considerable, with approximately an 11% increase on average per year (see Figure 3.1). By the end of the decade, more than 1,000 degrees were awarded annually. While the growth in the number of doctoral degrees has been slower in the 2000s than in the 1990s (3% on average per year), the number of degrees awarded in 2015 was 63% higher than in 2000.

The number and growth of doctoral degrees awarded annually vary across disciplines (see Table 3.1). When comparing the three-year averages between 2007–2009 and 2013–2015, the growth has been strongest in chemistry and engineering-related fields. The relative growth in the number of doctoral degrees was among the strongest also in pharmacy. In biological and environmental sciences and health sciences the number of doctoral degrees awarded annually decreased when comparing the three-year averages between 2007–2009 and 2013–2015.

Medical sciences account for 16% of all doctoral degrees awarded annually (three-year average in 2013–2015), ICT and electrical engineering being the second largest disciplinary group with a proportion of 12% (see Table 3.1). Compared to other fields, the degree of MD has more impact on career advancement also in the clinical profession, which makes it attractive for a larger proportion of graduates from medical schools.

Figure 3.1. Number of doctoral degrees awarded in Finland in 1981–2015.



Source: Ministry of Education, Science and Culture; Vipunen – Education Statistics Finland (available from 2005).

Table 3.1.
Three-year average of and change (%) in the number of doctoral degrees awarded in different disciplinary groups in 2007–2009 and 2013–2015.

Disciplinary group	2007–2009	2013–2015	Change in the no. of doctoral degrees in the disciplinary group (%)	Proportion of disciplinary group (2013–2015)
Mathematics, statistics	27	29	9%	2%
Physics, geosciences, space science	121	148	23%	8%
Chemistry, chemical engineering	73	103	40%	6%
ICT and electrical engineering	163	219	35%	12%
Engineering, other fields	105	147	40%	8%
Business studies and economics	108	118	10%	6%
Biological and environmental sciences	153	135	-12%	7%
Agricultural and forest sciences	57	71	24%	4%
Medical sciences	265	288	9%	16%
Pharmacy	20	28	39%	2%
Health sciences	57	54	-5%	3%
Behavioural sciences	114	122	6%	7%
Social sciences, other fields	120	144	20%	8%
Linguistics	46	54	18%	3%
Art and literature research	58	65	13%	4%
Humanities, other fields	76	93	22%	5%
All fields	1,565	1,823	17%	100%

The three-year average has been rounded to a whole number. The change has been calculated using actual three-year averages. The row "All fields" also includes doctoral degree holders whose doctoral degree's research field was other natural sciences (2007–2009 on average 1.3 and 2013–2015 on average 4.3 doctoral degrees per year).

Source: Data collected by Statistics Finland; Ministry of Education, Science and Culture.

3.2 Doctoral degree holders in working life

In 2013, there were approximately 24,300 doctoral degree holders in Finland's labour force, of which approximately 23,200 were employed. Altogether, doctoral degree holders accounted for about 2% of human resources in science and technology^{8,9}.

In 2013, the largest employer sector for doctoral degree holders was universities, accounting for 37% of all employed doctoral degree holders who had gained their doctorate in 2012 or earlier (see Table 3.2).¹⁰ The proportion of doctoral degree holders working in universities varies across disciplines. While over half of the employed doctoral degree holders in linguistics, mathematics and statistics, behavioural sciences and art and literature research worked in universities, the proportion was less than one-third in medical sciences, pharmacy, health sciences and agricultural and forest sciences. It is useful to note that the proportion of medical sciences of all employed doctoral degree holders is 24% and it thus affects the statistics: if they are left out, the proportion of doctoral degree holders working in universities is 44%.

The proportion of doctoral degree holders in agricultural and forest sciences working in government research institutes was slightly higher (33%) than of those working in university (31%). Government research institutes, such as VTT Technical Research Centre of Finland Ltd and Natural Resources Institute Finland, also attract doctoral degree holders in physics, geosciences and space science as well as biological and environmental sciences, the proportions being 20% and 18%, respectively.

The public sector was, as expected, the largest employer sector for doctoral degree holders in medical sciences and health sciences. The large number of MDs affects the public-sector statistics as they compose over half of the sector. Without their contribution, the proportion of doctoral degree holders working in the public sector was 18%. Doctoral degree holders in behavioural sciences and social sciences tend also to work in the public sector.

Nearly one-third (30%) of doctoral degree holders in pharmacy worked in the private sector¹¹. The private sector was frequent also among doctoral degree holders in chemistry and engineering-related fields, as well as in humanities (excl. linguistics and art and literature research). The high proportion of the private sector in humanities may be due to the definition of 'private sector' in the source data: it includes, as a rule, non-profit institutions, religious communities and foundations.

Nearly one-fourth of doctoral degree holders in pharmacy were entrepreneurs. As the sector accounted for only 6% of all employed doctoral degree holders, this makes only a small contribution to the overall statistics.

⁸ Persons aged 16–74 with a tertiary-level degree or working in expert tasks.

⁹ Vipunen – Education Statistics Finland » Korkeakoulutus ja t&k-toiminta » T&k-henkilövoimavarat (only in Finnish).

¹⁰ Doctoral graduates who obtained their degree during the examined year were excluded from the analysis of placement by employer sector. This gives a more realistic view of placement after the doctoral degree. If doctoral graduates of 2013 are included in the analysis, the proportion of doctoral degree holders working in universities was 38%.

¹¹ Here, entrepreneurs are separated from other private sector.

Table 3.2.**Doctoral degree holders working in different employer sectors by disciplinary group in 2013.**

The table shows the proportion of employed doctoral degree holders who were awarded their degree in 2012 or earlier by disciplinary group.

Disciplinary group	University	Government research institute	Public	Private	Entrepreneur	Total (no.)
Mathematics, statistics	62%	5%	15%	15%	4%	369
Physics, geosciences, space science	40%	20%	14%	22%	3%	1,683
Chemistry, chemical engineering	38%	12%	11%	36%	3%	1,188
ICT and electrical engineering	41%	8%	8%	37%	5%	1,845
Engineering, other fields	39%	11%	13%	31%	6%	1,329
Business studies and economics	48%	4%	20%	22%	5%	1,203
Biological and environmental sciences	43%	18%	17%	18%	4%	1,989
Agricultural and forest sciences	31%	33%	13%	18%	4%	876
Medical sciences	15%	3%	59%	14%	9%	5,220
Pharmacy	27%	4%	15%	30%	24%	315
Health sciences	28%	8%	44%	16%	4%	618
Behavioural sciences	51%	4%	29%	11%	5%	1,404
Social sciences, other fields	48%	6%	27%	15%	4%	1,569
Linguistics	74%	3%	9%	10%	4%	558
Art and literature research	51%	0,5%	22%	18%	8%	618
Humanities, other fields	47%	1%	14%	31%	7%	1,020
All fields	37%	9%	27%	21%	6%	21,966
All fields (no.)	8,106	1,899	6,021	4,623	1,296	21,966

Doctoral degree holders whose graduation year is unknown are included in the analysis (177 people). Universities of applied sciences are included in the public or private sector depending on their ownership. University hospitals and the National Defence University are included in the public sector. Government research institutes are as of 2013. The column "Total" includes 21 doctoral degree holders whose employer sector was "other or unknown". The row "All fields" includes 162 doctoral degree holders whose detailed field of research was unknown. Further information about the employer sectors is available in section 2, Data and methods.

Source: Data collected by Statistics Finland, Vipunen – Education Statistics Finland.

4 Careers of doctoral degree holders

This section analyses doctoral degree holders' career paths based on the survey data. The section first looks at their current employment situation. Many of the respondents worked for more than one employer, so the analysis also covers those with multiple types of employer. Finally, the section deals with the whole career path from the time before dissertation work to the current situation.

4.1 Employers of doctoral degree holders

The respondents were asked about their current employer or work situation. They could choose multiple types of employers or work situations, but were asked to indicate the most important one. In ecology and history, university was the most frequent most important employer (34% and 37%, respectively), while company was the most frequent in materials science and technology and medical engineering and health technologies (39% and 34%, respectively) (see Table 4.1). The second most frequent employer for ecology was government research institute, 16% of respondents, when only 7% of all respondents had marked that as most important employer. Doctoral degree holders in history and medical engineering and health technologies tend to work in public-sector organisations more often than respondents from other fields.

Only 2% of respondents in history indicated that their most important employer is a company but 7% said they were entrepreneurs, self-employed or freelancers. Doctoral degree holders in history tend to be entrepreneurs, self-employed or freelancers more often than doctoral degree holders in other fields. They also work in non-profit organisations or have a personal scholarship or grant more often than doctoral degree holders in other fields.

The respondents were not asked to specify the current number of employers, only to indicate the different types of employers¹² they worked for. Altogether 14% of the respondents reported that they were employed by more than one type of employer (see Table 4.2). In history and medical engineering and health technologies, about one-fourth (23% and 25%, respectively) reported that they were working for multiple types of employers. In ecology, the proportion was 10% and in materials science and engineering only 6%.

When a doctoral degree holder was working for multiple types of employers, most often one of the employers was a university (see Table 4.3). Of the respondents in ecology who were working for multiple types of employers, over half (54%) were entrepreneurs, self-employed or freelancers. Nearly half (48%) of the respondents in history with multiple types of employers had a personal scholarship or grant. Of doctoral degree holders in materials science and technology, 78% worked in a company if they had more than one type of employer. This accounts for seven doctoral degree holders in materials science and technology out of nine who worked for more than one type of employer. In medical engineering and health technologies, 44% of those working for multiple types of employers worked in a public-sector organisation.

If a doctoral degree holder was working for more than one type of employer, the most common combination was university-personal scholarship/grant. University-public sector, university-company, university-entrepreneur and public sector-entrepreneur were also quite common combinations.

The respondents were given an option to write the name of their employer as an open-ended answer. Their answers show that there were respondents from 13 Finnish universities (see Table 4.4). Only the University of Lapland was not mentioned in the open-ended responses. In the public sector, doctoral degree holders work in many different organisations including government agencies, ministries, municipalities and schools. Some respondents were working in universities of applied sciences as well, which are included in public-sector organisations in Table 4.4, although some of them are privately owned.

Table 4.4 includes some examples of typical employers for doctoral degree holders. Organisations with fewer than 15 employees are not included in the table, which leaves out the entrepreneurs, self-employed, freelancers and some of the companies. The companies and non-profit organisations where doctoral degree holders work typically relate to their original field of research. However, there are also exceptions, indicating that besides substance-related knowledge and skills, doctoral dissertation research also provides generic skills and competences for working life. Research-based abilities are further discussed in section 6, Significance of the doctoral degree.

¹² Entrepreneurs, self-employed or freelancers and personal scholarship or grant holders are also counted here as a type of employer.

Table 4.1.
Current employer or work situation of doctoral degree holders in four research fields.

The most important employer or work situation indicated by the respondents.

	Ecology	History	Materials science and technology	Medical engineering and health technologies	All respondents (%)	All respondents (no.)
University	34%	37%	30%	26%	32%	179
Personal scholarship/grant	5%	9%	0%	3%	4%	23
Government research institute	16%	1%	7%	3%	7%	42
Public-sector organisation	12%	21%	7%	24%	14%	77
Non-profit organisation	2%	5%	1%	0%	2%	11
Company	11%	2%	39%	34%	23%	128
Entrepreneur, self-employed or freelancer	1%	7%	3%	3%	4%	21
Unemployed	11%	8%	7%	6%	8%	46
In total (%)	100%	100%	100%	100%	100%	564
In total (no.)	153	124	183	68	564	

All respondents include 36 respondents who could not be allocated to the four research fields. There were six respondents on parental leave and 31 who reported they currently had "Other employer or work situation." 'Company' refers to private or state-owned companies or enterprises.

Source: Academy of Finland's survey on the role of doctoral degree holders in society, 2016.

Table 4.2.
Employed doctoral degree holders who are working for more than one type of employer.

	Respondents with multiple types of employers	All employed respondents	Proportion of respondents with multiple types of employers of all employed respondents
Ecology	13	124	10%
History	23	102	23%
Materials science and technology	9	159	6%
Medical engineering and health technologies	16	63	25%
All respondents	65	481	14%

All respondents include 36 doctorates who could not be allocated to the four research fields.

Source: Academy of Finland's survey on the role of doctoral degree holders in society, 2016.

Table 4.3.
Proportion of type of employer if the doctoral degree holder is working for multiple types of employer.

	Ecology	History	Materials science and technology	Medical engineering and health technologies	All respondents (%)	All respondents (no.)
University	62%	57%	78%	69%	63%	41
Personal scholarship/grant	8%	48%	11%	25%	29%	19
Government research institute	23%	0%	33%	13%	12%	8
Public-sector organisation	23%	30%	22%	44%	29%	19
Non-profit organisation	15%	13%	11%	0%	9%	6
Company	23%	17%	78%	25%	31%	20
Entrepreneur, self-employed or freelancer	54%	43%	11%	31%	38%	25
In total (no.)	13	23	9	16	65	65

All respondents include 36 doctorates who could not be allocated to the four research fields. 'Company' refers to private or state-owned companies or enterprises.

Source: Academy of Finland's survey on the role of doctoral degree holders in society, 2016.

Table 4.4.
Examples of employers by research field and type of employer.

ECOLOGY

Type of employer	Examples of employers
University	AU, TUT, UEF, UH, UJ, UO, UTU, ÅAU
Government research institute	EVIRA, FMI, LUKE, SYKE
Public-sector or non-profit organisation	Academy of Finland, Finnish Association for Nature Conservation, Finnish 4H Organisation, Finnish Wildlife Agency, Häme University of Applied Sciences, Ministry of Agriculture and Forestry, municipality, Regional State Administrative Agency, WWF
Company	Neste, State Forest Enterprise, Thermo Fisher Scientific, Vapo, YLE (Finnish Broadcasting Company)

HISTORY

Type of employer	Examples of employers
University	UH, UJ, UNIARTS, UO, UTA, UTU
Public-sector or non-profit organisation	Comprehensive school, Evangelical Lutheran Church of Finland, Finnish Defence Forces, Finnish Immigration Service, Finnish Transport Safety Agency, foundation, high school, library, municipality, trade union, university of applied sciences

MATERIALS SCIENCE AND TECHNOLOGY

Type of employer	Examples of employers
University	AU, LUT, TUT, UEF, UH, UJ, UO, ÅAU
Government research institute	FMI, SYKE, VTT
Public-sector or non-profit organisation	Comprehensive school, European Chemicals Agency, Finnish Defence Forces, Finnish Patent and Registration Office, high school, industries federation, municipality
Company	ABB, CSC, Fennovoima, Fiskars Finland, Huntsman, Kemira, Microsoft, Murata Electronics, Orion, Paroc, Pöyry, Ramboll, SSAB, Stora Enso, Valmet, Varian Medical Systems Finland

MEDICAL ENGINEERING AND HEALTH TECHNOLOGIES

Type of employer	Examples of employers
University	AU, TUT, UEF, UH, UO, UTA, UTU
Public-sector organisation	Ministry of Economic Affairs and Employment, Oulu University of Applied Sciences, (university) hospital
Company	Comptel, Fimlab, Mylab, Nexstim, Orion, Philips, Rovio, Sanoma, Suunto, Wapice

Universities of applied sciences are listed among public-sector organisations although some of them are privately owned. 'Company' refers to private or state-owned companies or enterprises. Entrepreneurs, self-employed, freelancers and very small enterprises are not included.

Source: Academy of Finland's survey on the role of doctoral degree holders in society, 2016.

4.2 Career paths of doctoral degree holders

Besides the current¹³ working situation, the doctoral degree holders were also asked about their employers before, during and after dissertation research. This makes it possible to get some indications of factors influencing how doctoral degree holders end up working for a certain type of employer. The career paths differ somewhat between research fields (see Tables 4.5 and 4.6). Below are first some general remarks and then a field-specific discussion. In the analysis of career paths, some of the employer types have been combined: university and personal scholarship or grant; other public sector and non-profit organisation; company and independent entrepreneur, self-employed or freelancer.

In all fields, all or almost all (97–100%) doctoral degree holders who were currently working in university had worked in a university also before or during their dissertation research (see Table 4.5). Half of the respondents in history had worked in a university both before and during their dissertation work while for other fields the proportion was 64–68% (see Table 4.6). Half of the respondents who were currently working for an employer outside university had worked for the same type of employer also before gaining the doctorate. Little less than two-fifths (38%) of those who reported they are currently working outside university had not worked outside university prior to their doctorate.¹⁴

There were in all 56 respondents who were currently unemployed; 27% had been unemployed also before or during their dissertation research and 7% both before and during their dissertation research.

Ecology

Of doctoral degree holders in ecology, 72% of those who were currently working in a government research institute (GRI) had worked in a GRI before or during their dissertation work and 44% had worked in a GRI both before and during their dissertation work. About half (46–54%) of the doctoral degree holders working either in public-sector or non-profit organisations or in a company had worked for the same type of employer before or during their dissertation work.

About one-third (29%) of those working in a company had worked in a company both before and during their dissertation work. Among respondents working in public-sector or non-profit organisations, the proportion of those who had worked for the same type of employer both before and during their dissertation work was 13%.

History

In history, 82% of the doctoral degree holders currently working in public-sector or non-profit organisations had worked for the same type of employer before or during their dissertation research and over half (56%) both before and during their dissertation research. Half of the respondents working in a company had worked in a company before or during and about one-fourth both before and during their dissertation work.

Materials science and technology

Slightly less than half (47%) of the 15 respondents in materials science and technology currently working in a GRI had worked in a GRI before or during their dissertation research. Of them, all except one had worked in a GRI both before and during their dissertation work. There were also 15 respondents in materials science and technology working in public-sector or non-profit organisations. Only one of them had worked for the same type of employer before or during and none of them both before and during their dissertation research. Of the respondents working in a company, 37% had worked in a company before or during their dissertation work. Only one-tenth had worked in a company both before and during their dissertation work.

Medical engineering and health technologies

Of the 17 doctoral degree holders in medical engineering and health technologies working in public-sector or non-profit organisations, 71% had worked for the same type of employer before or during their dissertation research and 41% both before and during their dissertation work. About two-fifths (39%) of the respondents working in a company had worked in a company before or during and about one-fifth (18%) both before and during their dissertation work.

¹³ 'Current' refers to the time of the survey (May 2016).

¹⁴ From source data.

Table 4.5.
Respondents working for the same type of employer now and before or during the dissertation work.

	Ecology			History			Materials science and technology			Medical engineering and health technologies			All respondents		
	Now and before <u>or</u> during		%	Now and before <u>or</u> during		%	Now and before <u>or</u> during		%	Now and before <u>or</u> during		%	Now and before <u>or</u> during		%
	Now (no.)	during (no.)		Now (no.)	during (no.)		Now (no.)	during (no.)		Now (no.)	during (no.)		Now (no.)	during (no.)	
University (incl. personal scholarship or grant)	66	64	97%	66	64	97%	59	57	97%	25	25	100%	228	222	97%
Government research institute	25	18	72%	–	–	–	15	7	47%	–	–	–	45	26	58%
Other public-sector or non-profit organisation	24	13	54%	39	32	82%	15	1	7%	17	12	71%	99	59	60%
Company (incl. entrepreneurs, self-employed and freelancers)	24	11	46%	24	12	50%	82	30	37%	33	13	39%	181	76	42%
Unemployed	21	4	19%	12	8	67%	16	2	13%	4	0	0%	56	15	27%

All respondents include 36 doctoral degree holders who could not be allocated to the four research fields. ‘Company’ refers to private or state-owned companies or enterprises. In history and in medical engineering and health technologies, there were one and two respondents, respectively, currently working in a government research institute.

Source: Academy of Finland’s survey on the role of doctoral degree holders in society, 2016.

Other remarks

Among doctoral degree holders in history, there seems to be a link between the type of employer they are currently working for and the type of employer they have worked for before the doctorate, more often so than among doctoral degree holders in other fields (with exception of those who were working in a university). This may be linked to the higher age when doctoral degree holders in history gain their degree compared to fields in natural

sciences or engineering.¹⁵ Historians may start their doctoral dissertation research while they already have a job and continue working for the same or at least the same type of employer after gaining the doctorate. Master’s degree graduates in natural sciences or engineering may more often continue to a doctoral degree right after gaining the master’s degree and pursue a job outside university only after that.

¹⁵ Vipunen – Education Statistics Finland » University education » Students and degrees.

Table 4.6.
Respondents working for the same type of employer now, before and during the dissertation work.

	Ecology			History			Materials science and technology			Medical engineering and health technologies			All respondents		
	Now (no.)	Now, before and during (no.)	%	Now (no.)	Now, before and during (no.)	%	Now (no.)	Now, before and during (no.)	%	Now (no.)	Now, before and during (no.)	%	Now (no.)	Now, before and during (no.)	%
University (incl. personal scholarship or grant)	66	42	64%	66	33	50%	59	39	66%	25	17	68%	228	140	61%
Government research institute	25	11	44%	–	–	–	15	6	40%	–	–	–	45	18	40%
Other public-sector or non-profit organisation	24	3	13%	39	22	56%	15	0	0%	17	7	41%	99	33	33%
Company (incl. entrepreneurs, self-employed and freelancers)	24	7	29%	24	6	25%	82	8	10%	33	6	18%	181	32	18%
Unemployed	21	2	10%	12	2	17%	16	0	0%	4	0	0%	56	4	7%

All respondents include 36 doctoral degree holders who could not be allocated to the four research fields. ‘Company’ refers to private or state-owned companies or enterprises. In history and in medical engineering and health technologies, there were one and two respondents, respectively, currently working in a government research institute.

Source: Academy of Finland’s survey on the role of doctoral degree holders in society, 2016.

5 Where do the doctoral degree holders work?

This section examines where the doctoral degree holders are making their work contributions, based on the survey data. The section first looks at the geographical location where doctoral degree holders work in Finland. It then analyses the site and reach of contribution by examining which expert communities the doctoral degree holders belong to and their views on the geographical areas that are affected by the activities of their expert community.

5.1 Geographical location of employed doctoral degree holders in Finland

To define the subregion where a doctoral degree holder is located we mapped¹⁶ the postal code into respective subregions.¹⁷

In general, it can be said that employed doctoral degree holders of a given research field tend to work in areas close to universities that have research and education in that field (see Figures 5.1a–d). Government research institutes and university hospitals located in the same area also attract doctoral degree holders.

Ecology

Of employed doctoral degree holders in ecology, 41% were located in the Helsinki subregion (see Figure 5.1a). Jyväskylä and Oulu had the second largest proportion, 12%. Less than one-tenth (7%) of employed doctoral degree holders in ecology were located in the Joensuu subregion, which had the fourth largest proportion. In the subregions mentioned above, there is a university and government research institutes relevant to doctoral degree holders in ecology.

History

Two-fifths of the employed doctoral degree holders in history were located in the Helsinki subregion (see Figure 5.1b). The proportions of respondents working in Jyväskylä, Oulu, Tampere or Turku subregions equalled about 10% each. The above-mentioned subregions have universities with research and education in the field of history. The rest of the respondents in history were located in subregions forming a belt extending from the Raasepori subregion in the south to the Joensuu subregion in the east and subregions near the Oulu subregion.

Materials science and technology

If determined by the number of subregions where the employed doctoral degree holders were located, doctoral degree holders in materials science and technology are distributed more broadly in Finland compared to other fields (see Figure 5.1c). However, the proportion of those located in the Helsinki subregion is almost equal to ecology and history, 42%. In the Helsinki subregion there are two universities where the respondents had gained their doctoral degree and also government research institutes the respondents reported as their employer. In the Jyväskylä and Tampere subregions, which have the second largest proportions (10% each), there is also a university and a government research institute relevant to the field. Doctoral degree holders in materials science and engineering thus tend to work in areas near universities. Besides the subregions mentioned above, they also include the Turku subregion in the southwest, the Lappeenranta subregion in the southeast, the Joensuu and Kuopio subregions in the east and the Oulu subregion in the north.

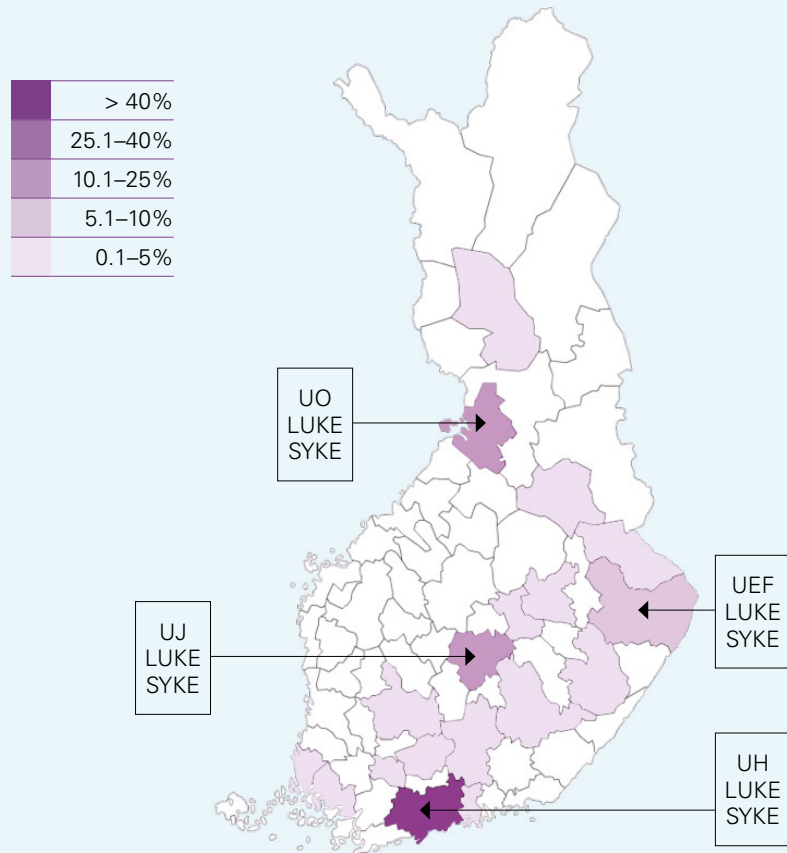
Medical engineering and health technologies

The employed doctoral degree holders in medical engineering and health technologies cover fewer subregions than employed doctoral degree holders in other fields, but they are distributed more evenly between the subregions (see Figure 5.1d). In contrast to other fields, the subregion with the largest proportion of employed doctoral degree holders is Tampere (30%), although the proportion of the Helsinki subregion is almost the same (27%). Subregions with about one-tenth of the employed doctoral degree holders in medical engineering and health technologies are Kuopio (11%), Oulu (8%) and Turku (8%). There is both a university and a university hospital located in the five subregions mentioned above. Doctoral degree holders in medical engineering and health technologies often work in hospitals. There is a central hospital in five out of six other subregions where the doctoral degree holders in medical engineering and health technologies work.

¹⁶ Stat.fi » Products and services » Paavo » Paavo data descriptions » Postal code – municipality key 2016.

¹⁷ In the survey, we asked: "Where is your (primary) workplace/post located?" The options were In Finland, please enter the postal code; Abroad, please enter the country; Other, please specify.

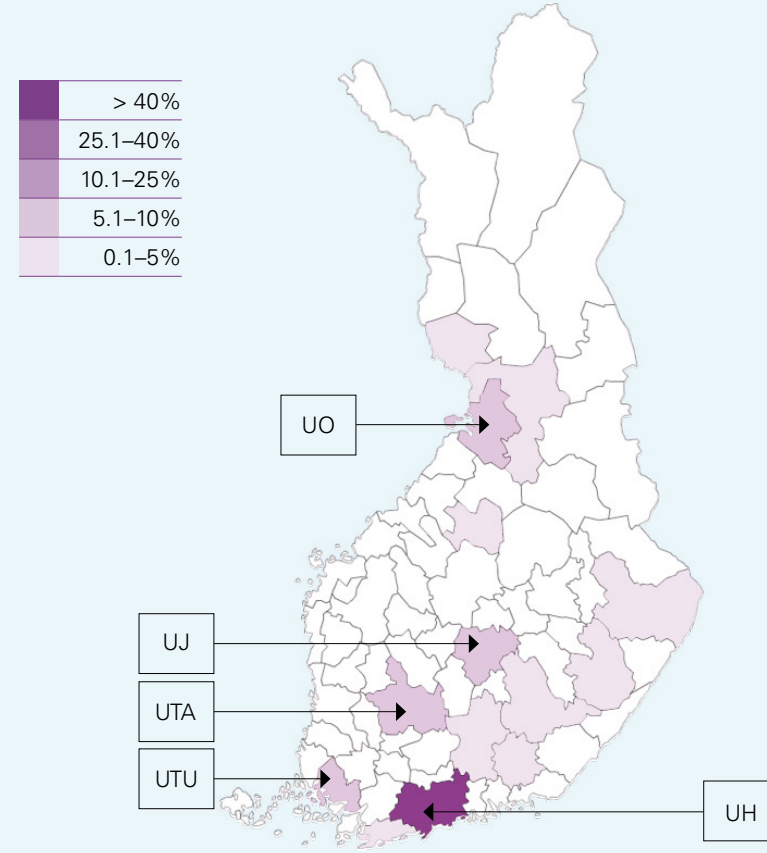
Figure 5.1 a.
Geographical locations of employed doctoral degree holders in ecology.



In the data set, the total number of employed doctoral degree holders in ecology is 124 (includes 8 doctoral degree holders whose specific location was unknown). The universities and government research institutes relevant to the field are indicated for the subregions with a proportion larger than 5% of the survey respondents.

Source: Academy of Finland's survey on the role of doctoral degree holders in society, 2016.

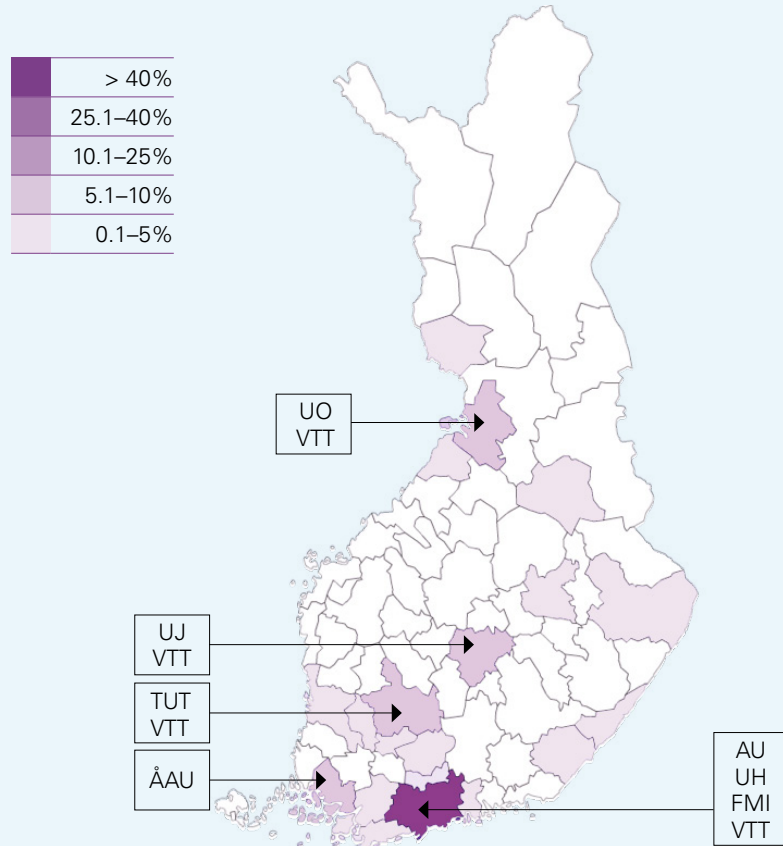
Figure 5.1 b.
Geographical locations of employed doctoral degree holders in history.



In the data set, the total number of employed doctoral degree holders in history is 102 (includes 7 doctoral degree holders whose specific location was unknown). The universities relevant to the field are indicated for the subregions with a proportion larger than 5% of the survey respondents.

Source: Academy of Finland's survey on the role of doctoral degree holders in society, 2016.

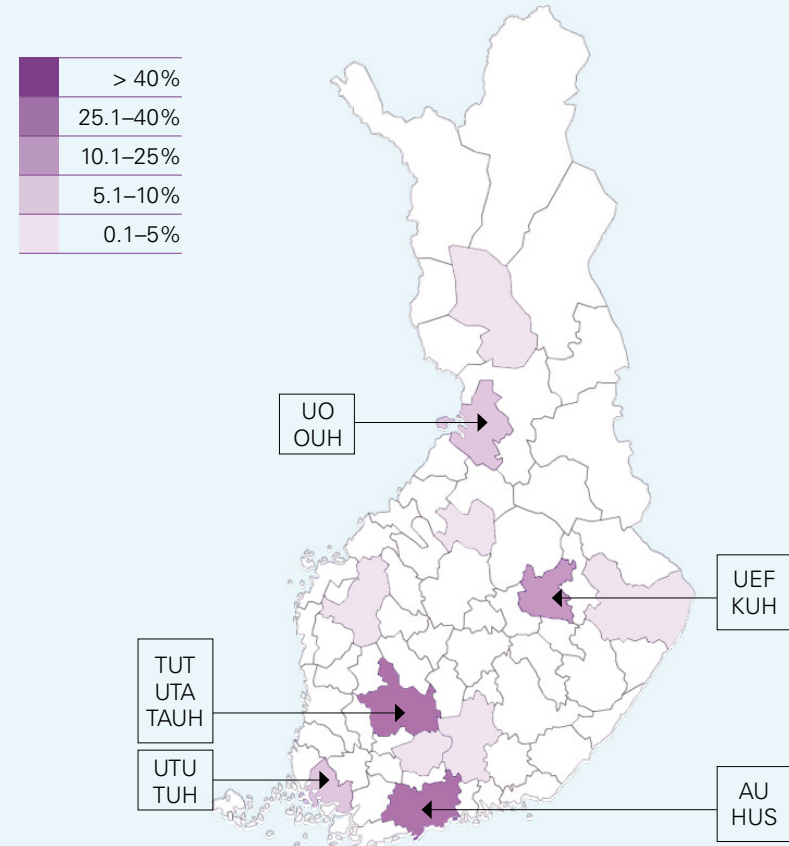
Figure 5.1 c.
Geographical locations of employed doctoral degree holders in materials science and technology.



In the data set, the total number of employed doctoral degree holders in materials science and engineering is 161 (includes 13 doctoral degree holders whose specific location was unknown). The universities and government research institutes relevant to the field are indicated for the subregions with a proportion larger than 5% of the survey respondents.

Source: Academy of Finland's survey on the role of doctoral degree holders in society, 2016.

Figure 5.1 d.
Geographical locations of employed doctoral degree holders in medical engineering and health technologies.



In the data set, the total number of employed doctoral degree holders in medical engineering and health technologies is 63 (includes 3 doctoral degree holders whose specific location was unknown). The universities relevant to the field and university hospitals are indicated for the subregions with a proportion larger than 5% of the survey respondents.

Source: Academy of Finland's survey on the role of doctoral degree holders in society, 2016.

5.2 Expert communities of doctoral degree holders

Besides being located in different parts of Finland and working for different types of employers, the doctoral degree holders make their contributions by belonging to different kinds of expert communities. In the survey, the respondents were asked to choose one to three¹⁸ expert communities that characterise their professional activities. The given options were:

- Research group or research network (e.g. focusing on a particular topic)
- Scientific/academic community (wider than above, e.g. consisting of researchers working in a research field)
- Occupational community (e.g. museum professionals, physicians, foresters)
- Research and/or development unit (e.g. within a company or public utility)
- Laboratory or research station (e.g. in hospital or experimental research)
- Expert organisation or network (e.g. in administration, business, or civil society)
- Local or regional community of experts (e.g. science park, business incubator)
- Educational community (e.g. college, society, or company with educational focus)

The expert communities the respondents chose differ between disciplines and employers¹⁹ (see Table 5.1). It is useful to note that the term “expert community” is by no means exact, and we need to remember possibility of the respondents’ different interpretations of what is meant.

Ecology

In ecology, respondents working in a university more often reported that they belonged to a research group or research network (82%) than to a scientific or academic community (68%). The proportions of respondents who chose these expert communities are of the same order for those working in government research institutes but much smaller for those working in public-sector or non-profit organisations or in a company.

The proportion of respondents who reported that they belonged to an expert organisation or network is higher than among all employed respondents for all employers, although for those working in a university the proportions are almost equal. Almost two-thirds of respondents in ecology working in public-sector or non-profit organisations and more than two-thirds of those working in a company reported that they belonged to an expert organisation or network while for all employed respondents the proportion was less than one-third. Doctoral degree holders in ecology working in a company more often reported that they worked in consulting or training than doctoral degree holders in other fields, which may explain the difference.²⁰

History

In history, 64% of the respondents working in a university reported that they belonged to a research group or research network and 85% of them belonged to a scientific or academic community. The proportions between these two communities are the other way around in ecology. The proportion of history respondents who reported that they belonged to an educational community is larger than for all employed respondents. Especially those who worked in public-sector or non-profit organisations or in a company reported that they belonged to an educational community (44% and 29%, respectively).

There were seven respondents in history working in a company who reported that they belonged to an educational community, and almost all of them also reported that teaching or education were included in their current job descriptions. Some reported that they occasionally gave lectures. Some reported that they were self-employed after retiring from a job in a school or that they were still working primarily in education and otherwise self-employed.

¹⁸ In the English version of the survey, the wording was “one or more” and the number of choices was not technically restricted to three. Altogether ten respondents marked four or five options.

¹⁹ This analysis takes into account the possibility for multiple types of employer. If a doctoral degree holder reported that they worked, for example, in a university and in a company, in Table 5.1 and Figure 5.2 they are shown in both groups “University” and “Company”.

²⁰ Proportions of doctoral degree holders working in consulting or training in company (from survey data): ecology 38%, history 21%, materials science and engineering 20%, and medical engineering and health technologies 15%.

Materials science and technology

Respondents in materials science and technology working in a university reported that they belonged to a research group or research network and a scientific or academic community almost as often (73% and 78 %, respectively). In government research institutes, the proportion of those belonging to a research group or research network equalled that of those in universities (73%), but the proportion of those belonging to a scientific or academic community was much lower (60%). The second most often chosen expert community among respondents working in a government research institute was research and/or development unit (67% of the respondents).

None of the 15 respondents in materials science and technology working in public-sector or non-profit organisations reported that they belonged to a research group or research network or scientific or academic community. As expected in this field, two-thirds of the respondents working in a company reported that they belonged to a research and/or development unit. Only one-tenth reported that they belonged to a scientific or academic community, which was a much lower proportion than for respondents in ecology or history working in a company.

Medical engineering and health technologies

Respondents in medical engineering and health technologies working in a university reported that they belonged to a scientific or academic community less often (40% of the respondents) than respondents in other fields. Only three out of the ten respondents reported that their most important employer or work situation was something else than a university or personal grant, and most of them indicated only one or two expert communities to which they belonged and still left the scientific or academic community out.

As for the respondents in medical engineering and health technologies working in public-sector or non-profit organisations, it can be noted that the proportion of respondents who reported that they belonged to a scientific or academic community is almost equal (35%) to that in university and higher than among all respondents in the field. Also, in public-sector or non-profit organisations, the proportion of those who reported that they belonged to a research group or research network was much larger among respondents in medical engineering and health technologies than among all respondents. A common employer for a doctoral degree holder in medical engineering and health technologies in public sector is a hospital, specifically a university hospital, which may explain the connection to academia even though the persons are not employed by a university. It may also explain the high proportion of doctoral degree holders in medical engineering and health technologies who worked in public-sector or non-profit organisations who reported that they belonged to an occupational community, 71%. This proportion is much higher than among respondents in other fields or even among respondents in medical engineering and health technologies working for other types of employers.

Open-ended responses

In addition to the survey options, the respondents were given an opportunity to report other expert communities in an open-ended question. Respondents working in a university also reported “faculty” or “administrative organisation” as the expert community to which they belong. Typical answers from respondents working in a company (as entrepreneur, self-employed or freelancer) were “independent work” or “just by myself”.

Table 5.1.
Expert communities to which the employed doctoral degree holders belong.

ECOLOGY

Type of employer Expert community	University	Research institute	Public-sector or non-profit organisation	Company	All employed respondents
Research group or research network	82%	72%	17%	8%	56%
Scientific/academic community	68%	68%	21%	29%	53%
Occupational community	14%	16%	21%	21%	17%
Research and/or development unit	5%	44%	8%	25%	16%
Laboratory or research station	8%	0%	0%	0%	4%
Expert organisation or network	17%	40%	63%	71%	38%
Local or regional community of experts	3%	0%	0%	0%	1%
Educational community	12%	8%	25%	4%	12%
Other expert community	2%	0%	4%	13%	4%
Number of respondents to the survey	66	25	24	24	139

HISTORY

Type of employer Expert community	University	Research institute	Public-sector or non-profit organisation	Company	All employed respondents
Research group or research network	64%	–	10%	29%	42%
Scientific/academic community	85%	–	23%	38%	57%
Occupational community	11%	–	28%	17%	17%
Research and/or development unit	9%	–	10%	13%	11%
Laboratory or research station	0%	–	0%	0%	0%
Expert organisation or network	14%	–	36%	29%	24%
Local or regional community of experts	2%	–	0%	0%	1%
Educational community	14%	–	44%	29%	25%
Other expert community	6%	–	8%	17%	8%
Number of respondents to the survey	66	1	39	24	130

continued »

Table 5.1.
Expert communities to which the employed doctoral degree holders belong (continued).

MATERIALS SCIENCE AND TECHNOLOGY

Type of employer Expert community	University	Research institute	Public-sector or non-profit organisation	Company	All employed respondents
Research group or research network	73%	73%	0%	20%	41%
Scientific/academic community	78%	60%	0%	10%	37%
Occupational community	3%	7%	20%	11%	9%
Research and/or development unit	17%	67%	20%	68%	46%
Laboratory or research station	7%	13%	0%	10%	8%
Expert organisation or network	8%	20%	47%	29%	23%
Local or regional community of experts	0%	0%	13%	2%	2%
Educational community	17%	7%	40%	2%	11%
Other expert community	0%	0%	7%	4%	2%
Number of respondents to the survey	59	15	15	82	171

MEDICAL ENGINEERING AND HEALTH TECHNOLOGIES

Type of employer Expert community	University	Research institute	Public-sector or non-profit organisation	Company	All employed respondents
Research group or research network	72%	–	59%	24%	47%
Scientific/academic community	40%	–	35%	12%	26%
Occupational community	28%	–	71%	24%	35%
Research and/or development unit	12%	–	12%	55%	32%
Laboratory or research station	12%	–	35%	9%	16%
Expert organisation or network	28%	–	41%	27%	30%
Local or regional community of experts	8%	–	0%	12%	8%
Educational community	0%	–	12%	6%	5%
Other expert community	0%	–	0%	0%	0%
Number of respondents to the survey	25	2	17	33	77

continued »

Table 5.1.
Expert communities to which the employed doctoral degree holders belong (continued).

ALL RESPONDENTS

Type of employer → Expert community ↓	University	Research institute	Public-sector or non-profit organisation	Company	All employed respondents
Research group or research network	73%	71%	18%	19%	46%
Scientific/academic community	72%	62%	20%	15%	44%
Occupational community	11%	11%	32%	15%	16%
Research and/or development unit	11%	53%	11%	51%	27%
Laboratory or research station	6%	4%	6%	7%	6%
Expert organisation or network	15%	33%	45%	35%	29%
Local or regional community of experts	2%	2%	2%	3%	3%
Educational community	12%	7%	33%	8%	14%
Other expert community	3%	0%	6%	7%	5%
Number of respondents to the survey	228	45	99	181	553

All employed doctoral degree holders include 33 respondents who could not be allocated to the four research fields. The table does not include answers from doctoral degree holders in history and medical engineering and health technologies working in government research institutes (N = 1 and N = 2, respectively). Of all respondents to the survey, 4% did not answer this question.

The survey question was: "What kind of expert community do you currently belong to? Choose one or more expert communities that characterise your professional activities." The tables show the shorter forms for the options. For the exact forms, see Appendix 1. Questionnaire.

Source: Academy of Finland's survey on the role of doctoral degree holders in society, 2016.

5.3 Reach of contribution

The doctoral degree holders were also asked to estimate the geographical area in which or extent to which the activities of their expert community have an effect: Finland (local or regional); Finland (national); other country; international; universal or independent of location. They could choose only one option.

In general, most of the doctoral degree holders working in a university or in a company reported that the area where the activities of their expert communities had an effect was international or universal. Most of those who were working in a government research institute or in other public-sector or non-profit organisations reported that the activities of their expert communities had an effect in Finland (nationally or locally/regionally) (see Figure 5.2). There were variations between different research fields, however.

Ecology

About one-fourth (24%) of those in ecology who were working in a government research institute reported that the activities of their expert community had an effect internationally, which is less than on average (33%). While over half (52%) of all doctoral degree holders working in public-sector or non-profit organisations reported that their expert community had an effect in Finland at local or regional level and one-third (33%) that it had an effect in Finland at national level, for doctoral degree holders in ecology the proportions between the two groups were almost equal (42% and 38%, respectively). Most of the respondents in ecology working in a company reported that the intended effects of their activities appeared in Finland, either nationally (42%) or locally/regionally (17%).

History

In contrast to other fields, most of the doctoral degree holders in history working in a university reported that the activities of their expert community had an effect in Finland. The proportions of those who reported that the activities of their expert community had an effect internationally and of those who reported that they had an effect nationally were almost equal (39% and 38%, respectively). Of the doctoral degree holders in history working in a company, 92% reported that the intended effects of their activities appeared in Finland, the proportion being much larger than on average.

Materials science and technology

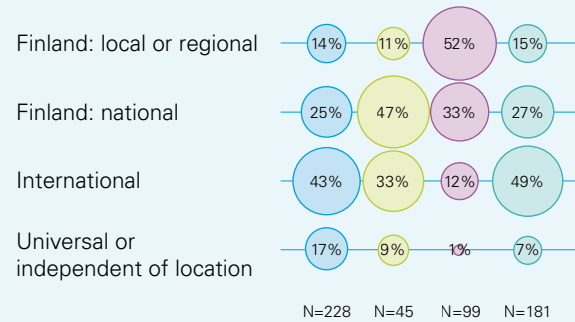
Among the 15 doctoral degree holders in materials science and technology working in a government research institute, the proportions of those who reported that the area where the activities of their expert communities had an effect was international and those who reported that it was national were equal (47%). Of the respondents working in a company, 70% reported that the intended effects of their activities manifested themselves internationally, the proportion being much larger than in other fields.

Medical engineering and health technologies

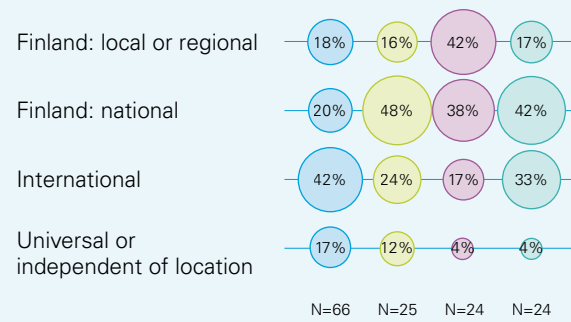
About one-third (29%) of the 17 doctoral degree holders in medical engineering and health technologies working in public-sector or non-profit organisations reported that the activities of their expert community had an effect internationally. In general, only about one-tenth (12%) of the respondents working for the same type of employer reported the same. The proportion of respondents in medical engineering and health technologies working in a company who reported that the intended effects of their activities appeared internationally was slightly smaller than on average (45% and 49%, respectively). On the other hand, about one-tenth (12%) reported that the effects appeared universally, which is more than on average (7%).

Figure 5.2.
Areas where the activities of the expert community of employed doctoral degree holders have an effect.

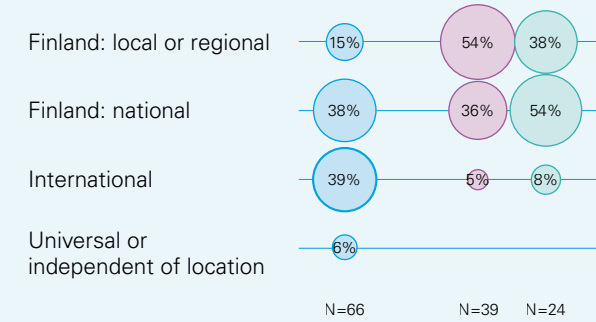
ALL RESPONDENTS



ECOLOGY

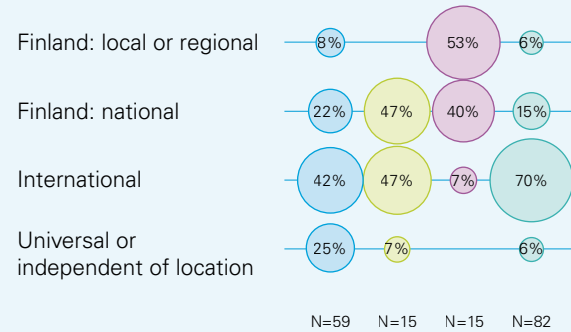


HISTORY

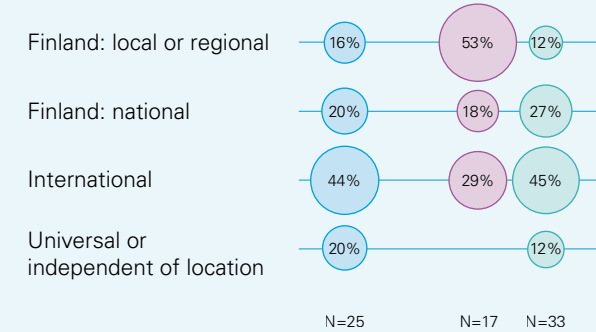


- University (incl. personal scholarship or grant)
- Government research institute
- Other public-sector or non-profit organisation
- Company (incl. entrepreneurs, self-employed and freelancers)

MATERIALS SCIENCE AND TECHNOLOGY



MEDICAL ENGINEERING AND HEALTH TECHNOLOGIES



All employed respondents include 33 doctoral degree holders who could not be allocated to the four research fields. The figure does not include data from one respondent in the field of history and two respondents in the field of medical engineering and health technologies who were working in a government research institute and a total of four respondents who had marked the option "other country". Of all employed respondents, seven did not answer this question.

The survey question was: "Where do the activities of this expert community have an effect? Please specify the area in which the intended effects of your activities manifest themselves."

Source: Academy of Finland's survey on the role of doctoral degree holders in society, 2016.

6 Significance of the doctoral degree

As shown in the previous chapter, doctoral degree holders have broad and varied influence in society as examined based on geographical location or different expert communities. In this chapter, the focus is on the significance of the doctoral degree. This is examined through the importance of research-based abilities for doctoral degree holders' careers and the significance of research-based expertise for society.

6.1 Importance of research-based abilities for doctoral degree holders' careers

In the survey, the doctoral degree holders were asked which research-based abilities had been important for their careers. They could assess the importance of the following abilities on a scale from one to five, five being "very important" and one being "unimportant":

- Scientific content or substance
- Broad understanding of own field
- General understanding of scientific research and academia at large
- Capacity for multisectoral/multidisciplinary collaboration
- Contacts with researchers and other scientific players
- Skills related to searching for, adopting and critically examining knowledge
- Ability to piece together and solve problems
- Managing large-scale projects.

The process of pursuing a doctoral degree gives the doctoral degree holder many abilities besides research-related ones. An ability to piece together and solve problems and skills related to searching for, adopting and critically examining knowledge were regarded as very important regardless of the research field or employer (see Figures 6.1 and 6.2). Only the doctoral degree holders working in public-sector or non-profit organisations had an average just under 4.5 in the statements concerning the importance of the above-mentioned skills for their careers. Furthermore, over 80% of the respondents in all research fields and employers reported that these skills had been fairly important or very important for their careers.

For the two other generic skills (capacity for multisectoral or multidisciplinary collaboration and managing large-scale projects), there was not a big difference in their importance among doctoral degree holders working for different types of employers (see Figure 6.1).

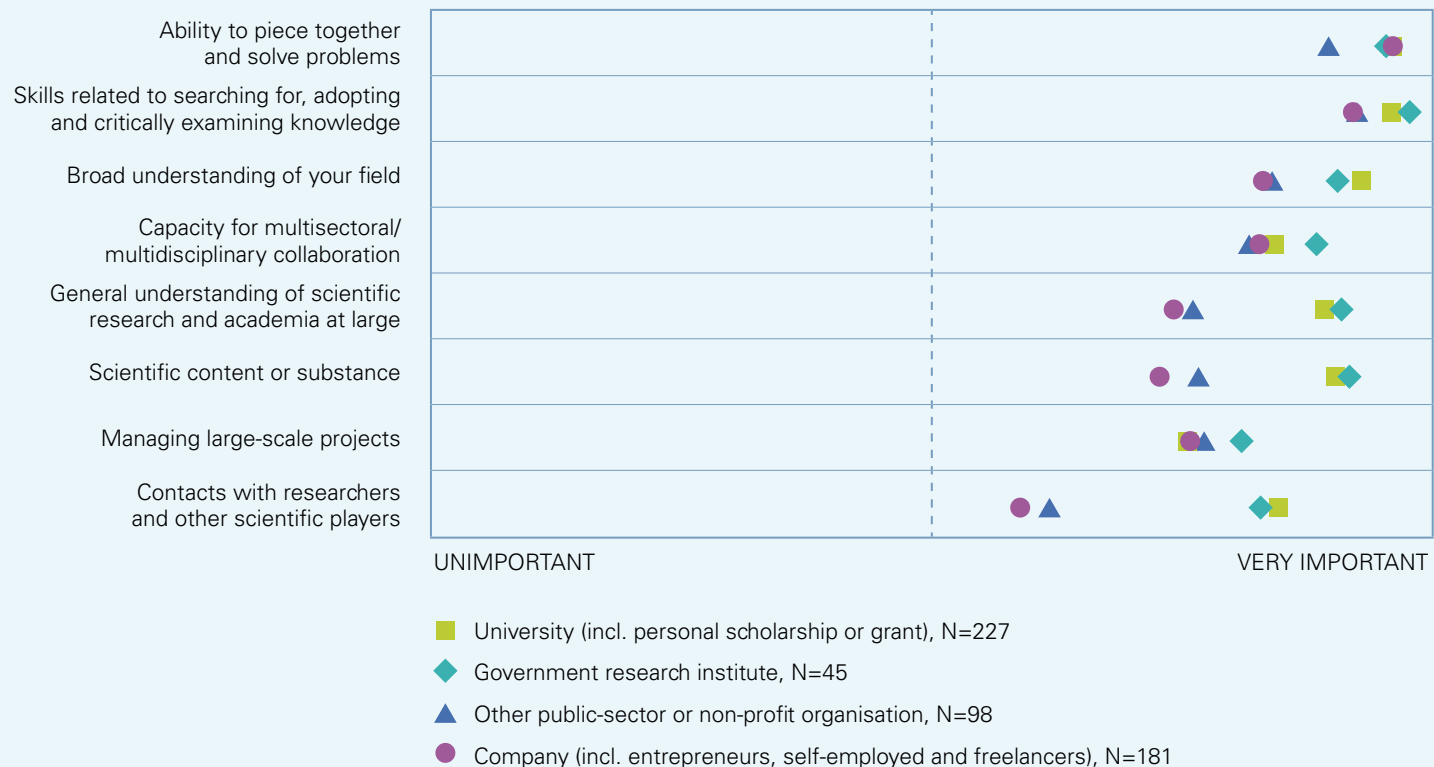
An analysis of the skills that are more closely related to the specifics of the field of research shows a clear distinction between those who work in a university or in a government research institute and those who work in public-sector or non-profit organisations or in a company. The average score for responses to statements about the importance of a general understanding of scientific research and academia at large, scientific content or substance and contacts with researchers and other scientific players was under 4.0 among doctoral degree holders working in public-sector or non-profit organisations or in a company. At the same time, a score of 4.0 corresponds to "fairly important".

An analysis of the importance of research-based abilities among doctoral degree holders in different research fields (see Figure 6.2) shows that the difference in the importance of the skills that are more closely related to research is not as big as it is for doctoral degree holders working for different types of employers. Only in contacts with researchers and other scientific players there is a clear difference between doctoral degree holders in ecology and history and doctoral degree holders in materials science and technology and medical engineering and health technologies. The latter two reported that this was less important. While in other research fields a broad understanding of one's own field is among the top three skills, when assessed by the average of responses, in medical engineering and health technologies the capacity for multisectoral or multidisciplinary collaboration was clearly more important.

Figure 6.1.

Importance of research-based abilities for the careers of doctoral degree holders working for different types of employers.

The figure shows the average of responses, given on a five-point scale, of doctoral degree holders working for different types of employers.



The survey question was: "Which research-based abilities have been important in your career? Please assess the importance of the following abilities in terms of your career."

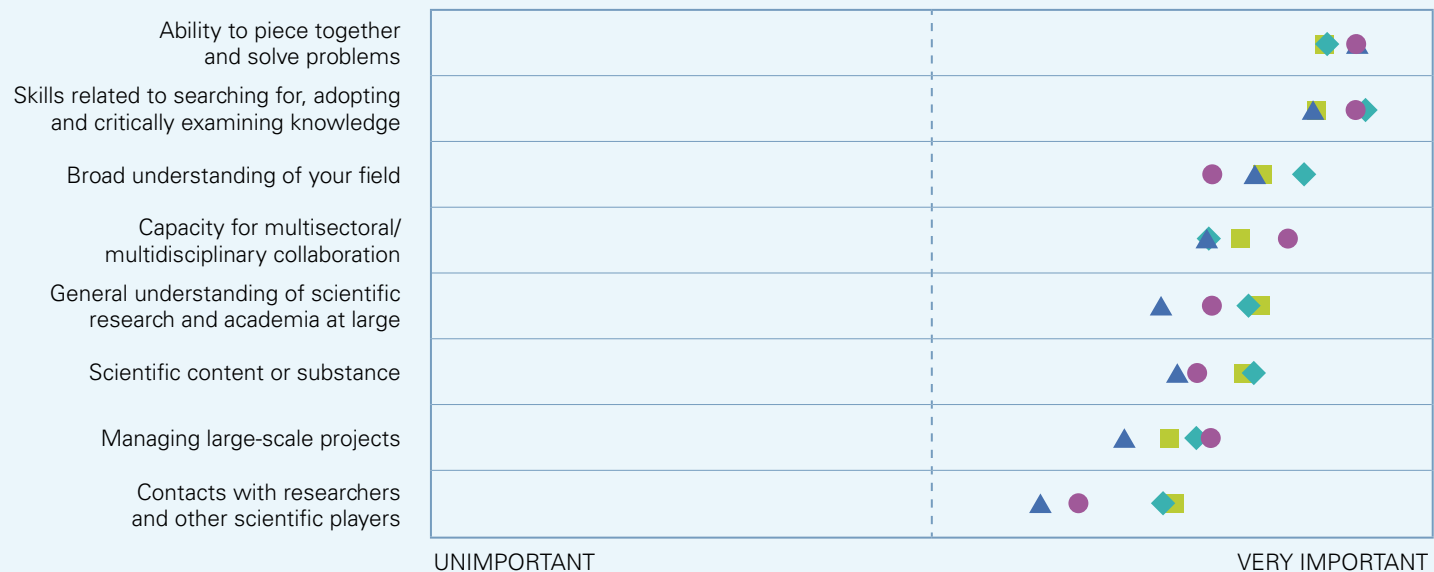
- 5 = very important
- 4 = fairly important
- 3 = neither important nor unimportant
- 2 = fairly unimportant
- 1 = unimportant
- IDK = I don't know

The averages do not include IDK answers. The employer choices given in the questionnaire were as follows: university; government research institute; other public-sector organisation; private or state-owned company/enterprise; independent entrepreneur, self-employed or freelancer; personal scholarship/grant; non-profit organisation; parental leave; unemployed; and other employer or work situation. Doctoral degree holders who selected any of the last three choices are not included in the figure.

Source: Academy of Finland's survey on the role of doctoral degree holders in society, 2016.

Figure 6.2.
Importance of research-based abilities for the careers of doctoral degree holders in different research fields.

The figure shows the average of responses, given on a five-point scale, of employed doctoral degree holders in different research fields.



- Ecology, N=124
- ◆ History, N=101
- ▲ Materials science and technology, N=159
- Medical engineering and health technologies, N=63

The survey question was: "Which research-based abilities have been important in your career? Please assess the importance of the following abilities in terms of your career."

- 5 = very important
- 4 = fairly important
- 3 = neither important nor unimportant
- 2 = fairly unimportant
- 1 = unimportant
- IDK = I don't know

The averages do not include IDK answers.

Source: Academy of Finland's survey on the role of doctoral degree holders in society, 2016.

There are some differences in the importance of research-based abilities if analysed in terms of both research fields and types of employers.²¹ Among all respondents, there was not a very big difference between the doctoral degree holders working for different types of employers in the importance of a broad understanding of one's own field. However, in ecology, those who were working in a company found this less important than those who were working elsewhere. In history, the average of responses to each statement was the smallest among those who were working in public-sector or non-profit organisations. Among all respondents, the averages of responses of doctoral degree holders working in public-sector or non-profit organisations were the smallest only for some statements.

Doctoral degree holders in materials science and technology who work in public-sector or non-profit organisations clearly regard contacts with researchers and other scientific players as less important than others, with the average of responses being as low as under 3.0 (“neither important nor unimportant”). It thus seems that when working for these types of employers, there is less use for specific expertise in their field. At the same time, it is good to remember that there were only 15 respondents in materials science and technology from public-sector or non-profit organisations (9% of the respondents). Doctoral degree holders in medical engineering and health technologies working in public-sector or non-profit organisations found research-based abilities more important than those from other research fields. The average of responses is above 4.0 for all abilities except for contacts with researchers and other scientific players, for which it was slightly smaller.

In open-ended questions, the respondents were also given an opportunity to enter other abilities than the listed research-based abilities. Common answers included an ability to write scientific texts, language skills, interaction skills and an ability to work independently.

6.2 Significance of research-based expertise for society

It is evident that the doctoral degree has impact on the doctoral graduates themselves, but with the doctoral degree holders the knowledge and skills obtained during the doctoral research work have an impact also more widely on society. Research-based knowledge and skills are part of the self of doctoral degree holders and thus it influences their everyday lives both at work and in their leisure time. This was noticeable also in the open-ended responses where

the doctoral degree holders were asked where, how and for what purposes they use their research-based abilities.

Besides doing research, educating future experts and supervising master's and doctoral theses, doctoral degree holders working in research tasks in a university or government research institute use their research-based abilities to contribute to society in many different issues. Some respondents in ecology working in a university or in a government research institute reported that they influenced decision-making on environmental issues by disseminating their research results to end-users, by cooperating with environmental authorities or by belonging to a working group appointed to solve environmental issues. There were respondents both in ecology and in history working in a university who reported that they had societal impact through popular science writings. Some respondents in history reported that their writings do more than spread information about their own research – they also bring issues to public discussion and deepen the cultural understanding of the public. Doctoral degree holders in materials science and technology working in a university or in a government research institute often use their research-based abilities in collaboration with companies to commercialise research-based innovations. Some respondents in medical engineering and health technologies, too, reported that they cooperated with companies or offered them consultation. Some doctoral degree holders in medical engineering and health technologies who had a post both at a university and at a university hospital reported that they used their research-based abilities to improve the treatment of patients and to influence legislation.

At universities, doctoral degree holders also work in other tasks than research or education. These include administrative tasks, research-supporting tasks and tasks concerning the development of doctoral education. These tasks may not require competence in the substance of the research, but doctoral education does develop understanding of how research is done and many other skills needed in these other tasks. Some respondents working in a university also reported that a doctoral degree had given the credibility needed in their community.

Doctoral degree holders in ecology working in public-sector or non-profit organisations often reported that they used their research-based abilities to disseminate knowledge both in their own organisation and to support policy-making. In ecology, history and materials science and technology, a common area to utilise substance-related and other research-based

²¹ A figure of this is not included in this report, but the data can be found in the Aila Data Service provided by the Finnish Social Science Data Archive (<https://services.fsd.uta.fi/catalogue> » FSD3159 Survey on the Role of Doctoral Degree Holders in Society 2016).

abilities was teaching or developing teaching methods or educational materials. Some doctoral degree holders in medical engineering and health technologies reported that their work included educating people, not students in schools but professionals in their work community.

There were some respondents in history working in public-sector or non-profit organisations whose working tasks were related to compiling and developing archives. They felt they were also building culture and intellectual wellbeing. In history, there were also some doctoral degree holders who reported that they did not use their research-based abilities at all. However, this is again a subjective judgement.

Doctoral degree holders in materials science and technology working in public-sector or non-profit organisations often reported that the doctoral research had given them competence to adopt and apply scientific literature and new technology and to communicate them to others. Being able to develop medical devices and measurement techniques was part of the work of some respondents in medical engineering and health technologies, and they felt doctoral research had given them the necessary proficiency.

Many doctoral degree holders in ecology working in a company reported that they used their research-based abilities in monitoring environmental effects and developing Finland's environmental sector but also in providing consultancy in environmental issues. However, like with the history doctorate holders above, there were also a few respondents in ecology who felt that they did not use their research-based expertise at all in their current job.

In history, doctoral degree holders more often work as entrepreneurs, self-employed or freelancers than as employees in a company. Many of them reported that they worked as an author of nonfiction books and that they also gave lectures related to their research work. Some of these respondents had already retired from their paid work.

Doctoral degree holders both in material sciences and technology and in medical engineering and health technologies working in a company often reported that they used their substance-related competence in their work. Either the product their company produced was based on their dissertation work or later research work or the competence gained from research work was needed to perform their task. The respondents also reported that their substance-related competence and expertise in research work helped them to network and establish connections within academia.

Based on the doctoral degree holders' answers to the question of the significance or added value of their research-based expertise for society, it clearly seems that many of the respondents feel that they really contribute to society. Besides enhancing their own research field, they also produce knowledge to support decision-making, enhance people's knowledge of the surrounding world, its history and culture, influence innovations and the development of new products, and develop practices in different professions. However, many of the doctoral degree holders said that it is not just how they influence society as individuals that matters but also how science and researchers as a community influence society.

7 Conclusions

The broader impact of research in society is widely discussed today: the questions of how one should define, evaluate, and support it have become one of the main themes in science and innovation policy. One important route to broader impact of research is through people working outside academia who have been trained in research, e.g., have a doctoral degree. With their research-based knowledge and skills they have impact on various sectors of society. This report provides an overview of the results of the survey of doctoral degree holders to accumulate concrete examples and data on the topic.

The total number of doctoral degrees awarded annually in Finland has increased since the early 1990s. At that time, the circumstances were favourable for increasing researcher training. The growth has continued in the 2000s, although the speed of the growth has subsided. The growth rates vary between different research fields, and in some fields the number has even decreased during 2007–2015. Collecting and utilising data and case studies about the significance of the doctoral degree for doctoral candidates and for society is essential when debating whether to increase or decrease the number of doctoral graduates overall or in a certain research field.

The careers and employment situations of doctoral degree holders are diverse. Doctoral training is not exclusively meant for those who are pursuing an academic career. Most doctoral degree holders work outside university, although the proportion varies across the research fields. Some doctoral degree holders have worked for the same or at least the same type of employer outside university already before gaining the doctorate, while others are pursuing a job outside university only after their degree. Different career paths are something to keep in mind when designing doctoral programmes. Continuing to a doctoral programme straight after the master's degree has its benefits, as the doctoral graduate can then sooner start a job that fits their researcher training. On the other hand, spending some time outside academia after the master's degree may give the doctoral candidate experience and points of view that are beneficial in their studies.

There are also doctoral degree holders who work for more than one employer, usually one of them being a university. Doctoral degree holders may want to maintain their contacts to academia by, for example, occasionally giving lectures. Some of them may want to continue their own research work with a personal grant. However, this may also reflect changes in working life: it is becoming increasingly common to either have multiple employers or to be engaged in entrepreneurship or freelancer work besides the daily job.

Doctoral degree holders work all over Finland, although they are more concentrated in the areas with universities and research institutes. Besides working for a certain employer or for multiple

employers, doctoral degree holders belong to different expert communities. The boundaries of the expert communities are not fixed and they exceed the boundaries between workplaces. The concept of belonging to an expert community is subjective, of course, and two individuals working in the same kinds of tasks may see the communities to which they belong very differently. The areas where the effects of the actions of doctoral degree holders manifest themselves can vary through the activities of the expert communities. The effects can be very local or they can appear at international or even universal level, i.e. be independent of location. A doctoral degree holder can sometimes benefit their own local community by, for example, developing their own practices, while with the same ideas introduced to a wider audience the doctoral degree holder can benefit their colleagues around the world as well.

A doctoral degree gives qualifications to work as a researcher or as an expert in demanding research and development tasks. Besides that, the research work carried out while pursuing the doctoral degree provides generic skills that the doctoral degree holders value in their career. Skills related to searching for, adopting and critically examining knowledge and the ability to piece together and solve problems are needed widely in working life, whether related to research in a university or work in public-sector and non-profit organisations or in companies. Thus, the possible employers of doctoral degree holders should not be limited only to those relevant to the substance of their doctoral dissertation but should also extend to those that could benefit the wider spectrum of skills of these highly educated experts.

Doctoral degree holders and their expert communities do have an impact on society. While the added value of the actions of an individual doctoral degree holder for society may not be significant, the cumulative added value of research and research-based expertise is. These skilled experts influence how we interpret the surrounding world and affect decision-making, practice development and the development of new products and innovations, among other things. These are the same societal contributions that are expected of scientific research, or the roles of science in society, as discussed in the State of Scientific Research in Finland 2016 review.²²

The data collected for this report would enable an even deeper analysis of the careers, work tasks and research-based abilities of doctoral degree holders and the added value of their expertise for society. Similar kinds of surveys could also be conducted in other research fields, although the four research fields that were the focus of the present survey provide a good overview of doctoral degree holders with different backgrounds. The discussion on the education, employment and role of doctoral degree holders will continue and reviews of this kind would provide valuable insights to that discussion.

²² See, for example, www.aka.fi/en » Research & science policy » State of scientific research » Broader impact of research in society.

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Appendix 1. Questionnaire

Academy of Finland's survey on the role of doctoral degree holders in society

BACKGROUND INFORMATION

1. **When did you receive your doctoral degree? ***
2. **Which university awarded your doctoral degree? ***
 - Aalto University (or earlier HSE, UIAH, HUT)
 - University of Helsinki
 - University of Eastern Finland (or earlier University of Kuopio, University of Joensuu)
 - University of Jyväskylä
 - University of Lapland
 - Lappeenranta University of Technology
 - University of Oulu
 - Hanken School of Economics
 - University of the Arts Helsinki (or earlier Sibelius Academy, Theatre Academy, Academy of the Fine Arts)
 - Tampere University of Technology
 - University of Tampere
 - University of Turku (or earlier TSE)
 - University of Vaasa
 - Åbo Akademi University
3. **Which of the following fields does your doctorate mostly represent? ***

Choose the last option only if your doctoral degree or dissertation has no relevant connection to any of the mentioned fields.

 - Ecology, evolutionary biology and ecophysiology
 - History
 - Materials science and technology
 - Medical engineering and health technologies
 - None of the above is relevant/Other, please specify

4. **Your current age**

5. **Your gender**

- Female
- Male

DISSERTATION RESEARCH AND CAREER

6. **Dissertation research as part of your work history**

Where have you worked before, during and after your dissertation research? Please choose all alternatives that apply to your situation. Work during and before Master's (or equivalent) studies are not taken into account.

	Before	During	After
University	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Government research institute	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other public sector organisation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Private or state-owned company/enterprise	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Non-profit organisation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Self-employed entrepreneur or freelancer	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Personal scholarship/grant	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Parental leave	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Unemployed	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other employer or work situation, please specify	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

7. **Number of different employers after your dissertation research**

Working as self-employed entrepreneur, freelancer or scholarship/grant holder is not taken into account.

- 0
- 1
- 2-4
- 5 or more

CURRENT EMPLOYER AND DUTIES

8. Your current employer or work situation *

Choose one or more options. In the accompanying text field(s), enter the name of or other information on your employer (optional). Mark the most important in the later column.

- University _____ ○
- Government research institute _____ ○
- Other public-sector organisation _____ ○
- Private or state-owned company/enterprise _____ ○
- Non-profit organisation _____ ○
- Independent entrepreneur, self-employed or freelancer _____ ○
- Personal scholarship/grant _____ ○
- Parental leave _____ ○
- Unemployed _____ ○
- Other employer or work situation, please specify _____ ○

9. Where is your (primary) workplace/post located? *

- In Finland, please enter the postal code _____
- Abroad, please enter the country _____
- Other, please specify _____

10. Which of the following tasks are included in your current job description?

Choose one or more options. This classification is used in the national career monitoring of Master's and doctoral degree holders; it does not cover all dimensions of expert work, but you can specify your selection(s) in the accompanying text field(s).

- Research or R&D _____
- Teaching or education _____
- Planning or development _____
- Managerial or supervisory duties _____
- Administrative duties _____
- Customer service or patient care _____
- Consulting or training _____
- Office work _____
- Financing and financial administration _____
- Communications and media _____

- Marketing and sales _____
- Legal work _____
- Religious work _____
- Artistic work _____
- Other, please specify _____

IMPORTANCE OF RESEARCH-BASED ABILITIES IN CAREER

In this section, we will survey the importance of research-based knowledge, understanding, vision and skills in your career (hereafter: "research-based abilities"; cf. elements listed in question 11).

11. Which research-based abilities have been important in your career?

Please assess the importance of the following abilities in terms of your career.

(5 = very important, 4 = fairly important, 3 = neither important nor unimportant, 2 = fairly unimportant, 1 = unimportant, IDK = I don't know)

	5	4	3	2	1	IDK
Scientific content or substance	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Broad understanding of your field	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
General understanding of scientific research and academia at large	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Capacity for multisectoral/multidisciplinary collaboration	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Contacts with researchers and other scientific players	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Skills related to searching for, adopting and critically examining knowledge	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ability to piece together and solve problems	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Managing large-scale projects	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other ability, please specify _____	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

12. In what context have the research-based abilities been useful in your career?

Please assess the importance of your research-based abilities in the following contexts.

(5 = very important, 4 = fairly important, 3 = neither important nor unimportant, 2 = fairly unimportant, 1 = unimportant, IDK = I don't know)

	5	4	3	2	1	IDK
Applying for your current job	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Performing your current duties	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recruitments over the course of your career	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Performing your previous duties	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

13. What added value have you gained in the workplace by being trained as a doctor?

Please assess the extent to which your research-based abilities have enhanced your career opportunities in the following respects.

(5 = very much, 4 = fairly much, 3 = somewhat, 2 = a little, 1 = not at all, IDK = I don't know)

	5	4	3	2	1	IDK
Employment, position, or career development	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
More demanding or interesting duties	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Influence, or opportunities to make a difference	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Development of personal outlook or vision	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other added value, please specify _____	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

BROADER IMPACT OF RESEARCH-BASED ABILITIES

In this section, we will survey the impact of your research-based abilities beyond your own work/career.

14. What kind of expert community do you currently belong to?

Choose one or more expert communities that characterise your professional activities.

- Research group or research network (e.g. focusing on a particular topic)
- Scientific/academic community (wider than above, e.g. consisting of researchers working in a research field)
- Occupational community (e.g. museum professionals, physicians, foresters)
- Research and/or development unit (e.g. within a company or public utility)
- Laboratory or research station (e.g. in hospital or experimental research)
- Expert organisation or network (e.g. in administration, business, or civil society)
- Local or regional community of experts (e.g. science park, business incubator)
- Educational community (e.g. college, society, or company with educational focus)
- Other expert community, please specify _____

15. Where do the activities of this expert community have an effect?

Please specify the area in which the intended effects of your activities manifest themselves.

- Finland: local or regional
- Finland: national
- Other country
- International
- Universal or independent of location

16. In what ways do your current work/professional activities relate to academic research and know-how? *

Please assess the relevance of the following activities in your current job description. (5 = highly relevant, 4 = relevant, 3 = somewhat relevant, 2 = of minor relevance, 1 = irrelevant, IDK = I don't know)

	5	4	3	2	1	IDK
Producing new knowledge and/or educating new professionals	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Applying scientific knowledge in practice (e.g. innovation activities, development work)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Conveying research-based expertise and skills to junior colleagues (e.g. mentoring, training)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Distributing research-based knowledge to other experts (e.g. multisectoral collaboration, mobility between organisations)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Disseminating, interpreting or critically examining research-based knowledge (e.g. science communication, popular articles)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Identifying and highlighting (new) demands for research, education or innovation (e.g. communicating the needs of public sector to the academic community)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Administrating research, education or innovation activities (e.g. funding, structural development)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Monitoring and commenting on research, education or innovation activities (e.g. statements, reports)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

17. Please briefly describe where, how and for what purpose you use your research-based abilities.

18. Factors that influence the impact of research-based abilities

Please assess the following factors in terms of your current professional activities.

Your research-based expertise:

- a) My research-based expertise is
 irrelevant or outdated relevant and up-to-date
- b) My doctoral degree
 weakens my credibility strengthens my credibility
- c) My research-based expertise
 does not empower me to pursue important goals empowers me to pursue important goals
- d) For sharing and using my research-based expertise
 there is no time or resources there are enough time and resources

Your professional environment:

- e) Trust in research-based knowledge/expertise
 is weak is strong
- f) The relevance of research-based knowledge/expertise
 is often questioned is mostly indisputable
- g) The relative importance of research-based knowledge/expertise
 is often low in practice is often high in practice
- h) Competition for research-based knowledge/expertise
 limits its extensive use encourages its extensive use

19. Please elaborate on the factors that enable and limit the use of your research-based expertise.

Enabling factors

Limiting factors

20. What is the significance/added value of your research-based expertise for society? *

Please describe in concrete terms what tasks in society would remain unaccomplished were you not to contribute to them with your research-based expertise. Consider both the impact of your expert community and your own contribution to the performance of that community

Appendix 2. Abbreviations

Universities

AU = Aalto University

TUT = Tampere University of Technology

UEF = University of Eastern Finland

UH = University of Helsinki

UJ = University of Jyväskylä

UO = University of Oulu

UTA = University of Tampere

UTU = University of Turku

ÅAU = Åbo Akademi University

Government research institutes

EVIRA = Finnish Food Safety Authority

FMI = Finnish Meteorological Institute

LUKE = Natural Resources Institute Finland

SYKE = Finnish Environment Institute

VTT = VTT Technical Research Centre of Finland Ltd

University hospitals

HUS = Helsinki University Hospital

KUH = Kuopio University Hospital

OUH = Oulu University Hospital

TAUH = Tampere University Hospital

TUH = Turku University Hospital



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