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Commercialization at Finnish universities: Researchers' perspectives on the motives and challenges of turning science into business

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COMMERCIALIZATION AT FINNISH UNIVERSITIES

Researchers' Perspectives on the Motives and Challenges of Turning Science into Business

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ABSTRACT: For developed countries, continuous innovation has been a prerequisite for economic growth for some time. Because radical innovations often require considerable slack and freedom in researching the relevant underlying phenomena, universities are considered the primary loci for generating knowledge leading to radical leaps in the development of platforms on which future technologies build. Thus, to facilitate the improvement of premises for university research and its application in industry, much effort has been spent on understanding university innovation processes and the transfer of technology between universities and companies. Much of the research and the related discussions have been conducted on either the national, regional or organizational levels. The focus on institutional actors has largely orphaned another fundamentally important actor: the individual researcher. This report examines individual university researchers and their role in the commercialization of research in Finland.

Based on a survey of roughly 2800 researchers active in different fields of science at 11 Finnish research universities, this report covers a variety of topics ranging from university-industry collaboration to ownership of intellectual property and the commercialization services provided to researchers. The primary theme uniting these topics, however, is the subjective motivation for researchers to engage in the commercialization of their research. Why do researchers cooperate with companies, and how do they expect to benefit from collaboration? What are the reasons why some researchers to commercialize their results, while others distance themselves from such endeavors? Do certain dedicated university services support researchers in their commercial ambitions or actually inhibit them? These are the specific questions this report seeks to descriptively answer.

The results establish that commercial motives play only a minor role in the various activities in which researchers engage. For instance, potential commercial aspects have almost no impact on the choice of a researcher's research orientation. Furthermore, direct industrial collaboration is relatively uncommon among researchers. Even those researchers that have experience with industry collaboration reported that collaboration mostly serves academic ends such as securing research funding and searching for new research ideas. In addition, only 10% of all researchers have received complementary business education. Given that approximately 40% of researchers are believed to have produced inventions with commercial potential, 10% seems a fairly small share. This is also reflected in the researchers' clear lack of familiarity with the principles that govern the allocation of ownership rights to inventions that arise from academic research, a prerequisite to any commercial endeavors.

In parallel with these findings, the propensity of researchers to commercialize their results is much less affected by economic factors such as potential economic returns than it is by altruistic, socio-cultural, or personal motives. This makes designing proper incentive mechanisms difficult. The three most important factors mentioned by inventors who have made the decision to facilitate the commercialization of their inventions include (i) the inventions' potential to have a beneficial impact on society, (ii) the researchers' ambition of self-fulfillment and (iii) securing funding for academic research. Societal goals and reasons related to pure intrinsic ambition seem to dominate other motives. It seems that *commercialization* and related *economic* aspects bear little value to researchers.

Regarding support in commercialization, Finnish researchers are quite satisfied with the services provided to them by their respective research and innovation service units. Only a closer look at the possible needs of researchers and the degree that the service units match these needs through services reveals the true challenges regarding the operation of the units. In fact, the match between needs and provided services seems to be rather weak, and many researchers indicate that they do not need most of the services in the first place. This leads to

only one conclusion: the service units are not an integral part of the university culture as yet. Being satisfied with services that do not match needs tells us that researchers have not yet embraced such services as a relevant part of their work or of the technology transfer process. To remedy this situation, much emphasis needs to be put on communicating the range of available services to the research community. This is a first step. The second step would be to design a set of services that address the true needs and ambitions of researchers and provide proper incentives for researchers to participate in the transfer of their research results.

KEY WORDS: Commercialization of research, university-industry collaboration, motives for commercialization, challenges of commercialization, innovation support services

JEL: O30, O38, O33, O34

TAHVANAINEN, Antti-Jussi – **NIKULAINEN**, Tuomo, **KAUPALLISTAMINEN SUOMALAISISSA YLIOPISTOISSA – Kannustimet ja haasteet tutkijoiden näkökulmasta**. Helsinki: ETLA, Elinkeinoelämän Tutkimuslaitos, The Research Institute of the Finnish Economy, 2010, 47 s. (Keskusteluaiheita, Discussion papers, ISSN 0781-6847; No. 1234).

TIIVISTELMÄ: Kehittyneissä maissa talouskasvun yksi edellytys on jo pitkään ollut jatkuva innovaatiotoiminta. Yliopistoja on pidetty sopivimpana toimijoina tuottamaan tähän tarvittavaa tietoa, koska radikaalien innovaatioiden synnyttäminen edellyttää usein perusilmiöiden tutkimukseen tarvittavaa vapautta ja resursseja. Yliopistoinnovaatioprosessien sekä yliopistojen ja yritysten välisen teknologiansiirron ymmärtämiseen on panostettu paljon, jotta yliopistotutkimuksen puitteita voitaisiin parantaa, ja tutkimuksesta syntyvien teknologioiden teollista ja muuta yhteiskunnallista käyttöönottoa voitaisiin edistää. Suurin osa tutkimuksista ja aiheeseen liittyvästä keskustelusta on käyty joko valtakunnallisella, alueellisella tai institutionaalisella tasolla. Tästä syystä keskusteluissa on yksi keskeinen toimija jäänyt yleensä huomiotta: tutkija. Tämä selvitys tarkastelee yksittäistä tutkijaa ja tämän roolia tutkimuksenkaupallistamisessa Suomessa.

Nojaten noin 2800 eri tieteenaloilla ja 11 suomalaisessa tutkimusyliopistossa toimivaa tutkijaa käsittävään kyselyaineistoon selvitys käsittelee lukuisia aiheeseen liittyviä erillisteemoja alkaen yritysyhteistyöstä ja immateriaalioikeuksien tunnettuudesta aina yliopistojen tarjoamien tukipalveluiden rooliin. Selvityksen keskeisimpänä teemana ovat kuitenkin yliopistotutkijoiden henkilökohtaiset motiivit osallistua tutkimustulostensa kaupallisen tai muun yhteiskunnallisen käyttöönoton edistämiseen. Miksi tutkijat osallistuvat yritysyhteistyöhön, ja mitä hyötyjä he odottavat saavuttavansa sillä? Mistä syystä toiset tutkijat haluavat kaupallistaa löydöksiään, ja miksi toiset puolestaan eivät sitä tekisi? Onko yliopistojen tarjoamista tutkimus- ja innovaatiopalveluista tukea tutkijoiden kaupallistamisyrityksille vai haittaavatko palvelut jopa niitä? Näihin erityisiin kysymyksiin selvitys etsii vastauksia.

Tulokset todentavat, että kaupalliset motiivit eivät ole merkittäviä vaikuttimia tutkijoiden työssä. Esimerkiksi tutkimussuunnan valintaan mahdolliset kaupalliset näkökulmat eivät vaikuta juuri lainkaan. Lisäksi suora yritysyhteistyö näyttäisi olevan oletettua harvinaisempaa. Jopa ne tutkijat, joilla on kokemusta yritysyhteistyöstä, kertovat yhteistyön palvelevan pääasiallisesti akateemisia tarkoitusperiä. Näitä ovat esimerkiksi tutkimusrahoituksen turvaaminen ja uusien tutkimusideoiden löytäminen. Edelleen vain 10 prosenttia vastanneista tutkijoista on saanut täydentävää kaupallista koulutusta. Kun huomioidaan, että n. 40 prosenttia tutkijoista ilmoitti kuitenkin tehneensä mielestään selvää kaupallista potentiaalia omaavan keksinnön viimeisen viiden vuoden aikana, vaikuttaa 10 prosenttia varsin pieneltä osuudelta. Kaupallisten näkökulmien pieni rooli tutkijantyössä heijastuu myös tutkijoiden tietoisuuteen immateriaalioikeuksien omistuksen määrittelemisen periaatteista, joka on suorastaan erittäin heikko.

Samalla tavalla taloudelliset tekijät vaikuttavat vain vähäisesti tutkijoiden halukkuuteen kaupallistaa omia löydöksiään. Altruistiset, sosio-kulttuuriset, ja henkilökohtaiset tekijät vaikuttavat edellä mainittuihin tekijöihin verrattuna huomattavasti vahvemmin. Tämä vaikeuttaa teknologiansiirtoon kannustavien, kompensaatioperusteisten kannustinjärjestelmien suunnittelua merkittävästi, koska ne edellyttäisivät tutkimuskulttuurin muuttamista. Kolme vahvinta tekijää, jotka vaikuttavat tutkijoiden kaupallistamispäätöksiin ovat (i) keksintöjen potentiaali hyödyttää yhteiskuntaa, (ii) tutkijoiden kunnianhimo toteuttaa itseään, ja (iii) tutkimusrahoituksen varmistaminen. Kaupallistamisella ja siihen liittyvillä näkökulmilla ei ole itsessään suurta merkitystä tutkijoiden keskuudessa.

Kysyttäessä kaupallisten tai tutkimuksellisten hankkeiden tukemisesta tutkijat vaikuttavat olevan kohtalaisen tyytyväisiä yliopistojen tarjoamiin tutkimus- ja innovaatiopalveluihin. Todelliset haasteet paljastuvat vasta tutkittaessa kuinka hyvin tutkijoiden yksittäiset tarpeet ja palveluiden tarjonta todellisuudessa kohtaavat. Selvityksessä paljastui, että nämä kohtaavat kohtalaisen heikosti. Itse asiassa monet tutkijat ilmoittavat, etteivät tarvitse suurta osaa palveluista laisinkaan. Tästä voidaan vetää johtopäätös, että innovaatiopalvelut eivät vielä ole kasvaneet osaksi tutkimus- ja tutkijakulttuuria. Tosiasia, että tutkijat ovat suhteellisen tyytyväisiä palveluihin, jotka eivät vastaa heidän tarpeisiinsa, kertoo, etteivät he koe palveluita relevanttina osana työtänsä tai teknologiansiirtoprosessia. Tilanteen korjaamiseksi tulisi tiedotusta saatavilla olevista palveluista lisätä merkittävästi. Tämä on ensimmäinen askel. Tämän jälkeen yliopistollisen teknologiansiirron tehostamiseksi tarvitaan palveluita, jotka ovat räätälöityjä tutkijoiden todellisiin tarpeisiin.

AVAINSANAT: Tutkimuksen kaupallistaminen, yliopisto-yritysyhteistyö, kaupallistamismotiivit, kaupallistamishaasteet, innovaatiopalvelut

JEL: O30, O38, O33, O34

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1. Introduction

Innovation has been a prominent subject in research and policy discussions that lay out strategies for developing and retaining the competitive advantage of nations in a globalizing world where purely production cost-based strategies are quickly becoming obsolete. Particularly for developed countries, continuous innovation has already been a prerequisite for economic growth for some time because far-eastern countries in particular command not only superior low-cost production capabilities but have determinedly entered the innovation race as well. With the still-trailing contenders quickly closing the distance, developed economies are hard pressed to focus efforts on facilitating the inception and development of even more radical and discontinuous innovations – innovations that potentially shift technological paradigms and are the yield of a fundamentally more advanced, cumulative knowledge base that is difficult to imitate – and exploiting them commercially to generate economic growth.

Because radical innovations hardly ever emerge from incremental development efforts and often require considerable slack and freedom in researching the relevant underlying phenomena (prerequisites that companies often lack), universities are considered the primary loci for generating knowledge leading to radical leaps in the development of platforms on which future technologies are built. Thus, to facilitate the improvement of premises for university research and the application of that research in industry, much effort has been spent on understanding the university innovation processes and the transfer of technology between universities and companies.

Much of the research and the related discussions have been conducted on either the national, regional or organizational levels. This is mostly due to the prevalent notion of the "national innovation system," according to which technological innovation is affected by an entire network (or system) of public and private institutions and actors that create, improve and constitute the very environment in which innovation is occurring. Such institutions include primary education, universities, research institutes, companies, ministries, agencies, municipalities, and foundations. Research on innovation is thus largely focused on dissecting and analyzing the activities of single actors or the systemic interaction among several actors.

Implicitly, the focus on institutional actors has largely orphaned another fundamentally important focal point: the individual researcher. Analyses need to take into account the specificities of particular research environments, beginning with the mandates of public institutions as laid down in law, the size and functionality of financial markets and the entrepreneurial culture in the surrounding society, among others.

In Finland, the need for integrating the individual researcher into the research on the larger framework of the innovation system is dire. The country is facing a dilemma that, if it remains unresolved, could have a decisive impact on the nation's competitive advantage in the long run. While Finland boasts world-class research in many areas of science, even leading-edge research in some, it seems to be unable to spawn economic activity on an equivalent scale. Finland seems to be underperforming in the commercialization of its research. Experts thus speak of a commercialization paradox (Georghiou et al., 2003, and VNK, 2006).

This report rises to the challenge by analyzing individual university researchers and their role in the commercialization of research in Finland. This report covers a variety of topics ranging from company collaboration to ownership of intellectual property and the commercialization services provided to researchers. The primary theme uniting these topics, however, is the subjective motivation of researchers to engage in the commercialization of their research. Why do researchers cooperate with companies, and how do they expect to benefit from collaboration? What are the reasons why some researchers to commercialize their results, while others distance themselves from such endeavors? How do prevalent intellectual property rights regimes affect such decisions? Do certain dedicated university services support researchers in their commercial ambitions or actually inhibit them? These are the specific questions this report seeks to descriptively answer. Finding these answers will bring illumination into an area of the Finnish innovation system that, despite prior efforts to make it transparent, still remains largely obscure.

The report is structured as follows. Section 2 describes the methodology and data applied and used in the study. Section 3 provides insights into the basic characteristics of Finnish universities and researchers, and Section 4 discusses the research environments in which researchers operate. Section 5 reports the results on researcher-firm collaboration. Section 6 quantifies the amount of discoveries with commercial potential emerging from Finnish university laboratories and analyzes their respective ownership distributions. Section 7 summarizes the personal motives of researchers to engage in or to distance themselves from attempts to commercialize their research. Finally, Section 8 studies the role that technology transfer services at Finnish universities play in researchers' commercialization decisions. Section 9 concludes the report and addresses its implications.

2. Delimitations, data, and methodology

The focus of this paper is on the activities of researchers in the fields of natural and engineering sciences. This implicitly excludes a large body of academic disciplines from the analyses. The reason for this choice relates to the nature of research conducted in different academic fields. The fields chosen to be analyzed represent areas in which tangible academic discoveries with commercial potential are most likely to occur. In other areas (such as social sciences, for example), discoveries with commercial potential may also emerge, but on a much smaller scale and often in a more intangible form. The commercialization of such discoveries would necessitate a separate study tailoring the design of research questions to the unique nature of the respective sciences. To focus the analysis on the natural and engineering sciences, we have made several methodological choices that need to be addressed before characterizing the universities and researchers involved.

To identify the targeted population of researchers and to exclude those active in areas of science that did not fit our focus, we used the Thompson ISI - Science Citation Index (Expanded), which indexes citations to articles published in 8,060 major journals across 150 disciplines, and excluded the Thompson ISI - Social Sciences Citation Index (comprising 2,697 journals across 50 social sciences disciplines). In addition to delimiting the targeted population, this served the purpose of imposing a quality control, as journals included in the ISI indexes are perceived to be of higher quality than journals not included. In a second stage, we identified the nationality of the corresponding authors for all articles published in an ISI-ranked journal, and in cases in which an author was affiliated with Finland, the article in question was retrieved from the database. To achieve a manageable database size and to focus on researchers still pursuing an active career, we only collected articles for 2008 and 2009. After removing duplicates from the obtained author list, the final population consisted of 6876 individuals. In summary, the procedure identified a set of individual researchers who are active in Finland and have published articles in journals indexed by the ISI database in areas of science that are known to spawn results with commercial potential. This includes researchers working in the public sector (universities, research institutes and hospitals) and the private sector (companies).

After the identification of the relevant population, an online survey questionnaire was sent out to each individual researcher. A total of 2781 responses were received, which is a response rate of 40%. As our focus in this paper is on university researchers, our analyses are based on a sub-sample of the data including only those researchers who work at a university. We received 1723 responses from a population of 4524 university researchers (a 38.1% response rate) as identified from the ISI database. As university-specific response rates strongly varied, the analyses in this study include only those universities that submitted responses from at least 5 individual researchers and displayed sufficiently high overall ISI level publication activity. This left us with 11 Finnish universities. The universities excluded from the analyses are less active in the Science Citation Index, but may be more active in research indexed by the Social Sciences Citation Index. This aspect is not considered in the paper.

The analyses presented in the paper are mostly based on arithmetic averages of responses. We use university identifiers and a dummy variable that categorizes respondents into inventors and non-inventors as stratification variables for building response distributions. The dummy variable identify-

ing respondents as inventors obtains the value one (1) if a particular respondent claims to have produced an invention with "obvious commercial potential" in the past five years prior to survey implementation. The assessment of the potential is, of course, subjective. Given the reliance on averages, the results presented here are descriptive and must be interpreted with caution when making arguments about possible explanations underlying any particular phenomenon. The statistical differences between different groups are highlighted when appropriate.

3. Finnish universities and the characteristics of researchers

The purpose of this section is to establish a descriptive characterization of the universities and researchers that have provided their valuable insights for the analyses of this paper. This characterization will help in depicting and understanding the respondents as well as the organizational environment in which Finnish research is being carried out. It will further facilitate in associating the perspectives and opinions expressed by researchers with their respective, specific premises and institutions.

3.1 University-specific populations, response rates, and invention activity

Table 1 summarizes some of the key indices characterizing the size and survey response sensitivity of respondents.

Table 1 Key indices by university

University	Population	Observations	Response %
Åbo Akademi University	156	61	39%
Helsinki Univ. of Techn.	539	213	40%
University of Helsinki	1283	481	38%
University of Joensuu	155	59	38%
University of Jyväskylä	335	131	39%
Lappeenranta Univ. of Techn.	99	30	30%
University of Oulu	512	203	40%
Tampere Univ. of Techn.	259	101	39%
University of Kuopio	322	120	37%
University of Tampere	233	91	39%
University of Turku	573	233	41%
Total	**4466**	**1723**	**39%**

Before commencing with the analyses, some caveats regarding the interpretation of Table 1 need discussion. First, the Helsinki School of Economics, Turku School of Economics, Universities of Vaasa and Lapland, Hanken, Sibelius Academy, and the University of Art and Design are not reported in the table due to a low number of observations. The low number of observations from these universities is due to their focus on scientific disciplines that were, to a large extent, excluded from the analyses (see Section 2). Consequently, the above-mentioned universities will not appear in any of the subsequent examinations presented in this paper.

Second, one of the central findings affecting the interpretation of the results throughout the rest of this paper is the rather homogeneous response rate across all universities. The response rate varies between roughly 37 and 41% with the exception of the Lappeenranta University of Technology. These are fairly high response rates considering the web–based approach to the survey implementation, and given the high number of total observations in the data, these rates should translate into a high representativeness of the total population as well as the university-specific subpopulations.

Finally, the university-specific response rates have been calculated based on adjusted population sizes. We multiplied each university-specific population – as inferred from the ISI database (see Section 2) – by a factor of 0.9 because 10% of all sent survey invitations were returned as undeliverable. We assumed the respective researchers were not active at the time of survey implementation and excluded them from the population. Due to the lack of university-specific information regarding excluded subpopulations, we assumed an identical bounce rate of invitations for all universities. The procedure adjusted the response rates upwards by an average of 3.8%.

3.2 Characteristics of researchers

This subsection briefly summarizes some of the characteristics that describe the respondents of the survey. Reported characteristics include age, level and scope of education, field of current research activities, work experience, and the number of academic publications and patents.

Stratifying respondents into those having produced an invention (as defined in Section 2) and those not having done so, the data reveals that inventors are somewhat older (44.4 years vs. 40.5 years) and more educated than their non-inventing counterparts, with 85.7% of inventors having a PhD degree and only 73.9% of non-inventors having this degree (see Tables 2 and 3). There is no reason to believe that age or education have a direct impact on a person's invention capability beyond the fact that an older person has simply had more time to obtain a PhD degree and, implicitly, to generate inventions. The data have merely captured respondents in different stages of their academic career. Interestingly, the most seasoned researchers on average are to be found at the Technical University of Tampere, while the youngest work at the Åbo Akademi. The largest share of researchers with a PhD degree is at Åbo Akademi, and the lowest is at the University of Joensuu (see Appendices A2 and A3 for details).

Table 2 Age by category

Obs: 1719	Inventors	Non-inventors	Stat.sig.	All
Age (yrs)	44.37	40.45	***	42.05

* p<0.10, ** p<0.05, *** p<0.01

Table 3 Level of education by category (%)

Obs: 1716	Inventors	Non-inventors	All
PhD/Lic.	85.67	73.86	78.44
Master's	13.73	25.53	20.98
Other	0.60	0.61	0.58

Table 4 breaks down respondents by their field of education, i.e., the field of science in which they have completed their highest degree. As the table shows, categories are not exclusive, and the cumulative share exceeds 100%. This serves to indicate that (a) some of the respondents have completed several degrees and (b) some of the completed degrees do not fit into any single category.

It is evident that the best represented field is medical science. Almost a fifth of researchers (18%) have received education in this particular field. Inventors, in particular, seem to be highly affiliated with medical science (20%). For non-inventors, the distribution across categories is much less skewed. Medical science is followed by biology (14%) and physics (12%). Non-inventors seem to be highly affiliated with biology compared to inventors, while the results for physics are less polarized.

Table 4 Field of education (%)

obs: 1724	Inventors	Non-inventors	Stat.sig.	All
Mathematical sciences and statistics	6.39	10.09	***	8.53
Data processing	4.90	2.83	**	3.77
Physics	9.81	13.22	**	11.89
Chemistry	9.06	6.96		7.95
Biology	8.47	18.47	***	14.10
Biochemistry	7.58	4.14	***	5.57
Environmental sciences	2.23	4.64	**	3.60
Biosciences	10.55	6.66	***	8.06
Machine or automation technology	2.67	0.81	***	1.57
Energy technology	1.34	0.30	**	0.70
Electrical engineering	7.58	2.72	***	4.70
Technical physics	4.01	2.93		3.31
Information or communication technology	7.58	3.03	***	4.93
Chemical engineering	5.35	1.82	***	3.31
Environmental engineering	1.78	0.81	*	1.28
Wood processing technology	1.78	0.50	**	0.99
Material technology	2.82	0.91	***	1.68
Industrial engineering & management	0.89	0.61		0.81
Medical sciences	19.76	17.46		18.45
Economics and management sciences	1.93	1.01		1.39
Law	0.15	0.20		0.17
Other	9.21	12.51	**	11.43

* p<0.10, ** p<0.05, *** p<0.01

As the focus of this study is on aspects of commercializing science, respondents were asked to indicate whether they have received additional business education that complements their primary degree in natural or technical sciences. Table 5 shows the distribution of answers across respondent categories.

Table 5 Business education (%)

obs: 1697	Inventors	Non-inventors	Stat.sig.	All
Received business education	11.45	7.06	***	9.07

* p<0.10, ** p<0.05, *** p<0.01

As Table 5 reveals, roughly every tenth researcher (9%) reported having received business education in any form. The figure is somewhat larger for inventors (11%) than for non-inventors (7%), but it is not particularly large for either category.

The assessment of whether the figures are alarming or not clearly necessitates an answer to the question of how much a share of researchers' business-related education is relevant in the first place. The researcher being interested in a purely academic career and being engaged only in basic research might arguably not benefit much from business education. However, considering the share of researchers producing inventions with "obvious commercial potential", a staggering 40% as reported above, the serious question arises of whether business education provided to researchers and postgraduates should be increased considerably in some form or other at Finnish universities. After all, basic knowledge of business opportunities, start-up requirements, potential funding sources, business plan design, strategic management, and intellectual property protection can be argued to be prerequisites for engaging in the commercialization of research. As it is at the moment, there seems to be a sizable disparity between the shares of inventors at a given institution and those who have received any kind of formal education in business matters. The situation differs from university to university, with the Technical University of Lappeenranta (where 21% of researchers have received business education) and Åbo Akademi (17%) leading, and the universities of Helsinki, Joensuu, and Jyväskylä forming the tail (7%, respectively) (see Appendix A5 for details).

Table 6 provides the distribution of respondents according to their field of current research activity. Again, the science categories are not exclusive.

Table 6 Field of current research (%)

obs: 1724	Inventors	Non-inventors	Stat.sig.	All
Mathematical sciences and statistics	8.77	10.70		9.86
Data processing	8.17	4.44	***	5.97
Physics	11.59	15.04	**	13.57
Chemistry	10.85	6.96	***	8.53
Biology	7.43	18.57	***	13.75
Biochemistry	7.13	4.84	**	5.74
Environmental sciences	6.24	8.38		7.37
Biosciences	18.87	10.80	***	13.92
Machine or automation technology	2.82	0.91	***	1.62
Energy technology	3.12	0.71	***	1.62
Electrical engineering	7.28	1.72	***	4.00
Technical physics	3.71	2.42		2.84
Information or communication technology	9.81	3.13	***	5.92
Chemical engineering	5.79	1.61	***	3.42
Environmental engineering	2.67	1.01	***	1.74
Wood processing technology	2.97	0.81	***	1.62
Material technology	6.39	1.72	***	3.60
Industrial engineering & management	1.04	0.50		0.75
Medical sciences	27.04	20.89	***	23.32
Economics and management sciences	2.97	1.01	***	1.80
Law	0.15	0.20		0.23
Other	9.36	11.91		10.96

* p<0.10, ** p<0.05, *** p<0.01

Here, the general focus on medical science is even more pronounced than in the distribution regarding educational backgrounds: 23% of all respondents reported conducting research related to medical science. Almost a third (27%) of all inventors and roughly every fifth of non-inventor are active in this field. It is by far the best represented field, as the second-largest categories (biosciences and biology) trail behind with 14% representation each.

To shed more light on the individual factors underlying the choice of field, respondents were asked to assess how well a number of given motives listed in Table 7 correspond with their personal decision to enter their current field of research. Respondents provided answers on a scale from 1 to 4 (1 = strongly disagree, 2 = somewhat disagree, 3 = somewhat agree, and 4 = fully agree).

Table 7 Motives for entering current field of research

obs: 1660-1712	Inventors	Non-inventors	Stat.sig.	All
Own research interests	3.74	3.63	***	3.68
Research interests of my supervisor	2.36	2.59	***	2.49
Availability of public funding	2.65	2.54	**	2.58
New or better instrumentation	2.12	1.85	***	1.96
New or better data	2.14	2.08		2.10
Visits abroad	2.26	2.09	***	2.17
Needs of companies	2.10	1.46	***	1.73
Opportunities to commercialize research	2.05	1.35	***	1.64
Employment opportunities	2.42	2.36		2.39

* p<0.10, ** p<0.05, *** p<0.01

Unsurprisingly, the motive respondents identified themselves with most strongly is their own research interests. The average of the four-step index is as high as 3.7. No other motive seems to affect the choice of research field positively to a noteworthy extent. Excluding a number of motives that researchers seem to be rather indecisive about (e.g., access to public funding or the interests of the respective supervisor), the remaining motives received relatively low grades and, therefore, seem to be rather irrelevant as a factor behind research orientation. Interestingly, with the exception of the technical universities of Lappeenranta (3.1) and Tampere (2.6), motives related to meeting the needs of industry and pursuing commercial opportunities were graded lowest among the alternatives (see Appendix A7 for details). This holds true even for inventors.

The results tell us an important story. It seems that research – or to be more precise, research orientation – in Finland is not driven by commercial or industrial agendas but is motivated by the individual researcher's intrinsic fascination with a particular field of science. Whether this is good or bad news for the long-term competitiveness of the Finnish industry hoping to draw on applicable and commercially relevant research results emerging from universities is open to discussion, but it certainly counters some of the fearful arguments according to which Finnish research is becoming ever more entangled in the principles of competitiveness and commercialism.

To complement the characterization of the respondents' overall past experience, researchers were further asked to disclose their work records. Table 8 summarizes the findings.

Table 8 Work experience (%)

obs: 1724	Inventors	Non-inventors	Stat.sig.	All
Finnish university	100.00	100.00		100.00
Foreign university	36.26	27.35	***	30.74
Finnish SME company	8.62	4.34	***	6.79
Finnish large company	13.37	6.76	***	10.15
Foreign company	2.53	1.41	*	2.15

* p<0.10, ** p<0.05, *** p<0.01

In addition to the implicit work experience at a Finnish university, 31% of respondents reported having worked at a foreign university at some point in time. This figure is somewhat larger (36%) for inventors than for non-inventors (27%). The universities of Turku (36%) and Helsinki (35%) have the largest shares of researchers that have cooperated with a foreign university, while the universities of Tampere (21%) and Joensuu (24%) have the smallest (see Appendix A8 for details). Regarding experience with industry collaboration, every tenth researcher reported experience in working for a large Finnish company, while 7% have worked for a small company. This share was larger in both categories for inventors (13% and 9% vs. 7% and 4%). The Technical University of Lappeenranta and Aalto University's School of Science and Technology seem to have the largest respondent shares that have engaged in industrial collaboration, while the universities of Helsinki and Jyväskylä have the lowest. Only 2% of all respondents have worked in a foreign company.

To deepen our understanding of the Finnish researcher, we also wanted to capture the scale and productivity of academic work. These are often measured based on academic publications. In addition to academic output, the study's focus on commercialization further necessitated a measurement of output that could serve as a basis for commercial activity. To this end, respondents were asked to disclose the number of inventions, as previously indicated, and the number of patent applications they have been involved in. While inventions have been devoted a section of their own, the number of patent applications is reported in Table 9, together with the number of academic publications.

Table 9 Number of publications and patent applications

obs: 1713-1719	Inventors	Non-inventors	All
Scientific publications			
0	0.15	0.3	0.23
1-9	24.44	44.14	36.77
10-19	19.08	18.79	18.85
20-49	19.82	17.58	18.15
50-100	16.24	11.31	13.26
100+	20.27	7.88	12.74
Patent applications			
0	50.3	90.88	74.31
1-5	40.42	8.71	21.48
6-10	4.34	0.2	1.93
11-20	2.84	0.2	1.34
20+	2.1	0	0.93

Table 9 reveals interesting results. Inventors participate more often in patent applications on average, which is rather intuitive given that patenting is a function of producing inventions in the first place, but they also have produced more publications on average than their non-inventing counterparts. This might be influenced in part by the fact that inventors are relatively more often found to operate in scientific fields that generally produce more publications, but the results also suggest that inventors seem to be simply more active academically. In line with the consensus of prevalent innovation research, this finding descriptively corroborates existing statistical results according to which commercialization efforts are in no way detrimental to academic ambitions and suggests that, in fact, the two are positively correlated. Researchers at the universities of Turku and Helsinki as well as Åbo Akademi exhibit the highest number of publications on average, while those working at the technical universities of Tampere and Lappeenranta as well as Åbo Akademi participate in a relatively higher number of patent applications (see Appendix A9 for details). We now turn away from the researcher to characterize the environment and the features of research conducted in Finnish universities.

4. Research and its premises in Finnish universities

This section will summarize the findings depicting some of the key features of the immediate research environments in which the respondents conduct their work. Among other issues, we will touch on how researchers divide their time between research, education and administrative tasks; how research itself is distributed between the basic, applied and R&D-related types; how the composition of research teams is distributed; and what role different funding sources play as seen by the respondents.

4.1 The characteristics of research

Table 10 shows the distribution of research into the basic, applied, and R&D-related types by respondent category. It is evident that inventors engage in applied and R&D-related research more often than non-inventors.

Table 10 Distribution of research types (%)

obs: 1724	Inventors	Non-inventors	Stat.sig.	All
Basic research	47.90	64.50	***	56.87
Applied research	44.13	32.23	***	37.25
Product development	7.04	1.97	***	4.41

* p<0.10, ** p<0.05, *** p<0.01

In fact, the majority of researchers (51.2%) identifying themselves as inventors claim to conduct research outside the realm of basic research. For non-inventors, the figure is 34.2%. The results are rather intuitive given that more applied research tends to produce more commercially attractive results.

Looking at the results geographically, exceptionally high percentages of researchers focusing on basic research are found at the universities of Jyväskylä (69.4%) and Helsinki (63.1%), and the lowest per-

centages are found at the technical universities of Lappeenranta (30.7%) and Tampere (42.7%). Exceptionally high percentages of researchers engaged in product development, on the other hand, are found in all three technical schools [Lappeenranta (8%), Tampere (9.1%) and Aalto University (7.2%)] (see Appendix A10 for details).

Table 11 Use of industrial standards (%)

obs: 1708	Inventors	Non-inventors	Stat.sig.	All
Yes	15.29	5.89	***	9.95

* p<0.10, ** p<0.05, *** p<0.01

Another aspect depicting the character of research conducted in Finnish universities is the adherence to given industrial standards. Table 11 provides an overview of the distribution of responses. Overall, 10% of researchers reported following certain industrial specifications of procedure or conduct in their work. The figure is somewhat higher for inventors (15%) than non-inventors (6%). There are also differences between universities themselves, with researchers at the University of Kuopio (23%) and the Technical University of Lappeenranta (20%) following industrial protocols most often, and those at the universities of Jyväskylä (2%) and Tampere (5%) doing so only rarely (see Appendix A11 for details). Whether there is a connection between following industrial protocol and the emergence of commercially potential inventions cannot be confirmed in this descriptive study, but when combining this finding with the earlier results regarding the greater focus of inventors on applied and R&D-related research, i.e., an arguably closer relationship with industrial application, the question certainly constitutes an appealing avenue for further research on structural means of infusing industrial vision into academic work.

Having established the distribution of research according to its nature, it would be interesting to characterize this distribution according to its volume relative to the other tasks university researchers are often confronted, namely, teaching and administration. Table 12 displays the distribution of the respondents' working time split among these three tasks.

Table 12 Distribution of working time (%)

obs: 1724	Inventors	Non-inventors	Stat.sig.	All
Research	54.12	61.05	***	58.07
Teaching	19.81	17.29	***	18.05
Administrative and other tasks	24.34	17.50	***	20.43

* p<0.10, ** p<0.05, *** p<0.01

The results reveal that, independent of stratification, research occupies a major share, close to 60%, of researchers' working time. The remaining residual is then divided into roughly equal shares between teaching and administrative tasks. Looking at the different groups, it seems that inventors have traded a share of their time spent on research for administrative tasks (24.3%) but also teach more than non-inventors. The significantly larger share of time spent on administration compared to non-inventors might relate to the fact that inventors seem to occupy higher positions in a research team, as shall be shown shortly. Leading positions are implicitly burdened with administrative tasks. Administration occupies the largest shares of time at the universities of Tampere (23.5%), Oulu (23.4%) and Åbo

Akademi (23%). Researchers are least burdened with administrative responsibilities at the universities of Joensuu (12%) and Jyväskylä (17%). Teaching occupies the most time at Åbo Akademi (23.6%), the University of Jyväskylä (22.2%), and the Technical University of Lappeenranta (20.3%), while the greatest shares dedicated to research are encountered at the universities of Joensuu (72.7%) and Kuopio (62.3%) (see Appendix A12 for details).

4.2 The characteristics of research teams

Tables 13-17 present the answers to questions related to a number of aspects depicting the composition and organization of the research teams in which the respondents work. Covered aspects include average team size, position within teams, the number of teams that respondents work in simultaneously, the scale of multidisciplinary approaches to team composition, and the average share of foreigners in teams.

Table 13 Research team size (%)

obs: 1588	Inventors	Non-inventors	All
# members			
1-3	37.31	36.54	36.71
4-6	45.98	47.49	46.66
7-10	12.54	10.61	11.84
11+	4.18	5.36	4.79

Regarding size (Table 13), research teams encountered most often in Finland are comprised of four to six researchers. Close to 47% of university researchers answering the survey estimated their average team size to be in this particular size category. Another 36.7% operate in smaller teams comprised of one to two individuals, while 11.8% work in teams of seven to ten colleagues. Only 4.8%, one in every twenty researchers, are part of a team of more than 10 researchers. There seems to be little difference between inventors and non-inventors in terms of average team size. Differences between universities are similarly small, with teams being largest at the universities of Turku and Kuopio and smallest at the Technical University of Lappeenranta and Aalto University's School of Science and Technology (see Appendix A13 for details).

Table 14 Multidisciplinarity of research teams (%)

obs: 1584	Inventors	Non-inventors	Stat.sig.	All
Yes	65.79	49.55	***	56.25

* p<0.10, ** p<0.05, *** p<0.01

Many of the teams seem to be multidisciplinary and include members from different scientific fields (Table 14). Fifty-six percent of researchers work with colleagues with backgrounds in other scientific disciplines. This figure is somewhat larger for inventors (66%) than non-inventors (50%). The biggest shares of researchers working in multidisciplinary teams can be found at the universities of Kuopio (75%), Tampere (72%), Helsinki (64%) and Åbo Akademi (64%). Multidisciplinary teams are least common at the Technical University of Lappeenranta, the University of Joensuu, and Aalto University's School of Science and Technology (see Appendix A14 for details).

Table 15 Share of foreigners in research teams (%)

obs: 1597	Inventors	Non-inventors	Stat.sig.	All
Share of foreigners	22.55	21.07		21.50

* p<0.10, ** p<0.05, *** p<0.01

While teams are frequently multidisciplinary, the participation of foreign researchers is much less common (Table 15), and only 21.5% of respondents report collaborating with a foreigner on the same research team. The figure does not vary significantly between inventors and non-inventors (21.1% vs. 22.6%), but there are some differences between universities. The capital region and Turku both seem to attract foreigners relatively more than the northern universities. Roughly 25% of researchers in Aalto University's School of Science and Technology and the University of Helsinki work together with foreign researchers, while close to 26% of Åbo Akademi's researchers and 24% of scientists working at the Technical University of Tampere report doing the same. The universities of Joensuu (14.4%), Jyväskylä (17.9%) and Oulu (17.1%) report the lowest shares (see Appendix A15 for details).

Table 16 Position of respondents in research teams (%)

obs: 1719	Inventors	Non-inventors	All
Position			
In charge of several teams	41.07	14.86	25.31
In charge of one team	29.17	23.05	24.96
Researcher	19.05	31.85	27.11
Post-graduate	6.85	20.93	15.13
Not working in a team	3.87	9.3	7.5

In addition to team size and composition, we were further interested in how respondents are positioned within teams (Table 16) and whether they work on more than one team at the same time (Table 17). The results indicate that roughly half (50.3%) of the researchers answering the survey occupy a supervising role in charge of one (25.3%) or more (25%) teams. Another 27% work as researchers on teams, while 15.1% are post-graduate students occupying junior researcher positions. On average, inventors (70.2%) seem to be found in a leading position much more often than non-inventors (37.9%), which is a rather strong finding. Similarly, inventors work more often on several teams simultaneously: 80.1% work on multiple teams, with about 25% working on more than three. The equivalent figures for non-inventors are roughly 59% and 11%.

Table 17 Number of teams that respondents work on simultaneously (%)

obs: 1586	Inventors	Non-inventors	All
# teams			
1	19.91	41.07	32.47
2-3	54.74	47.1	50.32
4-5	17.26	8.93	12.23
6-10	7.15	2.46	4.35
11+	0.93	0.45	0.63

After careful inspection of the above results, one can conclude that inventors seem to occupy higher positions, work more often on several different teams simultaneously, and participate more often in

multidisciplinary research than non-inventors. They also publish more and work more often in collaboration with companies. While grounded implications are challenging to draw based on the descriptive analyses presented in this study, the results suggest that inventors are generally more ambitious individuals with a greater drive to accomplish in all dimensions of their work. The question arises, then, of whether being able to spawn commercially viable ideas is actually more a function of an individual's innate personality, something that cannot be externally induced, than it is a function of the environment and external factors. Shedding more light on the issue should be a high priority, as the research and policy implications aimed at bolstering commercially thriving research at universities will be quite different depending on the results. Answering the challenge would necessitate rigorous statistical analyses scrutinizing the above factors in concert and controlling for external effects and is left for future research.

4.3 Research funding

Securing funding for research is the perennial challenge of every researcher in a leading position. Much of the administrative time discussed previously is spent on designing research and, to a large extent, on writing funding applications to finance the research. Particularly after the enactment of the largely revised Universities Act that initiated the financial detachment of universities from the government budget and made them financially independent at the beginning of 2010, there has been extensive discussion on how universities will structure research funding in the future. According to one of many fears, academic ambition will suffer for the sake of economically more viable projects as the now economically self-sufficient universities will strive to secure their financial stability (Tahvanainen, 2009).

Currently, research in Finland is funded by a handful of major governmental institutions, foundations, the European Union and the private sector. First, despite the reform of the Universities Act, the state still provides universities with the necessary funds to carry out the tripartite mission (education, research, and societal impact) it has mandated for the universities. With this reform, the government aimed at providing universities with greater financial flexibility that enables them, among other newly introduced liberties, to invest and retain returns from investments. The objective was by no means to withdraw public funding from universities. State funding is funneled to research through the individual universities and is captured in the survey in the category "basic funding of the organization" (i.e., the university).

Second, as an organizational subsidiary of the Ministry of Employment and the Economy, Tekes (the Finnish Funding Agency for Technology and Innovation) is one of the most central external providers of public funding. According to Tekes' own statements, the agency finances roughly 1,500 business R&D projects and close to 600 public research projects at universities, research institutes and polytechnics. Tekes' annual budget is roughly 500 million Euros.

Third, operating within the administrative sector of the Ministry of Education and Culture, the Academy of Finland is the principal funding organization for Finnish basic research. The Academy's annual total funding in 2010 was 314 million Euros and accounted for 16 percent of government R&D spending.

Fourth, there are numerous private foundations dedicated to the promotion of science in Finland. These foundations usually focus on narrowly defined scientific fields, as defined and laid out in their founding principles. Grants provided by foundations are usually personal but can often be used for hiring additional labor for the purposes of implementing the projects to be financed by the grants.

Fifth, the EU has been another major source of funding for academic research through framework programs and other instruments promoting international research collaboration across borders by giving preference to joint projects. While EU funding usually enables the design and implementation of fairly sizeable research endeavors, it is highly sought after and is said to come with considerable and burdensome red tape that makes entering said projects unattractive for many parties.

Finally, research collaboration with companies and industries has been a long-time tradition in the history of academia in Finland. Customarily, companies providing universities with funding have been entitled to the ownership rights to any inventions arising from such research. After the enactment of the University Inventions Act in 2007, rights to inventions funded by third parties belong automatically to the university. In reality, however, universities still design their contracts with companies in a fashion that bestows upon companies the rights to emerging research results (for more on the effects of the Act on research and ownership rights, see Tahvanainen and Nikulainen, 2010; Tahvanainen, 2009)

Table 18 Importance of funding sources

obs: 1497-1610	Inventors	Non-inventors	Stat.sig.	All
University budget	2.56	2.71	**	2.65
The Academy of Finland	2.96	2.82	**	2.88
Tekes	2.50	1.62	***	1.98
Finnish foundations	2.46	2.67	***	2.59
EU	2.08	1.71	***	1.86
Other non-Finnish sources	1.53	1.47		1.49
Companies	2.13	1.43	***	1.72

* p<0.10, ** p<0.05, *** p<0.01

Table 18 displays the different funding sources in order of importance as assessed by the respondents. The importance was assessed on a four step scale (1 = not at all important, 2 = somewhat important, 3 = rather important, and 4 = very important). The results are displayed as averages of the assessment index with a scale average of 2.5. The Academy of Finland is clearly seen to be the most important source of research funding (2.88). This is followed by the basic funding of the respondent's own university (2.65) and Finnish foundations (2.59). The averages for the remaining sources are clearly below the scale average and therefore not particularly important. In particular, foreign sources other than EU funding are deemed less important.

Unsurprisingly, company funding is assessed as being more important in the technical universities (2.79 for Lappeenranta and 2.48 for Tampere) than in others. The same holds true for funding provided by Tekes (2.9 and 3.12, respectively). Along the same lines, funding of the respondent's own university is deemed important in the less technically oriented universities, such as those of Jyväskylä,

Tampere and Helsinki. Funding by the Academy receives especially high grading at Åbo Akademi (3.26) and Aalto University's School of Science and Technology (3.01).

Comparing results between inventors and non-inventors, however, provides rather interesting insights. Funding provided by companies, Tekes and the EU seems to be more important for inventors than for non-inventors. This is most likely an indication of a closer relationship with industry. Most of the projects funded by Tekes involve collaborations with companies, as this is one of the most central criteria Tekes imposes on its approved projects. When asked for the explicit share of funding provided by companies, inventors report an average of 13.2%, and non-inventors reported an average of only 5.4%. Again, the average share is highest at the technical universities of Lappeenranta (23.7%), Tampere (19.6%), and Aalto University (16.8%) and lowest at the universities of Tampere (4.1%) and Helsinki (4.9%) (see Appendix A18 for details). When asked about the current growth trends of company-based funding, the majority assessed the growth to be neutral, while some respondents deemed it to be decreasing. To conclude the sub-section on research funding, Table 19 provides more detail on the share of research funding provided by companies.

Table 19 Research funding provided by companies (%)

obs: 1317	Inventors	Non-inventors	All
Decrease	31.67	17.80	24.22
No change	55.17	74.29	65.45
Increase	13.17	7.91	10.33

5. Interaction with firms

Having established that industry funding seems to be more important for inventors of potentially commercially viable inventions and having argued that this might serve as an indication for a closer relationship with companies, we will next turn to analyzing this relationship in greater detail. University-industry collaboration is generally regarded as one of the central mechanisms of commercial technology transfer (Nikulainen, 2010), and therefore, we feel that it is a vital area to be explored in the search to explain the Finnish commercialization paradox. We will touch on the types and intensity of company interactions, researchers' motivations to collaborate with industry, challenges in collaboration, and the types of companies interacting with researchers.

5.1 Channels and intensity of interaction

Table 20 shows the relative importance of different channels of interaction for respondents. Researchers assessed the extent to which they have been in contact with companies through the given channels on a scale from one to four (1 = not at all, 2 = to some extent, 3 = rather much, and 4 = very much). Again, the index scale average is 2.5.

Table 20 Extent of company interaction through different channels

obs: 1590-1642	Inventors	Non-inventors	Stat.sig.	All
Conferences and seminars	2.23	1.80	***	1.98
Partnering events and fairs	1.52	1.22	***	1.34
Training events	1.54	1.33	***	1.41
Supervision of theses	1.80	1.27	***	1.48
Joint publication	1.73	1.29	***	1.47
Research related consulting	1.95	1.42	***	1.63
Public research programs	2.02	1.28	***	1.58
Contract research	1.84	1.27	***	1.50
Outsourcing services provided by companies	1.44	1.20	***	1.30
Common research or other facilities	1.25	1.11	***	1.17
Employment relationships with companies	1.35	1.12	***	1.21

* p<0.10, ** p<0.05, *** p<0.01

In general, all channels of interaction received fairly low ratings. Even the most frequently used channel, conferences and seminars, averaged an index value of 1.98. Similarly, the figures for inventors, despite being more often in contact with companies than non-inventors, seem rather low, as expressed in the systematically higher scores for every channel. Contacts through outsourcing services provided by companies, the use of joint research facilities with companies, and having been employed by companies are the least frequent channels.

To add some contrast to the discussion, one can point to some differences in channel preferences between inventors and non-inventors. While many of the ways in which the two types of researchers are in contact with companies are similar regarding the order of their preference (e.g., conferences, research consulting, and public research programs), some ways are more important for the one than the other. For instance, contract research is a relatively more popular channel for inventors than for non-inventors, whereas joint publishing and training events rank higher in the order of preference for non-inventors. To summarize, the modest scores speak of a generally moderate role of direct industry contact in academic research. Thus, on average, collaboration between researchers and firms seems to be rather detached.

As Table 21 reveals, the contacts with industry have been established to fairly equal extents by researchers themselves (19.4%), by other team members (25.4%), or by companies directly (25.7%). Roughly 30% of respondents have not had contacts with industry at all. When researchers are stratified into inventors and non-inventors, however, the respective patterns differ drastically: over 40% of non-inventors have not been in contact with industry at all. The equivalent share for inventors is just above 10%. Inventors seem to be much more active in contacting potential industry partners in person, as close to 30% of inventors report establishing relations with industry themselves. Only 12.3% of non-inventors report having done the same. Again, inventors seem to possess a more active drive to take matters forward by establishing direct links with companies on their own relatively more often.

Table 21 Initiative in creating industry links (%)

obs: 1651	Inventors	Non-inventors	Stat.sig.	All
Self	29.37	12.32		19.38
Team member	29.52	22.79		25.44
Company	30.87	22.38		25.68
No contact	10.24	42.51		29.5

5.2 Motives for interaction

Given that links to industry are relatively detached, what could be the motivation to engage in a university-industry relationship in the first place? Respondents indicating contacts with industry were asked to assess a number of potential motives on a scale from one to four (1 = not at all important, 2 = somewhat important, 3 = rather important, and 4 = very important), as described in Table 22. Because those not having had contacts with industry were excluded from answering to the question, the number of researchers responding is somewhat lower than in the prior questions.

Table 22 Personal objectives regarding industry interaction

obs: 1116-1145	Inventors	Non-inventors	Stat.sig.	All
Securing research funding	2.95	2.52	***	2.74
Identifying new topics for research	2.73	2.42	***	2.58
Access to instruments or data	1.89	1.87		1.88
Identifying opportunities for commercialization	2.22	1.68	***	1.96
Getting to know the industry	2.16	1.88	***	2.02
Networking with a potential employer	1.94	1.94		1.93
Networking with a potential commercial partner	2.22	1.60	***	1.92
Industrial application of my research findings	2.47	1.71	***	2.11
Request of my supervisor	1.45	1.54	**	1.49

* p<0.10, ** p<0.05, *** p<0.01

The two most notable motives for establishing contact with industry relate to securing research funding (2.74) and identifying new ideas for research (2.58). All other motives received below-average scores. Motivations related to commercial aspects such as the industrial application of research results (2.11), familiarization with the business world (2.02), and identification of business opportunities (1.96) were considered "somewhat important" on average. Again, inventors were more motivated to collaborate with industry regardless of the motivation in question, but differed from non-inventors in the order of motive preference. While non-inventors ranked access to instrumentation and data, networking with a potential future employer, and general familiarization with the industry relatively high in the order of motives, inventors emphasized much more directly business-oriented motives such as networking with potential commercial partners, the identification of business opportunities, and the application of research results in an industrial setting. This further corroborates the earlier findings establishing inventors as more business- and practice-minded researchers than non-inventors.

When asked how well researchers were able to meet the above personal objectives, the average answers reflected a general atmosphere of disappointment. None of the objectives received scores above the scale average. Table 23 provides a summary of the results.

Table 23 Achieving objectives in industry interaction

Obs: 975-1070	Inventors	Non-inventors	Stat.sig.	All
Securing research funding	2.42	2.06	***	2.25
Identifying new topics for research	2.55	2.19	***	2.38
Access to instruments or data	2.04	1.85	***	1.95
Identifying opportunities for commercialization	2.06	1.46	***	1.79
Getting to know the industry	2.31	1.93	***	2.13
Networking with a potential employer	1.86	1.73	**	1.80
Networking with a potential commercial partner	1.97	1.43	***	1.73
Industrial application of my research findings	1.97	1.40	***	1.71
Complying with my supervisor's objectives	1.78	1.79		1.78

* p<0.10, ** p<0.05, *** p<0.01

The identification of new research ideas seems to be an objective that the respondents accomplished most often. It received an average score of 2.38. Objectives related to securing research funding from companies and familiarization with the industrial realm in general were also met "to some extent." The objectives that researchers felt were most unfulfilled related mostly to commercial aspects. The identification of commercial opportunities, getting in contact with a commercial partner, and the industrial application of research results received the lowest scores across all respondents. The results were largely similar for both inventors and non-inventors. There are clear differences between universities, however. All three technical schools included in the sample provided the best scores for almost all objectives, while the universities of Jyväskylä and Tampere gave the lowest scores (see Appendix A23 for details). Looking at the big picture, it seems that researchers have been able to accomplish objectives related to the academic aspects of industry collaboration to a larger extent than those related to the commercialization of research results.

5.3 Challenges in interacting with industry

Having established that respondents did not seem to be overly satisfied with the achieved outcomes in industry collaboration, the natural question arises of which factors have contributed to this view. To answer this question, the respondents were asked to assess the extent to which a given set of challenges has inhibited them in achieving set goals in their collaboration with industry. Responses were given on the four-step scale (1 = not at all, 2 = to some extent, 3 = rather much, and 4 = not at all), and the results are given in Table 24.

Irrespective of the stratification of respondents into inventors and non-inventors, the listed challenges did not seem to constitute major inhibitors. Even the most critical challenges received only moderate scores, barely reaching scale average. This means that we have either failed to capture the true challenges and inhibitors or, alternatively, that the results simply reflect the relatively low importance of commercialization and industry collaboration in comparison to academic objectives in general. The

latter interpretation is due to the assumption that inhibiting an activity that is not particularly important to an individual does not invoke strong counter-reactions. The fact that academic objectives outweighed commercial objectives regarding the motivations to collaborate with industry (see Table 22) supports to this particular interpretation.

Table 24 Challenges in university-industry collaboration

obs: 1046-1094	Inventors	Non-inventors	Stat.sig.	All
Passiveness of my project team	1.61	1.60		1.61
The nature of my research field	2.21	2.58	***	2.39
The early phase of my research	2.33	2.13	***	2.24
The identification of commercial opportunities	2.07	2.04		2.05
Communication with companies	1.99	1.85	***	1.93
Problems regarding the IPRs to my research	1.81	1.38	***	1.61
Personal lack of commercial expertise	1.94	1.84	*	1.90
Lack of support from the work environment	1.85	1.86		1.85

* p<0.10, ** p<0.05, *** p<0.01

Be that as it may, the challenges researchers identified to be most detrimental to reaching set objectives related to (a) the intrinsic features of their research, namely its field (2.39) and early stage (2.24), and (b) the researchers' own inability to identify relevant commercial opportunities (2.05) for achieved research results. Thus, problems seem to relate more to the researcher and his/her work than to any given external or environmental factor. Surprisingly, issues related to complications with intellectual property rights (IPR) (1.61) and problems with passivity and other types of cultural inertia within the respective research teams (1.61) seem to cause the least amount of challenges. In particular, IPR-related problems were expected to receive rather high scores as the related regulation has been found to be particularly unfamiliar to researchers (Tahvanainen and Nikulainen, 2010).

In summary, the results seem to indicate that collaboration between academic researchers and industry is less active than often presumed. The results further show that the motives to engage in such collaboration are rarely related to attempts to facilitate the commercial, industrial or other societal exploitation of the respondents' research results. Inventors are motivated by commercial aspects to a slightly greater extent than non-inventors, a finding that is rather intuitive, but even they assess such motives to be fairly weak. The fact that the identified challenges to industry collaboration do not elicit strong reactions from the respondents provides additional indications of the indifference of researchers regarding industry collaboration as a part of the larger context of academic work.

6. Commercialization of research

The analysis of results regarding firm collaboration, one of the major mechanisms of knowledge diffusion from universities to industry, already touched to some extent the issue of the commercialization of university research. Knowledge diffusion is a rather broad concept, however, that does not necessarily imply attempts to make research commercially available to commercial markets, as the results

discussed in the previous section clearly demonstrated. Many of the links to industry were found to serve the purpose of benefiting academic research in a way or the other.

To explicitly focus on the commercialization of research, we will narrow our examination in the following to comprise only those individuals we have so far dealt with as the "inventors," i.e., those researchers who have made scientific discoveries with commercial potential in the past five-year period prior to survey implementation. In this section, we will approximate the total quantity of inventions made in said period at Finnish universities, show how the ownership rights to the inventions are distributed over a number of relevant parties, quantify the share of inventions intended to be commercialized, review the mechanisms through which commercialization was attempted or achieved and, lastly, identify the motives to directly engage in the commercialization of research. Thus, this section represents the thematic core of the study.

6.1 Quantifying discoveries with commercial potential

To identify the relevant population of individuals who (a) have produced scientific results and (b) are convinced of their commercial potential, we asked respondents to answer the following question: "In the past 5 years, have you personally or jointly with a research team achieved research results that, according to your own estimation, have had obvious commercial potential?" Maintaining subjectivity in assessing the commercial potential of a discovery is a key aspect from the perspective of our analyses because we assume that only those individuals who are personally certain of their findings' potential will even tentatively consider making the effort to take concrete steps towards commercialization. The objective, unbiased potential of a given discovery is irrelevant in this setting. We are not evaluating true outcomes of commercial endeavors but aim to shed light on the personal motives and perceived challenges as experienced by researchers and to deepen our understanding of the incentives – inherently subjective in nature – to which these individuals adhere.

To facilitate a valid interpretation of the results presented in Table 25 below, we must discuss the construction of the respective indices first. The total number of inventions per university reported in Table 18 has been extrapolated from the number of individual inventions reported by their respective inventors. This causes a potential problem regarding multiple counting of inventions, as several individual respondents working in the same research teams could have referred to the same inventions when reporting the number of inventions they helped to produce. To counter the issue, we divided the extrapolated number of total inventions by the average size of research teams in any given university to obtain the true average number of inventions per researcher and multiplied the figure by the university-specific size of the population.

To make the interpretation entirely plastic, we summarize the definition of "inventor" once more. Researchers that we treat as "inventors" meet all three of the following criteria: 1) the individual has been published in an ISI-ranked academic journal in the last two years (2008 – 2009) prior to survey implementation, 2) the individual has made an identifiable scientific discovery in the last 5 years prior to survey implementation, and 3) the individual is convinced of the discovery's commercial potential. We acknowledge that due to the delimitations regarding sampling, the resulting total number of uni-

versity-specific inventions is potentially overly conservative, and we emphasize that the study does not attempt to identify the total number of inventions discovered by *all* researchers conducting research in Finland.

Table 25 Share of inventors and the number of inventions made

University	Total population	% Inventors	Estimated inventors	Inventions/ inventor	Inventions (5 yrs)	Inventions (per year)
Åbo Akademi University	156	48.28	75	0.73	54.65	10.93
Helsinki Univ. of Techn.	539	50.49	272	0.96	261.76	52.35
University of Helsinki	1283	33.90	435	0.66	285.70	57.14
University of Joensuu	155	40.00	62	0.55	33.75	6.75
University of Jyväskylä	335	23.26	78	0.89	69.27	13.85
Lappeenranta Univ. of Techn.	99	56.67	56	0.83	46.83	9.37
University of Oulu	512	41.54	213	0.62	132.86	26.57
Tampere Univ. of Techn.	259	58.76	152	1.03	156.14	31.23
University of Kuopio	322	51.30	165	0.50	83.04	16.61
University of Tampere	233	41.18	96	1.00	95.58	19.12
University of Turku	573	36.12	207	0.61	126.43	25.29
ALL	**4466**	**40.44**	**1806**	**0.74**	**1345.16**	**269.03**

The results of Table 25 approximate the scale of inventive activity at Finnish universities. As many as 40% of all respondents claim to have produced a discovery as defined above. This translates into 673 individual researchers that comprise the sample we use for the remaining analyses presented in this and the subsequent sections. The 1806 inventors reported in Table 25 are a weighted estimation of the total population of inventors at all Finnish universities, given the limitations regarding publishing activity and the field of science of the respondents. Correcting for the possible multiple counting of inventions, as explained above, inventors reported roughly 0.74 discoveries with commercial potential in the past five-year period on average. In sum, this adds up to 1345 (269 per year) inventions across all universities in the sample.[1] Again, this is an extrapolated estimation of the total amount of inventions and comprises the pool of discoveries that serves as a potential basis for commercialization.

Comparing the figures across universities reveals interesting variation in inventive activity. The share of inventors is highest at technical universities. Both Lappeenranta and Tampere report inventor shares of close to 60%. Aalto University's School of Science and Technology reports a share of 50%. The University of Kuopio is the only non-technical university achieving comparable figures, with 51% of respondents having made a discovery matching our criteria. The lowest percentage by far was obtained for the University of Jyväskylä; only 23% of researchers in Jyväskylä self-reported as being "inventors."

The number of inventions made per inventor, on the other hand, seems to follow a less-skewed distribution, in that it is found to be rather homogeneous across the universities. The maximum per-head number of inventions was established for the Technical University of Tampere (1.02), while the University of Joensuu reported the lowest number, with 0.55 inventions per researcher. The averages for

[1] Inventions – 5 years: (reported number of inventions/reported group size)*(total population * % of inventors among respondents) (/5, per annum).

the remaining universities are rather evenly distributed between these two figures. Whether the number of inventions is high or low given a timeframe of five years is left open for discussion, but they certainly suggest an active base of researchers who are able to produce potentially interesting results from the perspective of university-industry technology transfer.

The above results give rise to another intuitive question: given that there is a constant potential influx of inventions from university laboratories, how many of the inventors are actually interested in facilitating the commercial use of their inventions? To answer this question, we first need to identify those inventors who are in the position to have command over the use of their inventions in the first place, as ownership rights to inventions are not necessarily the property of the original inventor. We will turn to the discussion of the distribution of these rights next.

6.2 Distribution of invention ownership rights

To be able to have control over the use of their inventions and command their commercial application, inventors need to own the respective property rights. The new University Inventions Act enacted in 2007 regulates the allocation of rights between the different stakeholders partaking in university research. In simplified terms, the ownership rights to inventions emerging from projects that are purely university financed rest with the inventor. The same holds true for research funded by the inventors themselves through, e.g., grants. In projects financed by an external party, such as a company (contract research or industry sponsored research) or Tekes, the ownership rights rest with the university. Usually, the university transfers these rights to the particular company providing funds to the respective project. In the case of a third party or the university not being interested in the exploitation of the immaterial property rights of a given invention, the rights can be transferred back to the original inventor.

To assess the distribution of ownership rights to inventions, respondents were asked to submit the shares of ownership rights that different actors have to their inventions. Table 26 presents the distribution. It is noteworthy that the reported shares are not exhaustive, i.e., they do not add to 100%. This is due to the refusal or inability of some respondents to provide an answer.

Table 26 Distribution of ownership rights to inventions (%)

obs: 673	% owned
Personal possession or joint ownership with a research team	32.48
University / Research institute	34.70
Companies	14.87
Other third party	2.45

Inventors reported themselves to be endowed with roughly 32.5% of the ownership rights to their inventions. This also includes rights shared with other members of a research team, roughly 32.8% of the above or 10.7% of all ownership rights. We need to point out that the share is an average ownership share of inventions. It does not confer information about how many *inventions* are owned by inventors but is the share of owned *rights*. In addition, the share varies between inventors and represents the *average* over all respondents that identified themselves as inventors.

It is this share of inventions that we will be interested in when analyzing the mechanisms through which academic inventions find commercial application in the subsequent sub-section. The share of rights owned by the original inventors is particularly high at universities that also report allocating relatively more time to basic research than other universities (e.g., Joensuu, Jyväskylä, Tampere, and Helsinki). The present analysis cannot establish more extensive links between the two findings, but we must note that basic research is more often funded from universities' own budgets, while companies have more interest in research that might potentially yield applicable results. In the former case, the Universities Inventions Act allocates the ownership rights directly to the inventor, while in the latter case, rights belong to the university.

Much more interesting and controversial is the fairly large share of inventions owned by universities. Approximately 35% of rights to inventions rest with the different universities. While the fact that technical universities seem to own higher shares than those specializing in basic research is rather intuitive, the general size of absolute shares is surprising. One must immediately ask what universities intend to accomplish with the rights to over a third of inventions, as they are not endowed with the mission or the relevant assets required for direct commercialization. Why have these inventions not been either forwarded to the respective companies that were involved in the projects of the inventions' origin or, alternatively, been returned to the original inventors, who could then more effectively facilitate the promotion of the inventions' commercial application? Or do universities indeed attempt to take a more active role in the commercialization of research? Given the traditionally almost non-existent role of Finnish universities in such endeavors and further assuming that such traditions are difficult to break in the short-run, we must provocatively ask whether a third of academic inventions made in the past five years are, in fact, uselessly "gathering dust on the shelves" as an American university technology transfer specialist described similar circumstances (Tahvanainen and Hermans, 2009).

Along the lines of the above discussion, companies seem to possess a rather small share of inventions compared to the generally accepted notion that frequent university-industry co-operation has traditionally been a strong point in the academic culture in Finland. Only about 15% of the rights to inventions were reported to rest with a company. Again, shares are clearly higher at certain technical universities (Lappeenranta and Tampere).

6.3 Commercialization propensity and mechanisms

Having established that roughly 32.5% of inventions are *potentially* subject to commercialization attempts by academics, a more important question arises: how many of those inventors, who have control over or have some say in the use of their inventions, are willing to actually facilitate the commercialization process of their inventions? Table 27 provides the results.

Table 27 Share of inventors willing to commercialize proprietary results (%)

obs: 454	% inventors
None	51.54
Some	37.89
All	10.57

Of all the inventors (in our sample, 454 individuals) with varying degrees of ownership of their inventions, 48.5% indicated an explicit decision to facilitate the commercialization of one or more inventions in some form or other. To add some contrast to the figure, 10.6% of inventors with rights expressed their willingness to commercialize *all* of their inventions. This figures translate into 12.8% of *all respondents*, inventors and non-inventors combined, having made a decision to attempt the commercialization of research results with subjective commercial potential. This figure includes also those that have already engaged in commercialization attempts.

This select share of researchers was asked to indicate through which mechanisms they either plan to or already have attempted to commercialize their inventions. Three major mechanisms that are prominently featured in technology transfer literature were provided as available options: commercial consulting, the establishment of a start-up company, and the licensing or selling of inventions to third parties. The respondents provided their answers on a four-step scale assessing the extent to which any particular mechanism was to be exploited (1 = not at all, 2 = to some extent, 3 = fairly much, and 4 = very much). Table 28 presents these results.

Table 28 Commercialization mechanisms (%)

obs: 212-221	% inventors
Consulting	
Not at all	51.89
To some extent	36.32
Rather much	8.49
Very much	3.30
Licensing/selling	
Not at all	31.67
To some extent	30.77
Rather much	24.89
Very much	12.67
Entrepreneurship	
Not at all	53.18
To some extent	22.27
Rather much	15.00
Very much	9.55

The most striking finding concerns the low overall willingness to exploit any of the given options. For instance, despite receiving the best average grade (2.19 on the four-step scale) of the three mechanisms, roughly 32% of respondents indicated an unwillingness to use the licensing or selling option at all. Another 31% reported doing so only "to some extent". The other two options are even less popular. Approximately 52% of inventors distance themselves entirely from attempts to exploit the research results through consulting (average score 1.63), and 36% planned to engage in such activity to some extent. The equivalent figures for founding a proprietary company (average score 1.81) were 53% and 22%. There are minor differences in the results between universities, but they do not provide grounds for the identification of observable patterns regarding the nature of universities.

All things considered, the results draw a rather coherent picture. While the stated *intention* to commercialize could still be argued to be somewhat strong in general (Table 27), the *implementation* of intentions through specific action seems to suffer from pronounced passiveness (Table 28). Looking at the order of preference among the different commercialization mechanisms, it is clear that researchers prefer the one that involves the least personal commitment, i.e., licensing and selling, which further corroborates this line of interpretation. Investing personal effort, time, and other resources to advance the commercial application of results seems to be rather unappealing to researchers. In an attempt to shed more light on and bring more detail to the finding, we next analyze the personal motives underlying researchers' intentions regarding commercialization more thoroughly.

6.4 Motives underlying the willingness to commercialize research

Respondents that indicated a willingness to commercialize one or more of their proprietary inventions were asked to assess how important a given set of personal motives was for their decision to facilitate the commercialization process. Answers were provided on a four-step scale (1 = not at all, 2 = somewhat important, 3 = rather important, and 4 = very important). According to the findings in the previous subsection, we want to emphasize that the subsample discussed here represents a mere fraction of the original sample of 1723 respondents. Table 29 summarizes the results.

Table 29 Motives to commercialize

obs: 237-244	Avg
Beneficial societal impact of the results	3.07
Ambition to realize the results' potential	2.99
Securing research funding	2.68
Economic returns	2.50
Job variation	2.31
Promotion of academic career	2.31
Career re-orientation	1.94
Support from the work environment	1.68

Surprisingly, personal and idealistic motives seem to dominate more economic and materialistic motives. The drive to have a beneficial impact on society received the highest scores among the available options on average (3.07). The variation between universities is rather small, but inventors at the universities of Tampere, Helsinki, Jyväskylä and Joensuu are particularly strongly driven by the societal motive. None of the universities averaged below the 2.5 scale average in this motive category (see Appendix A29 for details).

The personal ambition to realize an invention's potential, an intrinsic drive related more to the discourse of self-fulfillment than that of altruism, and the avoidance of letting the potential of an invention be wasted in vain received the second highest average score (2.99). Inventors at the technical university of Tampere (3.25), Åbo Akademi (3.18), and the University of Turku (3.15) are especially motivated by this intrinsic ambition. Again, none of the universities scored this motive below the scale average.

Securing research funding through the participation in the commercialization of proprietary research results was graded the third most important motive (2.68). Providing access to an invention and its use to a company might persuade the company to fund the follow-up research of the respective researcher. Researchers at the universities of Joensuu (3.1), Kuopio (3.13) and Turku (2.86) graded this motive higher than those at other universities on average.

Motives related to possible economic returns were scored at the scale average (2.5), ranking the motive only fourth overall in importance. Researchers at the Technical University of Tampere (2.81), Aalto University's School of Science and Technology (2.92), and Åbo Akademi (2.91) provided the highest scores among the universities. Economic motives were least important at the universities of Oulu (2.08), Helsinki (2.29), and Kuopio (2.38). With most of economic studies either assuming or advocating incentive systems for researchers to be built based on monetary compensation schemes, this result is very important in giving a partial explanation as to why such schemes might be rather ineffective after all. As incentive systems should provide researchers with gains in those dimensions that they hold valuable, the rather low rank of economic returns as motives to commercialize indicates this is not one of those dimensions. How does one compensate researchers for commercial endeavors if they are mostly interested in more altruistic objectives such as benefiting society or securing resources for research?

The lowest scores were given to the support inventors have received from their work environment for their commercialization attempts. The average score is 1.68. Researchers at the universities of Jyväskylä (1.20) and Tampere (1.36) provided especially weak scores, while the environment seems to be most supportive in Joensuu (2.60) and Kuopio (1.93). A low score for the support of the work environment can be interpreted along two alternative lines. The first of these suggests that the low score might be an indication of a subjective indifference to the particular driver among respondents. According to this line of interpretation, respondents simply do not care whether their environments are supportive of their commercial ambitions or not. Alternatively, the low scores might indicate a lack of support from the environment in the first place. This would, of course, raise immediate concerns, as it could be interpreted to represent an inhibitor to the commercialization of research in Finland. To be able to argue for either one of the two lines of interpretation, we need to find out what the respondents identified as explicit challenges in their commercial endeavors. This will be the subject of the next subsection.

6.5 Challenges in commercialization

To probe factors that might inhibit commercial endeavors of academic inventors in depth and more explicitly, we asked the respondents to assess the significance of a number of potential inhibitors and challenges on a four-step scale (1 = not at all significant, 2 = somewhat significant, 3 = rather significant, and 4 = very significant). The question was posed to two distinct groups of respondents. The first (group A) consists of those inventors who indicated having explicitly decided against an attempt to commercialize one or more of their inventions. This group was asked to indicate the significance of *factors that might have affected the commercialization decision*. The second group (group B) consisted of (i) those respondents who have either already attempted or decided to commercialize all their inventions and (ii) those who are not inventors in the first place. This particular group was asked to assess the significance of *challenges for the commercial exploitation of research in Finland in general*. The options given

to both groups were largely identical except for two that were exclusively given to the former group. Tables 30 and 31 provide the results. We will consider the results for both groups jointly, as they seem to largely coincide.

Table 30 Factors underlying the decision to not commercialize inventions

obs: 378-396	Avg
Lack of time	3.02
Difficulties regarding financing	2.51
Economic risks	2.30
Lack of personal interest in commercialization	2.20
Lack of expertise regarding commercialization	2.06
Avoidance of conflicts of interest regarding research	2.04
Lack of support from the work environment	2.03
Complications with my organization's administration	1.98
Difficulties related to ownership rights	1.89
Incompatibility of commercialization and ethics of science	1.75
Own or colleagues' poor prior experiences	1.51
Opposition from other joint owners	1.25

Table 31 Challenges to the commercial exploitation of research in Finland

Obs: 985-1037	Inventors	Non-inventors	Stat.sig.	All
Lack of time	3.22	2.82	***	2.91
Lack of interest in commercialization	2.60	2.79	***	2.75
Difficulties regarding financing	2.92	2.66	***	2.72
The research environment opposes it	2.49	2.57		2.55
Economic risks	2.68	2.39	***	2.45
Commercialization invokes conflicts of interest	2.34	2.45		2.43
Difficulties related to administrative issues	2.67	2.34	***	2.41
Lack of knowledge regarding commercialization	2.49	2.36	**	2.39
Incompatibility with the ethics of science	2.06	2.33	***	2.27
Difficulties related to ownership rights	2.34	2.16	***	2.20

* p<0.10, ** p<0.05, *** p<0.01

The results reveal clearly that time constraints are the single most significant factor that the respondents deem to negatively affect commercialization attempts. In both respondent groups, the score average is close to 3. The variation between universities is negligible.

Securing financing for commercial endeavors seems to be the second most significant barrier or challenge identified by the respondents. The average response score of inventors who had explicitly forfeited commercial opportunities at some point in time (group A) was 2.51, while those who assessed the factor as a general challenge to academic commercialization in Finland (group B) argue that it is an even more significant inhibitor (2.72). Financing has been identified to pose a problem to the growth of Finnish high-technology companies emerging from academic research in prior studies (for biotechnology, see Tahvanainen, 2004). In particular, the rather steep information asymmetry regarding the true commercial potential of academic inventions between the inventors (or insiders of a given academic start-up) and the financial markets seems to pose a challenge to securing financing (for biotech-

nology, see Tahvanainen and Hermans, 2005), as the views on a fair valuation of inventions and start-ups seldom coincide among the different actors involved.

Economic risks related to commercialization attempts pose the third most significant threat. The average score of group A was 2.30, while that of group B was 2.45. The scores are still rather high and could be argued to relate to the previous findings regarding financing. With limited access to external funding, commercial endeavors would have to be financed to a greater extent based on proprietary resources, which could translate into significant economic risks to the individual, considering that high-technology start-ups often require significant long-term investments before reaching self-sufficiency. With the dawn of the reformed Universities Act, universities are now in a position to invest in commercial endeavors without the legal constraints that the old Universities Act enforced upon public institutions. Universities striving to establish themselves as promoters of technology diffusion might alleviate problems related to the personal economic risks of researchers by sharing the risk through direct investments.

The sheer lack of personal interest in commercialization on the part of the researchers was identified as the fourth most important factor inhibiting the commercialization of research. The average of group A is 2.20, and the average for group B is a staggering 2.75. As shall be argued in the concluding section of the study, the lack of interest is a recurrent and overarching theme that is also indirectly reflected in the responses given to a multitude of other questions in the survey. This lack of interest can be related to numerous factors that this study is unable to explicitly identify, but given the overall picture drawn in the study, it is clear that commercialization still occupies only a marginal space in the cultural, organizational, individual and normative dimensions of academic work. It is not an integral and established component of every researcher's work or professional mind-set. As long as the transfer of research results to commercial or other societal use is external to the academic mandate, no one can expect the research community to develop a keen interest in it on a broader scale.

Friction with the administration at the universities was further identified as a challenge. The average score is less alarming for those that have actually attempted commercialization, but the average for group B is rather high at 2.41. In particular, researchers at the universities of Kuopio (group A 2.27; group B 2.82) and Jyväskylä (group A 2.39; group B 2.32) seem to struggle with bureaucracy or other challenges related to organizational culture and management. The distribution of scores across the rest of universities seems to be much more dependent on which of the two respondent groups the inventors belong to. Group A also struggles with the university administration at the University of Turku (2.08) and Aalto University's School of Science and Technology (2.03). Group B is most unhappy with administrative friction at the University of Oulu (2.48) and the Technical University of Tampere (2.52) (see Appendix A30 and A31 for details). Friction with the local university administration can be a consequence of many different issues. It can be a function of simple bureaucratic encumbrance manifesting itself as prolonged decision times and other parts of the administrative process. It can also stem from a lack of university resources dedicated to university technology transfer, which necessarily translates into poor quality research and innovation services provided to inventors (Tahvanainen, 2009). It can further be a symptom of a lack of an explicit strategy guiding issues of technology transfer at a given university. This would result in poor guidance and an absence of support on issues of commercialization. Independent of the factual reason behind the scores, the results give grounds for

critiquing certain universities for their lack of attention to the issues of promoting researchers' commercial ambitions. This has been emphasized in prior literature as well (Tahvanainen, 2009).

Returning to the issue of support received from the direct work environment, the results do not give rise to exorbitantly alarming conclusions, but they are nevertheless non-negligible. Those who have explicitly decided not to commercialize a particular invention assess the lack of support from the environment to have influenced the decision to "some extent" (2.03). Here differences between universities are rather large. Researchers at the University of Jyväskylä feel the lack of support most strongly (2.50). The lack is felt least severely at the universities of Oulu (1.86) and Joensuu (1.75). Group B assesses the challenge to be more severe (2.55) on average, but there is only mild variation between the universities.

Surprisingly, ethical questions related to the incompatibility of academic and commercial ethics did not seem to be a significant issue, nor were difficulties regarding intellectual property rights regarded as strong deterrents to commercialization. The score averages of both issues were non-negligible but were among the less significant ones when compared to others.

Having established the degree and nature of challenges that researchers have experienced regarding the commercialization of their research results, the final section of this paper asks whether these hindrances have been addressed properly at Finnish universities. Among the major institutions dedicated to the promotion of researchers' commercial endeavors are the research and innovation service units present at all major universities in Finland. The primary purposes of these units are to help researchers to obtain financing for research and to support them in diffusing the respective results to industry or other parts of society. The units are the Finnish equivalent of so-called technology transfer offices (TTO). Whether Finnish TTOs have been able to provide researchers with services that match their needs and, thereby, have been able to facilitate in overcoming the challenges identified above is the focus of the final section.

7. Researchers' views on the effectiveness of Finnish technology transfer offices

The research and innovation services units (TTOs) operating at every Finnish university provide researchers and research projects with expert services regarding research collaboration with external parties and the societal and commercial exploitation of research results. In doing so, the TTOs operate as mediators between the scientific communities at universities, their units on remote campuses, external stakeholders such as companies, industrial associations, other TTOs, individual entrepreneurs, and financiers, as well as public actors such as Tekes, the Foundation for Finnish Inventions (Keksintösäätiö), the National Board of Patents and Registration of Finland (Patentti- ja rekisterihallitus), and the ministries.

Depending to a large extent on the particular TTO, services may include attracting company funding for collaborative research projects, dealing with the administrative coordination of EU–funded re-

search projects, handling the patenting procedures regarding academic inventions, educating researchers in issues of commercialization, designing business plans, evaluating the commercial potential of inventions, finding partners for commercialization, negotiating licensing deals, and providing industry feedback on inventions, among a plethora of other possible services.

As TTOs justify their existence by focusing on practices and services that are necessary for the successful transfer of university technology to societal use but lie outside of the competence area of researchers and other stakeholders in the process, their efficiency and effectiveness depend to a large extent on their success in matching said services with the actual needs of researchers. This section takes this assumption as a premise and asks how well a match has currently been achieved. We start by mapping the overall familiarity and frequency of use of TTO services first and proceed to assess how satisfied researchers are with a number of specific services.

As the TTOs serve the entire population of researchers through research support services, the following analyses do not exclude non-inventors from the sample of respondents. Research can be seen as the starting point of a technology transfer continuum, and commercialization takes place at the other end. Thus, we are just as interested in the TTOs' capabilities to serve the needs of research as we are in those serving more commercially oriented activities.

7.1 Familiarity and frequency of use of TTO services

Table 32 reveals that roughly 60% of researchers are at least to "some extent" familiar with the services provided by their respective local TTO. To be more precise, 40.3% of researchers are "somewhat familiar", 15.3% of respondents are "rather familiar", and another 4% assessed themselves to be "very familiar" with the range of services at their disposal. There is some variation in the percentages between universities, with the universities of Helsinki, Tampere and Joensuu displaying the lowest scores for familiarity, while respondents at the technical universities systematically provided the highest scores (see Appendix A32 for details).

Table 32 Familiarity with TTO services (%)

obs: 1662	Inventors	Non-inventors	All
Not at all familiar	19.00	54.72	40.37
To some extent familiar	45.10	37.16	40.25
Rather familiar	27.60	7.01	15.34
Very familiar	8.30	1.12	4.03

Stratifying respondents into inventors and non-inventors provides us with distributions that are much richer in contrast. For non-inventors, the share of respondents indicating that they are not at all familiar with the supply of TTO services is a staggering 54.7%. For inventors, the equivalent figure is only 19%. It is rather intuitive that inventors implicitly consort with their local TTOs more often than non-inventors because they are obliged to submit a law-mandated invention disclosure for each invention. Moreover, services related to the commercialization process of inventions are exclusively found at the TTOs, which further encourage inventors to familiarize themselves with the offices' services.

Nevertheless, it is quite alarming news that the clear majority of non-inventors seems to be entirely unaware of the services they could use in an attempt to promote their academic research. Only 8.1% are either "rather" or "very familiar" with available services. The figure for inventors is 35.9%. While the relatively high familiarity among inventors could be explained by an implicit necessity and a stronger need for the services and the low familiarity among non-inventors could relate to the more basic nature of their research or a lower position and, thereby, less administrative responsibilities on research teams, there clearly is much room for more and better communication about the TTOs' services at Finnish universities. Whether researchers actually need the services or choose to use them is a decision that each researcher has to make individually, but the fact that a large share of them are not even aware of their existence is a different matter, and the resolution of this is the clear responsibility of each and every individual university. To boost the effectiveness and efficiency of university-industry technology transfer, providing access to much-needed services is key. Knowledge about the existence of such services is even more important; it is a prerequisite. With every fifth inventor of a potentially commercially viable invention being unaware of the existence of such services, the situation as it is seems to be grave indeed.

Table 33 examines how the familiarity with the available TTO services translates into their actual use. Respondents were asked to indicate how frequently they have made use of the offices' services in the past 5 years prior to survey implementation.

Table 33 Frequency of use of TTO services (%)

obs: 995	Inventors	Non-inventors	All
Never	15.47	43.47	27.94
Occasionally	56.35	49.32	53.37
Often	28.18	7.21	18.69

Compared to the scores assessing the familiarity of respondents with their local TTO services, the frequencies of utilizing them seem to be higher. Roughly 28% reported no contact with their TTO; 54.4% converse with the office from time to time; and 18.7% use the services frequently. Again, we observe differences between universities, with the researchers at Aalto University's School of Science and Technology, Åbo Akademi, the University of Kuopio, and the Technical University of Lappeenranta being the most active users. The respondents at the universities of Helsinki, Tampere, and Jyväskylä are the most infrequent users (see Appendix A33 for details).

In line with the previous results, there are large differences between inventors and non-inventors. We found that 15.5% of inventors admit to not having utilized TTO services in the period of observation; 56.4% of them rely on the TTO from time to time; and 28.2% use TTO services frequently. The equivalent figure for non-inventors not using the services at all is 43.5%. Another 49.3% of them have conversed with their local TTO from time to time, however, and roughly 7% utilize the services frequently. Recalling the results from Table 32, this necessarily implies that many of the researchers using their TTO's services are not really familiar with what it provides, and this is an indication of at least two issues. First, many of the services used by researchers are most likely routine and relate to administrative tasks that can be performed by the TTO as stand-alone procedures not requiring the involvement of the researchers. This would implicitly involve less direct communication between the TTOs and the researchers and

would explain in part why the familiarity with provided services and the frequency of their use is rather low. Second, TTOs seem to be rather passive in educating their client researchers about the variety of other services offered, even when already in contact with them. An established contact with a researcher would seem to offer a natural opportunity to advertise other services of the TTO.

7.2 The degree of match between services and needs

The intensity of use of available TTO services is evidently one important quantitative indicator in the assessment of how well TTOs are able to reach and serve the academic community. Another equally important dimension to be measured is the match of a TTO's services and the needs of those researchers it aims to serve. To assess the match, the respondents were asked to provide scores for a number of given services and assess how well these services address their potential needs (1 = very inadequately, 2 = rather inadequately, 3 = rather well, 4 = very well, and "no need for service"). Table 34 presents the results.

Table 34 Match of user needs and service provision

obs: 798-849	Inventors	Non-inventors	Stat.sig.	All
Facilitation in the acquisition of external research funds	**2.19**	**2.36**	**	**2.25**
No need for service (%)	11.23	18.78		14.37
Education in commercializing research results	**2.51**	**2.44**		**2.48**
No need for service (%)	11.23	50.73		27.5
Support in preparing business plans	**2.25**	**2.31**		**2.26**
No need for service (%)	36.46	63.8		47.78
Scouting the competitive situation on markets	**2.34**	**2.22**		**2.30**
No need for service (%)	27.48	60.24		40.91
Evaluation of the commercial potential of my findings	**2.40**	**2.34**		**2.37**
No need for service (%)	19.66	56.6		35.09
Provision of industry feedback for my findings	**2.03**	**2.10**		**2.05**
No need for service (%)	33.04	65.57		46.49
Support in organizing IPR-related issues	**2.74**	**2.68**		**2.73**
No need for service (%)	20.39	55.16		34.86
Support in preparing patent applications	**2.60**	**2.63**		**2.61**
No need for service (%)	22.6	60.23		38.45
Identification of commercial users for my findings	**2.16**	**2.18**		**2.16**
No need for service (%)	23.01	60.36		38.4
Negotiation of license contracts	**2.39**	**2.48**		**2.42**
No need for service (%)	33.26	63.02		45.69
Identification of financiers for my own company	**1.91**	**2.09**	**	**1.96**
No need for service (%)	44.23	68.25		54.39

* p<0.10, ** p<0.05, *** p<0.01

The overall average scores do not provide evidence of a generally good fit between provided services and the needs of researchers. Services related to the clarification of IPR issues, the support in preparing patent applications, and the education regarding the commercialization of results are the only services to receive slightly above-scale-average scores. The lowest-scoring services comprise support in finding financiers for commercial endeavors, provision of industry feedback for inventions, and the identification of potential industrial users for inventions. Scores did not vary significantly between inventors and non-inventors (for university-specific results see Appendix A34 for details).

It is evident that services related to the commercialization of research in general grossly fail to match the needs of researchers. It seems that services that need to be produced in close vicinity of the academia-industry interface or even in direct interaction with companies fail especially seriously. This speaks of a lack of business skills and industrial experience on the part of the service units. It might also reflect a lack of resources dedicated to such services. As Tahvanainen (2009) finds, the Finnish research and innovation service units systematically suffer from a lack of both dedicated resources and the skills required for industry interaction. We will return to the implications in the concluding discussion of the study.

Attention should also be paid to the fact that a rather large share of respondents, up to roughly 50%, indicated that they did not need most of the services related to the transfer of technology in the first place. The phenomenon is most likely due to the fact that the sample of respondents answering the question included non-inventors, constituting roughly 60% of all respondents. However, even among inventors, depending on the service in question, shares of 20 - 40% indicate that they do without such services. We will return to the implication of this in the concluding discussion of the study.

7.3 Satisfaction with TTO services and their impact on commercialization

To close the discussion on TTOs and their value as perceived by researchers, we conclude the paper by assessing how the above findings affect researchers' overall satisfaction with their local TTOs and whether they have had an impact on the decision of inventors to proceed with the commercialization of their inventions. Tables 35 and 36 show the results. In Table 35, answers are provided on a four-step scale (1 = very dissatisfied, 2 = somewhat dissatisfied, 3 = rather satisfied, and 4 = very satisfied), while results presented in Table 36 are given on a three-step scale (1 = negative effect, 2 = no effect, and 3 = positive effect).

Table 35 General satisfaction with TTO services

obs: 871	Inventors	Non-inventors	All
Very dissatisfied	10.14	5.82	8.27
Somewhat dissatisfied	30.42	29.36	29.74
Rather satisfied	50.10	57.89	53.62
Very satisfied	9.34	6.93	8.38

Despite the relatively poor match between the services provided by TTOs and the needs researchers have regarding the commercialization of research, respondents seem to be rather satisfied with the performance of their respective TTOs. The results show that 53.5% are "rather satisfied", and another 8.4% report being "very satisfied" with received services. Roughly 30% express some dissatisfaction, while only 8.3% are very dissatisfied. There is very little variation between universities, with the Technical University of Tampere (2.74) and the University of Helsinki (2.75) receiving slightly better average scores, and the University of Tampere (2.51) and Aalto University's School of Science and Technology (2.39) obtaining the lowest. The comparison between inventors and non-inventors yields equally small differences, with inventors being slightly less satisfied than those not having made inventions. This could indicate that support services related to commercialization attempts perform less satisfactorily than those supporting more academic ambitions.

Summarizing the overall results regarding the performance of TTOs, it seems that both the familiarity with the TTOs' services and their match with the needs of respondents leave considerable room for improvement. On the other hand, respondents seem to be fairly satisfied with what they are offered. While the controversy seems puzzling at first, there is a simple intuition that could explain it: TTOs and their services are simply not very important to researchers, and they play only a minor role in their everyday activities. They are not perceived as an integral part of the immediate work environment, nor are their services integrated into the processes researchers go through in their respective projects. Thus, the researchers' dependence on and, hence, expectations towards the services are low from the start and can therefore be satisfied relatively easily. This, in turn, serves as further indication of the TTOs' failure to effectively communicate the potential value they could provide and poses a tangible challenge for the immediate future.

8. Concluding discussion

This paper set out to address a critical question at the heart of current discussions regarding the sustainability of the global competitive advantage of the Finnish economy: what motivates the university researcher to participate in the transfer of research results to industrial and broader societal use?

Extant analyses have pointed to a discrepancy between the high quality and strong academic competitiveness of research conducted in Finnish universities on the one hand and the share of the respective research outputs that has been commercialized on the other hand. As the capability to transform cutting-edge research into industrially applicable innovations is one key prerequisite for the economic long-term competitiveness of high-cost, developed economies, providing proper incentives for researchers to disseminate their knowledge and ideas in one form or another to potential users and commercial partners is of great importance. To this end, one must fundamentally understand the intrinsic motives of researchers to conduct research and to engage in possible dissemination activities.

The various results of this research paper give rise to a number of conclusions that address this concern. We established that commercial motives play only a minor role in the various work-related activities in which researchers engage. For instance, potential commercial aspects have close to no impact on the choice of a researcher's research orientation, i.e., the substance of her research. Furthermore, industrial collaboration is relatively uncommon among researchers. Even those researchers who reported experience with industry collaboration reported that collaboration mostly serves academic ends. These include securing research funding and searching for new research ideas. In addition, only 10% of all researchers have received complementary business education. Given that approximately 40% of researchers indicated having produced inventions with commercial potential, 10% seem a fairly small share. This is also reflected in the researchers' clearly feeble familiarity with the principles that govern the allocation of ownership rights to inventions that arise from academic research, which is a prerequisite to any commercial endeavors. In summary, the study shows that the juxtaposition between science and commercialization in Finnish academia still seems to be fairly pronounced.

This is unfortunate because our results show that the integration of science and commercial activities seems to produce promising results in both the academic and the commercial dimensions: academic inventors of commercially viable inventions do more of everything. They cooperate more with companies, and they have more extensive industrial work experience. They work more often in interdisciplinary research teams and are simultaneously part of more research teams than non-inventors. They spend more time on applied research than non-inventors, but less time on research in general. At the same time, however, they also publish more academically. Academic and commercial ambitions seem not to be a trade-off after all. In fact, the results provide indication of a synergetic effect.

If collaboration with industry and a more interdisciplinary, networked and application-oriented approach to research defines the typical researcher who has been able to produce inventions with commercial potential, what does make him take the next step and make the effort to facilitate the commercialization of these inventions? Making a discovery is certainly a necessary prerequisite for university technology transfer, but it is not sufficient. Participating in the transfer itself is an entirely different matter. This is one of the key questions in understanding the Finnish commercialization paradox.

The results addressing the question of the commercialization propensity of researchers provide challenging implications from an innovation policy perspective. First of all, researchers willing to participate in the transfer of their inventions to industrial or societal use are rare. Of the 40% of researchers claiming to be inventors, only 30% own the rights to their inventions. Of these, a majority distance themselves from commercial ambitions, leaving us with just 13% of all university researchers that are interested in commercialization. While this figure does not seem to be alarmingly small overall, one must bear in mind that this is the maximum population of individuals that will ever even *try* to commercialize research. It is not the population of researchers that actually have *done* so.

Furthermore, it seems that the propensity to commercialize is much less affected by economic factors such as potential economic returns or a career in industry than it is by altruistic, socio-cultural, or personal motives. This makes designing proper incentive mechanisms difficult. The three most important factors mentioned by inventors who have made the decision to facilitate the commercialization process of their inventions include (i) the inventions' potential to have a beneficial impact on society, (ii) the researchers' ambition of self-fulfillment and a determination to avoid letting the potential of an invention be wasted in vain, and (iii) securing research funding for further academic research. Societal goals and reasons related to pure intrinsic ambition seem to dominate other motives. It seems that *commercialization* and related *economic* aspects bear little value to researchers. It is just one potential mechanism that serves greater ends. The low importance of commercialization as such is also evident in the fact that the participants of the study did not identify strong inhibitors or challenges to the commercialization of research. It seems that commercial ambitions are not of enough importance to affect strong reactions regarding possible challenges to such endeavors. In fact, of all challenges, the lack of time was identified as the most common deterrent to commercial ambitions, a finding that strongly speaks of the low priority of commercialization compared to other objectives in the researchers' work. Researchers simply do not regard commercialization to be a part of their work.

The implicit question is how to promote an environment and how to design incentive structures for researchers that address these socio-cultural drivers to boost the transfer of technologies from Finnish

universities. If the system-level tasks of remolding the Finnish culture to embrace more self-centered and entrepreneurial values and redefining the role of academia in society are considered too daunting (in the end, these define the perceptions of the appropriate ambitions in and objectives of academic research) and incentive structures built on monetary incentives seem to be inefficient at best, is there anything one can do on the university level?

Research and innovation service units operating at most of the Finnish universities have taken on the very task of answering this challenge. They are charged with the mission of helping researchers attract financing for their research endeavors and supporting them in various ways in commercializing or transferring the emerging research results. These units could brand themselves as facilitators of technology transfer for the benefit of the greater society, servicing the researcher and his needs according to his vision and ambition and distancing themselves from exclusively economic objectives. In fact, the most successful of professional technology transfer units at elite US universities operate according to these very stipulations and emphasize treating the researcher as a cherished customer and listening to his needs as the basis for designing appropriate services (Tahvanainen and Hermans, 2009). One of the central stipulations in their code of conduct is that monetary objectives cannot serve the role of the ultimate objective in university technology transfer because it often leads to inefficient or even detrimental outcomes from the perspective of the university, society and the individual researcher.

In general, Finnish researchers are quite satisfied with the services provided to them by their respective research and innovation service units. Only a closer look at the possible needs of researchers and the degree to which the service units match these needs through proffered services reveals the true challenges regarding the operation of the units, and the revealed match between needs and provided services is rather weak. In fact, researchers indicate that they do not need most of the services in the first place. This leads to only one viable conclusion: the service units are not an integral part of the university culture as yet. Being satisfied with services that do not match needs indicates that researchers have not yet embraced such services as an important part of their work or of the technology transfer process. Poor service is of no consequence because researchers do not rely on the services in the first place. The units simply are not a part of their relevant domain, just as commercialization is not a part of their job description.

To remedy the situation, much emphasis needs to be put on communicating the range of available services to the researcher community. This is a first step. The second step would be to design a set of services that address the true needs and ambitions of researchers and to provide proper incentives for researchers to participate in the transfer of their research results. This will require further communication, patience, and close collaboration with the research community. It is a long-term task because the goal is nothing less than changing the prevalent academic culture built on centuries of cultural tradition.

However, designing a proper service range is not sufficient. Proper service requires proper resources. Tahvanainen (2009) found that the innovation service units, as they exist today, suffer from a chronic and acute deficiency in a number of vital resources, including personnel, appropriate business expertise and continuous, proprietary funding. At worst, the technology transfer operations of an entire university have been delegated to a single person who is simultaneously (if not primarily) charged with managing research-related administrative tasks as well. At most universities, personnel dedicated to technology

transfer services are not paid by the university but receive their salary from the Foundation for Finnish Inventions. This severely casts into question the continuity and availability of innovation services. Additionally, funding for market analyses, prior research and business plan development, which should be part of the basic service repertoire of any innovation service unit, must be sought (through application) from external parties, such as Tekes and its TULI-program because funds from the universities' own budgets are not available. At some universities, there is not even a publicly communicated technology transfer strategy demarcating the role of such activities among other university objectives. In fact, many units complained that the higher tiers of their respective university administration have not committed to matters of technology transfer in the least. It is evident that technology transfer services at Finnish universities still largely remain unwanted organizational orphans.

Molding academic culture and infusing it with values that are supportive of commercialization and other mechanisms of technology transfer are only possible by addressing academics directly. Breaking down out-dated conceptions and convincing researchers to construct and accept new ones depends very much on personal interaction. Innovation service units seem to be fairly well suited to such a mission because they already are present at most universities. The personnel of these units are also already well aware of the task ahead. They only lack the resources. This is a matter that universities must address explicitly in the nearest future. Succeeding in doing so might have a considerable impact on Finland's competitiveness in the long-run.

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APPENDIXES

Table A2 Age by category

University	ABO	HUT	HY	JOENSUU	JYU	LUT	OULU	TUT	UKU	UTA	UTU	ALL
Obs	*61*	*213*	*479*	*59*	*131*	*30*	*201*	*101*	*120*	*91*	*233*	*1719*
Age	44.67	39.85	43.01	40.27	39.71	43.33	43.77	38.89	39.77	44.07	43.27	42.05

Table A3 Level of education by category (%)

University	ABO	HUT	HY	JOENSUU	JYU	LUT	OULU	TUT	UKU	UTA	UTU	ALL
Obs	*61*	*212*	*478*	*59*	*131*	*30*	*201*	*101*	*120*	*91*	*232*	*1716*
PhD/Lic.	83.6	76.9	80.8	66.1	71.0	86.7	80.6	70.3	73.3	81.3	83.2	78.4
Master's	16.4	22.6	19.0	33.9	28.2	10.0	18.4	29.7	25.0	17.6	16.4	21.0
Other	0.0	0.5	0.2	0.0	0.8	3.3	1.0	0.0	1.7	1.1	0.4	0.6

Table A4 Field of education (%)

University	ABO	HUT	HY	JOENSUU	JYU	LUT	OULU	TUT	UKU	UTA	UTU	ALL
Obs	*61*	*213*	*481*	*59*	*131*	*30*	*203*	*101*	*120*	*91*	*234*	*1724*
Mathematical sciences and statistics	3.28	17.84	5.61	6.78	12.21	10.00	0.05	0.15	0.03	0.10	0.08	0.09
Data processing	4.92	5.63	2.70	6.78	3.05	3.33	0.02	0.07	0.03	0.09	0.03	0.04
Physics	1.64	15.02	12.06	22.03	15.27	6.67	0.08	0.16	0.13	0.00	0.13	0.12
Chemistry	26.23	4.23	8.52	5.08	18.32	6.67	0.04	0.08	0.13	0.00	0.05	0.08
Biology	19.67	0.00	19.54	33.90	19.08	0.00	0.20	0.02	0.03	0.02	0.19	0.14
Biochemistry	6.56	0.94	8.11	0.00	1.53	0.00	0.05	0.02	0.12	0.11	0.05	0.06
Environmental sciences	3.28	0.94	5.82	3.39	3.82	0.00	0.02	0.02	0.08	0.00	0.03	0.04
Biosciences	1.64	2.35	12.68	6.78	3.82	0.00	0.04	0.04	0.19	0.10	0.08	0.08
Machine or automation technology	0.00	6.57	0.00	0.00	0.00	10.00	0.02	0.06	0.00	0.00	0.00	0.02
Energy technology	3.28	2.35	0.00	0.00	0.00	10.00	0.00	0.02	0.00	0.00	0.00	0.01
Electrical engineering	0.00	19.25	0.62	1.69	0.00	6.67	0.06	0.17	0.00	0.01	0.02	0.05
Technical physics	1.64	16.43	1.04	0.00	2.29	3.33	0.00	0.10	0.00	0.00	0.00	0.03
Information or communication technology	0.00	14.08	0.42	0.00	3.05	13.33	0.05	0.28	0.00	0.01	0.02	0.05
Chemical engineering	27.87	8.45	1.25	0.00	0.76	26.67	0.02	0.01	0.01	0.00	0.00	0.03
Environmental engineering	1.64	1.88	0.00	0.00	0.76	6.67	0.03	0.04	0.03	0.01	0.00	0.01
Wood processing technology	9.84	2.35	0.21	0.00	1.53	0.00	0.01	0.01	0.00	0.00	0.00	0.01
Material technology	4.92	3.29	0.21	0.00	0.00	3.33	0.02	0.11	0.00	0.00	0.01	0.02
Industrial engineering & management	1.64	2.35	0.00	0.00	0.00	6.67	0.01	0.04	0.00	0.00	0.00	0.01
Medical sciences	1.64	2.35	23.49	0.00	1.53	0.00	0.27	0.06	0.26	0.38	0.30	0.18
Economics and management sciences	1.64	1.41	0.62	5.08	1.53	16.67	0.01	0.01	0.01	0.01	0.01	0.01
Law	0.00	0.00	0.00	1.69	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Other	13.11	5.63	13.31	15.25	21.37	0.00	0.06	0.04	0.12	0.27	0.09	0.11

Table A5 Business education (%)

University	ABO	HUT	HY	JOENSUU	JYU	LUT	OULU	TUT	UKU	UTA	UTU	ALL
Obs	*58*	*211*	*475*	*57*	*131*	*29*	*200*	*100*	*119*	*89*	*228*	*1697*
Received business education	17.24	10.90	6.74	7.02	6.87	20.69	8.50	14.00	8.40	8.99	9.21	9.07

Table A6 Field of current research (%)

University	ABO	HUT	HY	JOENSUU	JYU	LUT	OULU	TUT	UKU	UTA	UTU	ALL
Obs	*61*	*213*	*481*	*59*	*131*	*30*	*203*	*101*	*120*	*91*	*234*	*1724*
Mathematical sciences and statistics	4.92	19.72	8.52	5.08	12.98	3.33	5.91	14.85	5.00	7.69	9.83	9.86
Data processing	6.56	9.39	4.37	11.86	3.05	3.33	2.96	10.89	4.17	15.38	4.27	5.97
Physics	0.00	19.72	13.72	20.34	21.37	3.33	8.87	16.83	13.33	0.00	14.53	13.57
Chemistry	26.23	6.57	8.32	3.39	16.79	10.00	5.42	9.90	12.50	0.00	5.98	8.53
Biology	19.67	0.47	17.26	25.42	19.85	0.00	20.20	3.96	0.83	5.49	20.94	13.75
Biochemistry	8.20	0.94	8.32	0.00	5.34	0.00	5.91	0.00	12.50	6.59	5.13	5.74
Environmental sciences	11.48	2.35	11.23	8.47	8.40	6.67	4.93	0.99	11.67	2.20	6.84	7.37
Biosciences	6.56	3.76	22.04	13.56	8.40	0.00	8.37	11.88	28.33	14.29	11.54	13.92
Machine or automation technology	1.64	5.63	0.00	1.69	0.00	13.33	1.97	4.95	0.00	0.00	0.43	1.62
Energy technology	6.56	4.69	0.21	0.00	0.76	13.33	0.99	2.97	0.83	0.00	0.85	1.62
Electrical engineering	1.64	15.96	0.00	1.69	0.00	10.00	6.40	14.85	0.83	0.00	0.43	4.00
Technical physics	1.64	14.08	0.21	0.00	0.00	0.00	2.46	8.91	0.83	0.00	0.85	2.84
Information or communication technology	0.00	18.78	0.42	3.39	4.58	13.33	6.40	25.74	0.83	0.00	3.42	5.92
Chemical engineering	31.15	7.98	1.66	1.69	1.53	20.00	2.46	0.99	0.00	0.00	0.00	3.42
Environmental engineering	3.28	3.76	0.42	1.69	2.29	3.33	3.45	2.97	2.50	0.00	0.00	1.74
Wood processing technology	13.11	4.69	0.62	0.00	1.53	3.33	0.99	1.98	0.00	0.00	0.00	1.62
Material technology	13.11	8.45	1.25	0.00	0.00	0.00	4.43	14.85	0.83	1.10	1.71	3.60
Industrial engineering & management	0.00	1.88	0.21	0.00	0.00	6.67	0.49	4.95	0.00	0.00	0.00	0.75
Medical sciences	4.92	6.10	31.81	0.00	4.58	0.00	26.60	6.93	35.00	53.85	32.05	23.32
Economics and management sciences	3.28	2.82	1.66	3.39	1.53	13.33	0.49	0.99	1.67	1.10	0.85	1.80
Law	0.00	0.00	0.00	1.69	0.00	0.00	0.00	0.99	0.00	1.10	0.43	0.23
Other	11.48	6.57	12.68	16.95	19.08	0.00	7.39	4.95	8.33	26.37	7.69	10.96

Table A7 Motives for entering current field of research

University	ABO	HUT	HY	JOENSUU	JYU	LUT	OULU	TUT	UKU	UTA	UTU	ALL
Obs	*58-61*	*206-213*	*461-481*	*54-59*	*126-131*	*29-30*	*194-200*	*94-99*	*115-119*	*87-89*	*225-232*	*1660-1712*
Own research interests	3.58	3.67	3.69	3.47	3.74	3.47	3.66	3.58	3.63	3.72	3.79	3.68
Research interests of my supervisor	2.55	2.46	2.46	2.56	2.55	2.41	2.46	2.43	2.80	2.49	2.45	2.49
Availability of public funding	2.93	2.49	2.56	2.81	2.57	2.62	2.58	2.71	2.77	2.35	2.49	2.58
New or better instrumentation	2.15	1.81	2.05	1.84	1.97	1.93	1.87	2.00	2.08	1.80	1.97	1.96
New or better data	2.15	1.76	2.23	1.98	2.06	2.03	2.09	2.06	2.14	2.31	2.14	2.10
Visits abroad	2.38	2.14	2.21	2.06	2.05	2.13	2.15	2.20	2.19	1.98	2.21	2.17
Needs of companies	1.86	2.08	1.48	1.82	1.54	3.07	1.72	2.55	1.89	1.44	1.49	1.73
Opportunities to commercialize research	1.80	1.88	1.46	1.61	1.43	2.14	1.63	2.27	1.80	1.47	1.51	1.64
Employment opportunities	2.55	2.36	2.31	2.44	2.49	2.55	2.36	2.63	2.76	2.25	2.22	2.39

Table A8 Work experience (%)

University	ABO	HUT	HY	JOENSUU	JYU	LUT	OULU	TUT	UKU	UTA	UTU	ALL
Obs	*60-61*	*210-213*	*460-481*	*59*	*131*	*30*	*194-203*	*101*	*119-120*	*84-91*	*219-234*	*1666-1724*
Finnish university	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Foreign university	29.51	30.05	35.34	23.73	27.48	20.00	29.56	26.73	26.67	20.88	35.90	30.74
Finnish SME company	8.20	11.27	5.20	10.17	8.40	10.00	4.43	7.92	8.33	5.49	4.70	6.79
Finnish large company	11.48	19.72	7.28	3.39	4.58	30.00	10.84	11.88	5.00	9.89	10.68	10.15
Foreign company	3.28	3.29	1.87	5.08	0.76	3.33	1.48	4.95	0.83	1.10	1.71	2.15

Table A9 Number of publications and patent applications

University	ABO	HUT	HY	JOENSUU	JYU	LUT	OULU	TUT	UKU	UTA	UTU	ALL
Obs	*61*	*213*	*477-480*	*59*	*131*	*30*	*201-202*	*100-101*	*119*	*89-91*	*232-233*	*1713-1719*
Scientific publications												
0	0.00	0.47	31.88	54.24	0.00	0.00	1.49	0.00	0.00	0.00	0.00	0.23
1-9	26.23	47.89	18.13	16.95	38.17	46.67	35.64	48.00	42.02	34.07	27.47	36.77
10-19	16.39	18.31	20.63	11.86	22.14	33.33	16.34	20.00	18.49	20.88	19.31	18.85
20-49	16.39	15.96	15.83	8.47	19.08	10.00	20.30	16.00	13.45	14.29	20.60	18.15
50-100	21.31	7.98	0.00	8.47	9.16	10.00	13.37	8.00	12.61	13.19	17.17	13.26
100+	19.67	9.39	13.54	0.00	11.45	0.00	12.87	8.00	13.45	17.58	15.45	12.74
Patent applications												
0	62.30	67.61	75.47	84.75	84.73	60.00	72.64	62.38	73.11	82.02	78.88	74.31
1-5	26.23	26.29	22.01	15.25	11.45	36.67	19.9	31.68	25.21	14.61	17.67	21.48
6-10	9.84	2.35	1.05	0.00	1.53	0.00	2.49	3.96	0.84	2.25	1.29	1.93
11-20	1.64	1.41	0.84	0.00	0.76	0.00	2.49	1.98	0.84	1.12	2.16	1.34
20+	0.00	2.35	0.63	0.00	1.53	3.33	2.49	0.00	0.00	0.00	0.00	0.93

Table A10 Distribution of research types (%)

University	ABO	HUT	HY	JOENSUU	JYU	LUT	OULU	TUT	UKU	UTA	UTU	ALL
Obs	*61*	*213*	*481*	*59*	*131*	*30*	*203*	*101*	*120*	*91*	*234*	*1724*
Basic research	54.59	55.54	63.14	49.83	69.39	30.67	54.53	42.67	52.08	48.79	57.69	56.87
Applied research	38.85	37.89	32.91	42.37	27.40	54.67	37.83	47.43	42.58	44.62	36.67	37.25
Product development	6.39	7.18	3.16	4.07	2.29	8.00	3.84	9.11	5.50	3.08	3.21	4.41

Table A11 Use of industrial standards (%)

University	ABO	HUT	HY	JOENSUU	JYU	LUT	OULU	TUT	UKU	UTA	UTU	ALL
Obs	*61*	*213*	*475*	*57*	*130*	*30*	*201*	*101*	*120*	*88*	*232*	*1708*
Yes	11.48	9.86	7.16	7.02	2.31	20.00	11.44	7.92	23.33	4.55	13.79	9.95

Table A12 Distribution of working time (%)

University	ABO	HUT	HY	JOENSUU	JYU	LUT	OULU	TUT	UKU	UTA	UTU	ALL
Obs	*61*	*213*	*481*	*59*	*131*	*30*	*203*	*101*	*120*	*91*	*234*	*1724*
Research	52.79	61.13	60.96	72.71	59.69	53.33	52.07	57.72	62.33	50.44	52.91	58.07
Teaching	23.61	17.51	15.97	11.86	22.21	20.33	18.28	19.50	17.50	18.46	19.62	18.05
Administrative and other tasks	22.95	21.78	18.96	12.03	17.02	22.67	23.35	21.98	18.75	23.52	21.75	20.43

Table A13 Research team size (%)

University	ABO	HUT	HY	JOENSUU	JYU	LUT	OULU	TUT	UKU	UTA	UTU	ALL
Obs	*59*	*204*	*447*	*52*	*118*	*24*	*184*	*97*	*114*	*78*	*211*	*1588*
# members												
1-3	37.29	52.45	30.65	42.31	40.68	54.17	30.98	46.39	30.70	30.77	34.60	36.71
4-6	38.98	35.29	53.47	46.15	50.00	41.67	52.17	36.08	44.74	50.00	44.08	46.66
7-10	22.03	8.82	10.74	5.77	7.63	4.17	11.96	13.40	17.54	15.38	13.74	11.84
11+	1.69	3.43	5.15	5.77	1.69	0.00	4.89	4.12	7.02	3.85	7.58	4.79

Table A14 Multidisciplinarity of research teams (%)

University	ABO	HUT	HY	JOENSUU	JYU	LUT	OULU	TUT	UKU	UTA	UTU	ALL
Obs	*58*	*204*	*446*	*51*	*118*	*24*	*182*	*97*	*113*	*79*	*212*	*1584*
Yes	65.52	40.69	64.13	45.10	33.05	33.33	56.59	47.42	75.22	72.15	58.02	56.25

Table A15 Share of foreigners in research teams (%)

University	ABO	HUT	HY	JOENSUU	JYU	LUT	OULU	TUT	UKU	UTA	UTU	ALL
Obs	*59*	*204*	*451*	*52*	*118*	*24*	*185*	*97*	*114*	*79*	*214*	*1597*
Share of foreigners	25.76	25.10	25.43	14.42	17.88	20.83	17.14	23.71	12.98	18.10	20.93	21.50

Table A16 Position of respondents in research teams (%)

University	ABO	HUT	HY	JOENSUU	JYU	LUT	OULU	TUT	UKU	UTA	UTU	ALL
Obs	*61*	*213*	*480*	*59*	*131*	*30*	*202*	*101*	*119*	*90*	*233*	*1719*
Position												
In charge of several teams	42.62	26.76	24.58	15.25	21.37	30.00	26.24	35.64	24.37	25.56	20.17	25.31
In charge of one team	21.31	25.82	24.17	13.56	24.43	26.67	27.23	20.79	19.33	25.56	32.19	24.96
Researcher	22.95	27.23	27.50	38.98	21.37	20.00	26.24	26.73	34.45	25.56	26.18	27.11
Post-graduate	9.84	15.96	16.88	20.34	22.90	3.33	11.39	12.87	17.65	10.00	12.88	15.13
Not working in a team	3.28	4.23	6.88	11.86	9.92	20.00	8.91	3.96	4.20	13.33	8.58	7.50

Table A17 Number of teams that respondents work on simultaneously (%)

University	ABO	HUT	HY	JOENSUU	JYU	LUT	OULU	TUT	UKU	UTA	UTU	ALL
Obs	*59*	*203*	*446*	*52*	*118*	*24*	*183*	*96*	*114*	*79*	*212*	*1586*
# teams												
1	23.73	35.47	32.51	28.85	38.14	20.83	31.69	28.13	31.58	31.65	34.43	32.47
2-3	47.46	48.77	50.45	57.69	45.76	58.33	46.45	57.29	55.26	48.10	50.47	50.32
4-5	13.56	12.32	12.78	9.62	11.02	12.50	14.75	12.50	7.02	15.19	11.32	12.23
6-10	15.25	3.45	3.36	3.85	4.24	8.33	4.92	2.08	5.26	5.06	3.77	4.35
11+	0.00	0.00	0.90	0.00	0.85	0.00	2.19	0.00	0.88	0.00	0.00	0.63

Table A18 Importance of funding sources

University	ABO	HUT	HY	JOENSUU	JYU	LUT	OULU	TUT	UKU	UTA	UTU	ALL
Obs	*46-59*	*185-200*	*415-453*	*46-53*	*118-129*	*27-29*	*169-194*	*88-95*	*105-112*	*76-84*	*201-222*	*1497-1610*
University budget	2.52	2.50	2.69	2.60	2.88	2.83	2.66	2.49	2.68	2.83	2.59	2.65
The Academy of Finland	3.26	3.01	2.97	2.70	2.90	2.21	2.75	2.89	2.70	2.72	2.88	2.88
Tekes	2.58	2.65	1.65	1.90	1.53	2.90	1.98	3.12	2.30	1.36	1.59	1.98
Finnish foundations	2.56	2.19	2.82	2.33	2.49	1.69	2.67	2.07	2.61	2.56	2.84	2.59
EU	1.96	1.92	1.92	1.92	1.58	1.93	1.93	2.10	1.96	1.58	1.67	1.86
Other non-Finnish sources	1.67	1.49	1.60	1.22	1.39	1.26	1.45	1.35	1.42	1.32	1.55	1.49
Companies	2.26	2.27	1.42	1.68	1.47	2.79	1.73	2.48	1.78	1.25	1.48	1.72

Table A19 Research funding provided by companies (%)

University	ABO	HUT	HY	JOENSUU	JYU	LUT	OULU	TUT	UKU	UTA	UTU	ALL
Obs	*46*	*184*	*345*	*44*	*104*	*29*	*153*	*90*	*100*	*58*	*164*	*1317*
Decrease	41.3	23.91	20.87	13.64	16.35	44.83	26.8	40	28	3.45	25	24.22
No change	50	61.41	70.14	77.27	74.04	44.83	66.01	43.33	61	84.48	67.07	65.45
Increase	8.7	14.67	8.99	9.09	9.62	10.34	7.19	16.67	11	12.07	7.93	10.33

Table A20 Extent of company interaction through different channels

University	ABO	HUT	HY	JOENSUU	JYU	LUT	OULU	TUT	UKU	UTA	UTU	ALL
Obs	*60*	*198-203*	*440-461*	*49-55*	*125-127*	*30*	*186-193*	*92-96*	*111-114*	*78-82*	*217-223*	*1590-1642*
Conferences and seminars	2.08	2.11	1.91	1.80	1.74	2.60	1.98	2.34	2.04	1.83	1.91	1.98
Partnering events and fairs	1.52	1.40	1.30	1.22	1.29	1.67	1.35	1.59	1.38	1.25	1.26	1.34
Training events	1.50	1.35	1.40	1.38	1.24	1.73	1.44	1.63	1.47	1.44	1.37	1.41
Supervision of theses	1.73	1.82	1.28	1.48	1.43	2.30	1.50	1.97	1.37	1.31	1.33	1.48
Joint publication	1.68	1.63	1.39	1.54	1.31	2.00	1.47	1.81	1.50	1.28	1.36	1.47
Research related consulting	1.85	1.78	1.51	1.62	1.44	2.07	1.62	1.98	1.86	1.40	1.58	1.63
Public research programs	2.12	2.00	1.38	1.68	1.34	2.27	1.59	2.11	1.65	1.28	1.33	1.58
Contract research	1.67	1.81	1.30	1.31	1.29	1.90	1.53	2.15	1.74	1.23	1.36	1.50
Outsourcing services provided by companies	1.62	1.28	1.26	1.32	1.25	1.50	1.23	1.54	1.39	1.14	1.24	1.30
Common research or other facilities	1.25	1.25	1.14	1.16	1.14	1.23	1.15	1.24	1.12	1.15	1.13	1.17
Employment relationships with companies	1.20	1.26	1.16	1.36	1.12	1.33	1.23	1.33	1.25	1.21	1.20	1.21

Table A21 Initiative in creating industry links (%)

University	ABO	HUT	HY	JOENSUU	JYU	LUT	OULU	TUT	UKU	UTA	UTU	ALL
Obs	*59*	*205*	*465*	*55*	*128*	*30*	*193*	*97*	*115*	*83*	*221*	*1651*
Self	20.34	23.90	19.57	14.55	18.75	23.33	18.13	26.80	18.26	18.07	14.48	19.38
Team member	32.20	30.24	21.08	29.09	19.53	43.33	29.53	38.14	33.04	8.43	21.72	25.44
Company	18.64	26.83	24.73	29.09	18.75	30.00	25.39	26.80	29.57	32.53	26.24	25.68
No contact	28.81	19.02	34.62	27.27	42.97	3.33	26.94	8.25	19.13	40.96	37.56	29.50

Table A22 Personal objectives regarding industry interaction

University	ABO	HUT	HY	JOENSUU	JYU	LUT	OULU	TUT	UKU	UTA	UTU	ALL
Obs	*40-43*	*160-164*	*284-293*	*38-40*	*73*	*29*	*133-138*	*86-89*	*88-90*	*48-50*	*136-141*	*1116-1145*
Securing research funding	3.14	3.04	2.43	2.74	2.53	3.21	2.78	3.16	3.10	2.33	2.55	2.74
Identifying new topics for research	2.95	2.77	2.37	2.70	2.67	2.97	2.43	3.09	2.82	2.29	2.33	2.58
Access to instruments or data	2.02	1.86	1.84	1.95	1.86	1.97	1.76	1.99	1.93	2.00	1.91	1.88
Identif. opportunities for commercialization	2.05	1.97	1.78	1.87	1.78	2.03	1.98	2.28	2.33	1.73	1.98	1.96
Getting to know the industry	2.19	2.16	1.84	2.24	2.01	2.17	2.01	2.58	2.33	1.54	1.74	2.02
Networking with a potential employer	2.00	2.10	1.77	2.05	1.89	2.00	1.92	2.34	2.28	1.57	1.70	1.93
Networking with a pot. commercial partner	1.98	1.98	1.77	1.89	1.82	1.93	1.95	2.22	2.31	1.57	1.85	1.92
Industrial application of my research findings	2.33	2.27	1.95	1.97	1.93	2.03	2.10	2.50	2.41	1.78	1.98	2.11
Request of my supervisor	1.43	1.66	1.40	1.63	1.41	1.59	1.54	1.55	1.72	1.29	1.35	1.49

Table A23 Achieving objectives in industry interaction

University	ABO	HUT	HY	JOENSUU	JYU	LUT	OULU	TUT	UKU	UTA	UTU	ALL
Obs	*35-40*	*145-162*	*238-265*	*32-36*	*62-66*	*28-29*	*119-134*	*81-86*	*77-84*	*37-40*	*120-130*	*975-1070*
Securing research funding	2.55	2.59	2.05	2.21	2.02	2.45	2.24	2.65	2.23	1.95	2.12	2.25
Identifying new topics for research	2.64	2.62	2.27	2.44	2.17	2.66	2.32	2.72	2.21	2.41	2.22	2.38
Access to instruments or data	2.03	2.02	1.96	2.03	1.79	1.96	1.79	2.22	1.79	2.05	1.94	1.95
Identifying opportunities for commercialization	1.82	1.94	1.66	1.85	1.59	1.93	1.71	2.15	1.85	1.70	1.73	1.79
Getting to know the industry	2.33	2.36	2.00	2.18	2.03	2.43	2.02	2.50	2.10	1.76	2.01	2.13
Networking with a potential employer	1.95	2.03	1.66	2.00	1.67	2.04	1.80	2.17	1.74	1.49	1.59	1.80
Networking with a pot. commercial partner	1.70	1.90	1.60	1.79	1.59	1.86	1.66	1.98	1.81	1.51	1.73	1.73
Industrial application of my research findings	1.82	1.91	1.56	1.68	1.48	1.89	1.67	2.08	1.68	1.57	1.68	1.71
Complying with my supervisor's objectives	1.69	2.05	1.67	1.88	1.50	2.11	1.84	2.09	1.94	1.34	1.53	1.78

Table A24 Challenges in university-industry collaboration

University	ABO	HUT	HY	JOENSUU	JYU	LUT	OULU	TUT	UKU	UTA	UTU	ALL
Obs	*39-43*	*157-163*	*263-279*	*36-40*	*65-68*	*28-29*	*125-131*	*82-85*	*82-83*	*37-42*	*126-131*	*1046-1094*
Passiveness of my project team	1.45	1.64	1.55	1.64	1.62	1.69	1.56	1.77	1.81	1.62	1.51	1.61
The nature of my research field	1.95	2.36	2.44	2.63	2.69	2.00	2.44	2.24	2.34	2.26	2.42	2.39
The early phase of my research	1.98	2.25	2.19	2.10	2.24	2.10	2.18	2.48	2.49	2.21	2.22	2.24
The identification of commercial opportunities	1.83	2.03	2.00	2.03	2.20	1.93	2.05	2.25	2.19	2.00	2.03	2.05
Communication with companies	1.86	1.88	1.90	2.16	2.00	1.69	1.86	2.13	2.04	1.81	1.91	1.93
Problems regarding the IPRs to my research	1.63	1.70	1.62	1.54	1.63	1.54	1.48	1.69	1.76	1.58	1.49	1.61
Personal lack of commercial expertise	1.77	1.84	1.86	1.84	1.96	1.45	1.85	1.88	2.33	1.89	1.95	1.90
Lack of support from the work environment	1.44	1.80	1.88	1.67	2.18	1.66	1.90	1.73	1.91	1.97	1.89	1.85

Table A26 Distribution of ownership rights to inventions (%)

University	ABO	HUT	HY	JOENSUU	JYU	LUT	OULU	TUT	UKU	UTA	UTU	ALL
Obs	*30*	*104*	*166*	*23*	*31*	*17*	*85*	*57*	*60*	*36*	*86*	*695*
Personal possession/joint with res. team	14.00	27.31	36.33	51.30	41.61	18.24	35.18	25.79	25.50	35.56	30.81	31.64
University / Research institute	38.00	39.81	25.84	24.35	34.19	47.65	39.06	40.70	46.67	21.67	27.79	33.97
Companies	14.33	19.04	11.27	7.83	10.65	24.71	11.76	23.51	8.67	7.50	19.42	14.40
Other third party	3.33	1.63	2.95	2.17	0.97	9.41	2.12	0.53	1.17	2.50	3.37	2.39

Table A27 Share of inventors willing to commercialize proprietary results (%)

University	ABO	HUT	HY	JOENSUU	JYU	LUT	OULU	TUT	UKU	UTA	UTU	ALL
Obs	*22*	*71*	*112*	*19*	*25*	*5*	*54*	*38*	*37*	*21*	*59*	*463*
None	50.00	64.79	46.43	47.37	64.00	80.00	64.81	26.32	64.86	57.14	35.59	51.84
Some	40.91	32.39	38.39	47.37	32.00	20.00	24.07	55.26	24.32	38.10	52.54	37.80
All	9.09	2.82	15.18	5.26	4.00	0.00	11.11	18.42	10.81	4.76	11.86	10.37

Table A28 Commercialization mechanisms (%)

University	ABO	HUT	HY	JOENSUU	JYU	LUT	OULU	TUT	UKU	UTA	UTU	ALL
Obs	*9-10*	*22-23*	*57-58*	*9*	*9*	*1*	*21-24*	*24-26*	*16-17*	*9-10*	*36-38*	*214-223*
Consulting												
Not at all	33.33	59.09	50.00	55.56	11.11	100.00	61.90	45.83	62.50	55.56	55.56	51.87
To some extent	55.56	31.82	41.38	33.33	55.56	0.00	33.33	37.50	25.00	33.33	30.56	36.45
Rather much	11.11	9.09	6.90	0.00	22.22	0.00	4.76	12.50	6.25	11.11	8.33	8.41
Very much	0.00	0.00	1.72	11.11	11.11	0.00	0.00	4.17	6.25	0.00	5.56	3.27
Licensing/selling												
Not at all	0.00	22.73	32.20	44.44	11.11	100.00	34.78	30.77	31.25	40.00	42.11	31.84
To some extent	30.00	31.82	33.90	33.33	44.44	0.00	30.43	26.92	31.25	20.00	28.95	30.94
Rather much	50.00	22.73	20.34	22.22	33.33	0.00	34.78	26.92	25.00	30.00	15.79	24.66
Very much	20.00	22.73	13.56		11.11	0.00		15.38	12.50	10.00	13.16	12.56
Entrepreneurship												
Not at all	60.00	34.78	68.42	55.56	33.33	100.00	41.67	30.77	76.47	50.00	56.76	53.36
To some extent	20.00	21.74	17.54	33.33	44.44	0.00	33.33	23.08	11.76	30.00	16.22	21.97
Rather much	20.00	39.13	7.02	0.00	22.22	0.00	12.50	26.92	0.00	10.00	13.51	14.80
Very much	0.00	4.35	7.02	11.11	0.00	0.00	12.50	19.23	11.76	10.00	13.51	9.87

Table A29 Motives to commercialize

University	ABO	HUT	HY	JOENSUU	JYU	LUT	OULU	TUT	UKU	UTA	UTU	ALL
Obs	*11*	*25-26*	*64-68*	*10*	*9-10*	*1*	*25-26*	*26-28*	*15-16*	*11*	*40-43*	*240-249*
Economic returns	2.91	2.92	2.29	2.60	2.80	2.00	2.08	2.81	2.38	2.64	2.44	2.50
Beneficial societal impact of the results	3.18	2.77	3.25	3.20	3.20	3.00	3.04	2.78	3.06	3.27	3.07	3.08
Job variation	2.18	2.27	2.23	2.50	1.90	1.00	2.24	2.56	1.93	2.27	2.63	2.31
Ambition to realize the results' potential	3.18	3.00	2.91	3.10	2.90	2.00	2.64	3.25	2.88	3.09	3.15	2.99
Career re-orientation	1.73	2.12	1.80	2.10	1.33	1.00	1.76	2.27	2.07	2.09	1.95	1.93
Support from the work environment	1.55	1.64	1.63	2.60	1.20	1.00	1.64	1.67	1.93	1.36	1.76	1.68
Securing research funding	2.64	2.48	2.74	3.10	2.20	1.00	2.62	2.44	3.13	2.36	2.86	2.68
Promotion of academic career	2.00	1.96	2.51	2.50	1.90	2.00	2.16	2.11	2.67	2.45	2.36	2.30

Table A30 Factors underlying the decision to not commercialize inventions

University	ABO	HUT	HY	JOENSUU	JYU	LUT	OULU	TUT	UKU	UTA	UTU	ALL
Obs	*15-18*	*59-62*	*87-94*	*16-17*	*22-24*	*4-5*	*50-52*	*26-29*	*32-34*	*19-20*	*49-56*	*383-404*
Lack of expertise regarding commercialization	2.18	1.82	2.21	2.12	1.87	1.80	1.98	2.19	2.18	2.20	2.11	2.07
Incompatibility of comm. and ethics of science	2.00	1.60	1.92	1.88	2.17	1.75	1.59	1.44	1.61	1.90	1.65	1.75
Difficulties regarding financing	2.82	2.26	2.64	2.00	2.64	3.25	2.35	2.37	2.52	2.40	2.87	2.52
Complications with my organization's admin.	2.00	2.03	1.98	2.00	2.39	2.00	1.74	1.77	2.27	1.53	2.08	1.98
Difficulties related to ownership rights	1.88	1.80	1.88	1.69	2.09	1.50	1.88	2.12	2.09	1.58	1.90	1.89
Lack of time	3.12	3.07	3.17	3.12	3.04	3.25	2.82	3.07	2.76	3.00	3.00	3.03
Economic risks	2.47	2.30	2.26	1.94	2.25	2.75	2.35	2.37	2.36	2.25	2.33	2.30
Lack of personal interest in commercialization	2.22	2.25	2.20	2.19	2.54	2.60	2.17	2.04	2.27	2.30	2.11	2.22
Lack of support from the work environment	2.06	2.08	2.11	1.75	2.50	1.50	1.86	1.93	2.21	2.00	1.88	2.03
Avoidance of conflicts of int. regarding res.	2.59	2.00	2.07	2.00	2.25	1.25	2.00	1.74	2.21	1.95	1.98	2.04
Opposition from other joint owners	1.41	1.24	1.21	1.13	1.26	1.00	1.30	1.31	1.25	1.25	1.29	1.25
Own or colleagues' poor prior experiences	1.53	1.39	1.51	1.50	1.43	1.00	1.71	1.33	1.69	1.70	1.46	1.51

Table A31 Challenges to the commercial exploitation of research in Finland

University	ABO	HUT	HY	JOENSUU	JYU	LUT	OULU	TUT	UKU	UTA	UTU	ALL
Obs	*32-37*	*111-116*	*272-295*	*34-37*	*79-83*	*22-23*	*113-117*	*61-65*	*72-76*	*47-50*	*134-145*	*985-1037*
Lack of knowledge regarding commer.	2.24	2.23	2.42	2.43	2.36	2.17	2.51	2.29	2.53	2.44	2.36	2.39
Incompatibility with the ethics of science	2.03	2.10	2.26	2.47	2.53	1.87	2.29	1.98	2.32	2.49	2.38	2.27
Difficulties regarding financing	2.55	2.51	2.69	2.86	2.64	2.78	2.77	2.69	3.05	2.56	2.81	2.72
Difficulties related to administrative issues	2.19	2.39	2.40	2.18	2.32	2.36	2.48	2.52	2.82	2.40	2.31	2.41
Difficulties related to ownership rights	2.21	2.15	2.25	2.00	2.19	2.13	2.14	2.23	2.38	2.30	2.10	2.20
Lack of time	2.79	2.95	2.83	2.86	3.01	3.09	2.92	3.08	2.96	2.88	2.88	2.91
Economic risks	2.41	2.40	2.37	2.59	2.38	2.36	2.45	2.72	2.79	2.32	2.43	2.45
Lack of interest in commercialization	2.40	2.64	2.71	2.81	2.94	2.17	2.79	2.74	2.79	2.96	2.81	2.75
The research environment opposes it	2.21	2.55	2.58	2.60	2.63	2.41	2.65	2.43	2.45	2.61	2.54	2.55
Commercialization invokes conflicts of interest	2.27	2.37	2.42	2.62	2.77	2.13	2.46	2.26	2.36	2.76	2.30	2.43

Table A32 Familiarity with TTO services (%)

University	ABO	HUT	HY	JOENSUU	JYU	LUT	OULU	TUT	UKU	UTA	UTU	ALL
Obs	*60*	*204*	*466*	*56*	*128*	*30*	*195*	*96*	*116*	*85*	*226*	*1662*
Not at all familiar	41.67	33.33	55.58	50.00	30.47	20.00	24.10	28.13	31.03	51.76	40.71	40.37
To some extent familiar	35.00	36.27	33.69	30.36	55.47	46.67	54.87	34.38	48.28	30.59	41.15	40.25
Rather familiar	16.67	22.06	8.80	17.86	12.50	33.33	17.95	30.21	14.66	11.76	14.16	15.34
Very familiar	6.67	8.33	1.93	1.79	1.56	0.00	3.08	7.29	6.03	5.88	3.98	4.03

Table A33 Frequency of use of TTO services (%)

University	ABO	HUT	HY	JOENSUU	JYU	LUT	OULU	TUT	UKU	UTA	UTU	ALL
Obs	*35*	*134*	*208*	*28*	*90*	*24*	*151*	*70*	*78*	*41*	*136*	*995*
Never	17.14	15.67	33.65	25.00	55.56	8.33	28.48	24.29	20.51	34.15	23.53	27.94
Occasionally	57.14	47.76	54.81	57.14	37.78	79.17	54.97	61.43	52.56	51.22	55.88	53.37
Often	25.71	36.57	11.54	17.86	6.67	12.50	16.56	14.29	26.92	14.63	20.59	18.69

Table A34 Match of user needs and service provision

University	ABO	HUT	HY	JOENSUU	JYU	LUT	OULU	TUT	UKU	UTA	UTU	ALL
Obs	*20-26*	*62-107*	*68-140*	*10-21*	*23-55*	*10-18*	*50-109*	*30-54*	*30-59*	*17-32*	*44-106*	*364-727*
Facilitation in the acq. of ext. research funds	***2.04***	***2.16***	***2.36***	***2.48***	***2.02***	***2.22***	***2.18***	***2.17***	***2.68***	***2.09***	***2.27***	***2.25***
No need for service (%)	13.33	13.01	15.66	8.7	23.61	14.29	18.05	12.9	9.23	13.51	9.4	14.37
Education in commercializing research results	**2.31**	**2.35**	**2.54**	**2.93**	**2.89**	**2.39**	**2.51**	**2.74**	**2.42**	**2.00**	**2.40**	**2.48**
No need for service (%)	10.34	13.45	25.45	39.13	46.48	14.29	35.16	24.59	19.7	30.56	34.55	27.5
Support in preparing business plans	**2.26**	**2.28**	**2.23**	**2.60**	**2.65**	**2.17**	**2.14**	**2.56**	**2.16**	**2.10**	**2.14**	**2.26**
No need for service (%)	23.33	38.39	49.36	52.38	63.38	42.86	55.91	43.33	43.94	44.44	48.18	47.78
Scouting the competitive situation on markets	**2.35**	**2.18**	**2.48**	**2.31**	**2.62**	**2.38**	**2.17**	**2.51**	**2.20**	**1.95**	**2.16**	**2.30**
No need for service (%)	20.69	33.62	35.63	38.1	62.32	38.1	53.17	32.79	30.77	44.44	44.55	40.91
Evaluation of the commer. pot. of my findings	**2.46**	**2.25**	**2.50**	**2.83**	**2.71**	**2.14**	**2.36**	**2.52**	**2.21**	**2.14**	**2.18**	**2.37**
No need for service (%)	17.24	19.3	30.49	45.45	51.43	33.33	42.97	26.67	26.15	41.67	49.54	35.09
Provision of industry feedback for my findings	**2.04**	**2.05**	**2.06**	**2.20**	**2.48**	**1.92**	**2.05**	**1.94**	**1.95**	**1.95**	**1.98**	**2.05**
No need for service (%)	20.69	31.82	47.1	54.55	63.77	38.1	53.23	45.76	40	45.71	53.21	46.49
Support in organizing IPR-related issues	**2.62**	**2.79**	**2.65**	**2.92**	**2.83**	**2.47**	**2.66**	**3.11**	**2.78**	**2.35**	**2.68**	**2.73**
No need for service (%)	7.14	17.54	30.77	45.45	57.14	28.57	45.31	27.87	30.77	44.44	41.67	34.86
Support in preparing patent applications	**2.77**	**2.70**	**2.68**	**2.82**	**3.00**	**2.75**	**2.70**	**2.54**	**2.30**	**2.11**	**2.33**	**2.61**
No need for service (%)	10.34	28.7	35.19	50	61.43	23.81	44.53	23.33	33.85	45.71	48.6	38.45
Identification of commer. users for my findings	**2.15**	**2.10**	**2.17**	**2.23**	**2.62**	**2.38**	**2.19**	**2.05**	**2.10**	**2.05**	**2.09**	**2.16**
No need for service (%)	10.34	27.19	37.66	40.91	57.97	38.1	46.03	28.33	26.15	44.44	48.11	38.4
Negotiation of license contracts	**2.28**	**2.40**	**2.37**	**2.55**	**2.85**	**2.58**	**2.47**	**2.58**	**2.34**	**2.23**	**2.28**	**2.42**
No need for service (%)	16.67	34.23	46.45	50	62.86	42.86	53.6	38.98	46.15	38.89	49.53	45.69
Ident. of financiers for my own company	**1.90**	**2.02**	**1.82**	**2.10**	**2.30**	**1.70**	**2.08**	**2.03**	**2.13**	**1.76**	**1.77**	**1.96**
No need for service (%)	31.03	44.64	56.41	52.38	66.18	52.38	60	49.15	53.13	52.78	58.88	54.39

Table A35 General satisfaction with TTO services

University	**ABO**	**HUT**	**HY**	**JOENSUU**	**JYU**	**LUT**	**OULU**	**TUT**	**UKU**	**UTA**	**UTU**	**ALL**
Obs	*30*	*127*	*178*	*24*	*65*	*24*	*130*	*62*	*70*	*35*	*126*	*871*
Very dissatisfied	13.33	17.32	5.62	4.17	3.08	12.50	6.92	3.23	7.14	8.57	8.73	8.27
Somewhat dissatisfied	30.00	33.86	25.28	37.50	32.31	29.17	30.00	29.03	22.86	37.14	30.95	29.74
Rather satisfied	46.67	41.73	57.30	50.00	61.54	50.00	53.08	58.06	62.86	48.57	53.97	53.62
Very satisfied	10.00	7.09	11.80	8.33	3.08	8.33	10.00	9.68	7.14	5.71	6.35	8.38