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Universities, Funding Systems, and the Renewal of the Industrial Knowledge Base

UNI Project Findings

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This report summarizes the findings of the project entitled "Universities, funding systems, and the renewal of the industrial knowledge base" co-funded by Tekes from its innovation research instrument and partner organisations. The project team was drawn from ETLA, VTT, University of Helsinki, Aalto University, the University of Manchester, UK, and University of California, Davis. The project ran from 2012 to 2014. The project team wishes to thank Christopher Palmberg from Tekes and the project's support group, chaired by Professor Arto Mustajoki, for their valuable advice and support.

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Universities, funding systems, and the renewal of the industrial knowledge base – UNI project findings

Abstract

An important prerequisite for the renewal of Finland's industrial and economic base is the ability of the universities to promote the renewal of the knowledge base. The UNI project studied ways in which changes in external funding mechanisms and recent governance changes in Finnish universities have changed the framework conditions influencing innovativeness and innovation in university research. Innovation here refers to novel approaches and potentially, breakthrough research, requiring risk-taking. The UK provided a comparative perspective for the study. This report reprints four separate policy briefs and reports that the UNI project has produced and provides an overall concluding chapter for them.

A major conclusion of the study is that, so far, there has not been much impact from the recent policy changes on intellectual innovation in research in Finland. University governance influences research content very indirectly and is mediated by multiple other factors, meaning that policy changes are not, at least in the short run, translated into changed research content. As far as research funding organisations are concerned, Finland has not had a funding organisation that encourages risk-taking and intellectual innovation in research. Recent policy changes have not fundamentally altered this situation. In the UK, the established practice of performance measurement of universities seems to narrow notions of appropriate research content and standards of performance and is becoming an ominous factor in reducing variety and risk-taking in university research. This phenomenon is further developed in the UK, but Finland seems now to be 'catching up'.

In industry-university collaboration short-term commissions and most of Tekes' industrial collaboration support draw on existing knowledge and know-how and are not intended to promote highly innovative and high-risk activities. More flexible and longer-term contracts can in principle promote such research activities provided that the knowledge they produce will be in the public arena since scientific breakthroughs, to bear fruit, require a great deal of further development and wide adoption of the novel concepts, methods etc. by the scientific community.

Key words: University research, research funding, intellectual innovation in research, university governance

JEL: O38, O39

Yliopistot, rahoitusjärjestelmät ja teollisen tietopohjan uusiutuminen – UNI-projektin tuloksia

Tiivistelmä

Suomen teollisuuden ja talouden uusiutumiselle on tärkeää, että yliopistotutkimus edistää tätä tukevan tietopohjan radikaalia kehitystä. UNI-hanke tutki, missä määrin ulkopuolisen rahoituksen mekanismit ja yliopistojen johtamiskäytännöt vaikuttavat yliopistotutkimuksen innovatiivisuuteen ja ovatko tutkimuksen (intellektuaalinen) innovatiivisuus ja riskialttius muuttuneet sen vuoksi, että yliopistojen ulkoisen rahoituksen mekanismeissa ja yliopistojen strategisessa johtamisessa on tapahtunut muutoksia uuden korkeakoululainsäädännön vuoksi. Innovatiivisuus tässä tarkoittaa aivan uusia lähestymistapoja ja mahdollisesti läpimurtotutkimusta, joka edellyttää riskien ottoa. Tutkimuksen kohteena oli yliopistotutkimus Suomessa, mutta Iso-Britannia tarjosi Suomen tilanteelle vertailukohdan. Tämä raportti sisältää neljä hankkeen politiikka-relevanttia muistiota sekä kokonaisjohtopäätöksiä sisältävän luvun.

Tutkimuksen merkittävin johtopäätös on, etteivät edellä mainitut tutkimuksen olosuhteiden muutokset ole muuttaneet paljoakaan tutkimuksen innovatiivisuutta ja riskialttiutta. Yliopistojen strateginen johtaminen vaikuttaa tutkimuksen sisältöön vain epäsuorasti ja monien tekijöiden välittämänä ja siksi sen vaikutukset eivät näy tutkimuksen sisällöissä ainakaan lyhyellä tähtäimellä. Rahoitusmekanismit ja -organisaatiot taas eivät ole kannustaneet riskien ottoon ja innovatiivisuuteen ylipäätään, eivätkä viime aikojen muutokset ole olennaisesti muuttaneet tilannetta. Isossa-Britanniassa vakiintunut yliopistotutkimuksen arviointi on tulemassa merkittäväksi riskien ottoon vaikuttavaksi tekijäksi, joka kaventaa näkemyksiä tutkimussisällöistä ja tutkimuksen laatustandardeista ja sitä kautta voi vähentää tutkimuksen lähestymistapojen moninaisuutta ja riskien ottoa. Tämä ilmiö on kehittynyt pitkälle Isossa-Britanniassa, mutta Suomi on hyvää vauhtia tulossa perässä.

Yritysyhteistyössä lyhyen tähtäimen toimeksiannot sekä valtaosa Tekesin tuesta perustuvat olemassa olevaan tietoon eikä niitä sen vuoksi ole tarkoitettu tukemaan merkittäviä irtiottoja ja innovatiivisuutta tai riskien ottoa. Osa yritysyhteistyöstä käsittää myös joustavampia ja pitemmän tähtäimen tutkimushankkeita, jotka voivat mahdollistaa tällaisen kehityksen kuitenkin edellyttäen että tutkimustulokset ovat tiedon jatkokehittelyn vuoksi julkisia.

Asiasanat: Yliopistotutkimus, tutkimuksen rahoitus, tutkimuksen intellektuaalinen innovatiivisuus, yliopistojen johtaminen

JEL: O38, O39

Terttu Luukkonen

Changing conditions of university research and intellectual innovation – A summary

1 Introduction

The UNI project – Universities, funding systems, and the renewal of the industrial knowledge base – set out to study ways in which changes in external funding mechanisms and the recent governance changes in Finnish universities have changed the framework conditions influencing innovativeness and innovation in university research. An important prerequisite for the renewal of Finland's industrial and economic base is the ability of the universities to promote the renewal of their knowledge base. Innovation here refers to novel approaches and potentially, breakthrough research.

The project was motivated by recent changes in the operating environment of universities in Finland: the introduction of 'university reform' in 2010 and – of lesser importance – modifications in the funding principles of central public funders of university research. External and project-based funding of university research has grown steadily in Finland since the beginning of the 1990s and this fact highlights the importance of the conditions on which it is awarded.

The perspective of the study is systemic, though the study has collected information at both meso and micro levels. The study was empirical and conducted in Finland and the UK. The data largely consist of qualitative interview material obtained from research group leaders in six research fields and seven universities in Finland and two research fields and two universities in the UK (see Appendix). We also used statistical and documentary material relating to the factual situation and policies in the university sector in both countries and relevant research reports. Major attention is paid to the situation in Finland and the UK data provides a comparative perspective. In addition, the UNI project had a subproject at Aalto University which explored the selection by funders of radical innovation projects.

This report reprints four separate policy briefs or research reports which the project has produced. This first part of the report will analyse the major findings from the central viewpoint of the project, concerning the promotion of breakthrough and innovativeness in research. The following three separate reports each pay attention to features of the research funding system more broadly and do not limit their analysis exclusively to the promotion of breakthrough research. The appendix will give more detailed information of the empirical data collection and the methods for these studies. The fourth is the report by the Aalto University subproject that focused on project selection and the promotion of radical innovation by research funders. It used a different methodological approach than the other three reports.

2 Background

In Finland, the university reform of 2010 was motivated by an attempt to diversify the funding base of universities, to increase their research cooperation, to strengthen their role in the national innovation system and to encourage universities to allocate resources to internationally competitive research and strategic focus areas. The new law formally separated the universities from the state and made them independent legal personalities as either public corporations or private foundations. The reform also gave universities more power to steer their own activities, to pursue independent human resource policies, and to manage their own finances. Still, universities continue to depend on the Finnish Ministry of Education and Culture for the provision of the resources to cover their basic costs in teaching and research, though an increasing part of resource allocation will be results-based and/or strategic funding for specific purposes.

Modifications in the research funding principles of central funding organisations have seemingly been less far-reaching. These organisations have fine-tuned their traditional funding tools and their implementation (e.g., the Academy of Finland), or instituted changes in funding principles (especially Tekes) aiming to achieve more immediate return for funding inputs. Tekes' principles for the research projects it funds at public research organisations now entail a requirement of more intensive collaboration and engagement with industry and increased focus on top-down topic selection. Some of the changes in Tekes' principles have, however, been so recent (as of 2012) that few researchers in our study population had sought to obtain funding under these latest principles. It is to be noted that the new strategic funding instrument within the Academy of Finland, which is to start in 2015, will constitute a more profound change in the research funding landscape in Finland than the other changes related to the funding organisations so far, and its impact will be felt in the years to come outside the scope of our study. Whilst this study cannot directly assess the impact that such an instrument can bring about, some of our findings may improve understanding of the processes that are relevant in assessing its future impact.

3 Highly innovative research

This study drew attention to the impact of external funding mechanisms and university governance, especially strategic management, on highly innovative research conducted in universities. Highly innovative research is not easy to define. Features of such research include new departures, the unexpected nature of the research object and approaches, and possibly, at least at first, controversy; the research contains unconventional ideas and even speculative elements and there is a high risk that the research does not achieve what is expected of it (e.g., Travis and Collins 1991; Grant and Allen, 1999; Heinze 2008; Luukkonen 2012). It may also produce scientific breakthroughs that open up new research avenues and/or scientific disciplines. Interdisciplinary research is also regarded as highly innovative entailing much risk (Laudel 2006).

Highly innovative and breakthrough research is often created by serendipity and it is in the nature of serendipitous discoveries that they cannot be planned. Nevertheless, the pursuit of novel research lines emerging from such discoveries can be planned and specifically supported. In order for research funders to support such new departures, they need to provide fund-

ing that allows researchers to embark upon new areas, and because of the high risk, to be able to make changes in their research plans and to provide enough time to pursue novel ideas until they become sufficiently stabilized and more widely accepted. Overall, fostering flexibility in the processes and variety and diversity of approaches and research lines is likely to be supportive of intellectual innovation.

We defined specific features in research funding as vital for the pursuit of highly innovative research and used them as criteria by which different funding sources and other environmental factors were assessed. These features focus on flexibility and stability of funding as follows:

1. **leeway** the funding source provides to the researcher to define the research problem and to make changes during the project,
2. **stability** (length and volume of the funding and possibility to renew the grant),
3. possibility to **move to a new research field** (in which the researcher does not have previous activity), and
4. possibility to open up completely **new research lines** in the field (novel approaches, risk-taking).

Laudel and Gläser (2014) list closely related features though they add size of funding in their analysis of the institutional conditions that ERC (European Research Council) grants provide for high-risk/high gain research: high amount and flexible use of funding, long duration of funding, risk-tolerant selection process, and flexibility of standards governing project selection. Manso (2011) and Azoulay et al. (2011) also paid attention to the review process as a prerequisite for breakthrough science: they favoured long award cycles (typically renewed at least once), a review process providing high-quality feedback to the researcher, and the selection of people instead of projects as features that provide incentives for breakthrough science. The Aalto University subproject here touched upon some of these project selection features that are relevant for radical innovation.

4 Central findings

4.1 University governance[1]

The project paid special attention to strategic research management in universities and its influence on intellectual renewal of university research in two universities, in particular, Aalto University and the University of Helsinki[2]. Strengthening the capabilities and incentives for strategic research management was one of the objectives of the university reform of 2010. Strategic research management here means the formulation and implementation of the main research objectives of a university. It addresses university resources and its internal goals, monitors the external operating environment, and is usually a combination of top-down and bottom-up processes. The two universities, however, differed from each other in that Aalto

[1] This section draws on Tuunainen, Juha and Thomas, Duncan, Strategic Research Management and Intellectual Renewal of University Research, Tekes Policy Brief 7/2014. See page 21 in this report.

[2] The University of Helsinki (http://www.helsinki.fi/university) is the largest university in Finland with multiple disciplines. In international university rankings it is usually rated highest of Finnish universities. Aalto University was established in 2010 by a merger of the Helsinki School of Economics, Helsinki University of Technology and the University of Art and Design Helsinki. It is the spearhead of the reform of the Finnish university system and has collected and been granted quite a lot of extra resources to institute reforms and changes in its processes (see http://www.aalto.fi) .

University emphasized more top-down approaches while the University of Helsinki appeared to favour bottom-up processes. Our study found that different types of strategic management processes can play a role in advancing and/or hindering novelty and originality in research. These processes include:

- human resource policies
- research funding programmes
- funding of independent research institutes, centres and networks
- measures associated with internal financial systems
- research profiling

Human resource policies constitute a customary means of to influence research contents by way of defining the disciplines, or in a more narrow sense, the research areas of the professors who are to be appointed. The definition of the research areas has usually followed traditional definition of the disciplines or broad domains of professorships. Today, Aalto University is the only university using extensively a tenure track system for new recruitments which in Finland is a novelty though it is widely used in many countries, such as at US universities. The tenure track system at Aalto influences not only the research profile of the university through the selection of the research areas that will be strengthened by the new competitive recruitments – not only from Finland but internationally – but also through the allocation of a considerable share of the block grant to schools on the basis of the tenure track positions, even though the tenure track positions are still a minority of all the appointed professors' positions.

This human resource policy has become an important mechanism to influence the research profile of the university. Whether and the degree to which this mechanism will influence the novelty and originality of research is not self-evident. Impact depends on whether the principles used in the selection of the domains and the persons promote lower risk research areas at the cost of more novel areas and riskier ideas/approaches. As far as publications are emphasized as a way to measure excellence in track record, the selection of candidates may promote mainstream approaches and candidates who – as evidenced by some of our preliminary observations (Tuunainen and Thomas, 2014) – are strongly career-oriented, and therefore, less likely to embark upon risky new areas of research. However, this is at this stage conjecture and the impact on research novelty remains to be seen.

Research funding programmes provide a possibility to enhance novelty in research, although the degree to which this takes place depends on the nature of the programmes and the way in which they are implemented. At Aalto University such programmes offer generous research resources as well as long time frames, flexibility and freedom within the research process, thus enhancing novelty and risk-taking. However they are implemented in selected top-down defined research areas, which can be a negative feature, since highly innovative research ideas are often unexpected and discovered by serendipity. An alternative example of such programmes is offered by the University of Helsinki where they provide support to junior researchers wishing to establish themselves as independent researchers and award fairly small grants, but offer a possibility to pursue 'creative' basic research ideas. Because of the small size of the grants and the small size of the programme overall, it is not a significant strategic management tool and, though it may be important for starting young researchers, its impact on encouraging novelty and risk-taking in research seems to be of less importance.

At the University of Helsinki, **independent research institutes, centres and networks** are, by contrast, a significant strategic research management instrument. They are each in selected research fields (life sciences, information technology, humanities and social sciences) and besides offering positions and research grants for senior researchers on a competitive basis, they provide access to important research infrastructures, especially in biosciences. The research grants of these institutes provide money without too many strings attached, and thus, can be important for fostering novelty. Access to research infrastructures is also of importance in this respect.

The UK examples highlight further that the way in which specific independent research units have been organised and managed can affect their potential as a tool to foster risk-taking and novelty in research, with top-down steering structures potentially limiting such a function.

New **internal financial systems** of universities have, overall, brought about more centralised decision-making structures, e.g., for screening new project proposals, and have created new possibilities to steer research into desired directions. Furthermore, at Aalto University the efforts to improve the scientific performance of the university had led some researchers to believe that industrial or applied research would be less advantageous for the departments and less desirable than academically-oriented research. This view could lead to changes in the project portfolios and in principle be positive for pursuit of novelty and risk-taking in research provided researchers have such research ideas and academic funders have schemes promoting risky and novel research themes. However, as will be seen in the next section, Finland lacks funders that would encourage these features in research. Furthermore some industrial funding is generous both in terms of funding amount and the leeway for the researchers to pursue particular lines of research, but topic choice is restricted. Thus, the impact of the financial systems can be neutral with both pros and cons.

Besides human resource policy, **research profiling** in Finnish universities takes place through the adoption of departmental research agendas. The agenda formation process is distributed and bottom-up, and to a large extent, reflects the research lines that succeed in obtaining external research funding. In the UK, profiling takes place through national research assessment exercises – currently the Research Excellence Framework (REF) – and block grant funding is linked to the outcome of these assessments. Although the assessment and ensuing *de facto* profiling is effectively done by a wider, more distributed community of academics outside the particular university, efforts to improve success in the exercise have increasingly led to stronger periodic *internal* profiling of individual researchers and research groups before the formal external assessment takes place. The UK system has also defined more uniform notions and ways of measurement of research excellence thus potentially limiting system variety. In principle therefore the more bottom-up and diffuse system in Finland would be a system that is more conducive for the pursuit of novel lines of research than the UK's performance-based system – provided researchers have succeeded in obtaining external or internal research funds and that the funders encourage novelty.

In summary, even though the universities have several strategic management instruments at their disposal and these can influence the research profile and performance of the university, the impact of these instruments on intellectual innovation in research is not clear-cut. Strategic instruments can enhance or hinder intellectual innovation depending on the way in which they are designed and implemented and the way in which the research funding system oper-

ates. Overall though, top-down approaches in the definition of research priorities or standardised notions and measurement of research performance can reduce flexibility and variety and, thus, hinder intellectual innovation.

5 Funding principles[3]

External research funding is an important factor in the design and implementation of university, research group and individual researchers' research agendas. As reported above, universities can have their own research funding programmes, but overall, external funders now play a major role in the provision of funding for research. Each funding organisation has a different set of goals, funding profiles and priorities, evaluation procedures, and funding instruments. These differences mean some funders better than others create the circumstances conducive to risk-taking and innovation in research. However, besides the fairly recent European Research Council (ERC), no funding source in either Finland or the UK explicitly promotes all four features favourable for innovation in research, as defined in the beginning of this chapter: leeway, stability, a move to a new field, or opening new research lines.

In Finland, the Academy of Finland, private foundations, and university funds allow for leeway in research problem setting, and to a lesser extent, enable redirecting the research if need be, but none of them provide favourable circumstances in terms of stability of funding or facilitate moving to a new field of research or the opening up of new research lines. Meticulous attention to track (publication) record in the same scientific area as that of the proposal, e.g., by the Academy of Finland, effectively prevents a leap by the proposer to a new field[4]. However, by contrast, because Tekes, the Finnish Funding Agency for Innovation, does not pay as much attention to the academic track record of the applicants, but rather to industrial relevance and engagement, its funding may enable moves to a new field. Furthermore Tekes has a new funding scheme specifically aimed at encouraging new initiatives and approaches. However, since the areas funded by this scheme are predefined and are so far, few and far between, the role of this scheme in promoting innovative approaches and risk-taking in research seems limited. Overall, it is clear that the Finnish research funding system lacks a funder that would strongly encourage risk-taking and novel approaches.

In contrast to our expectations, the UK funding system turned out not to differ much from that in Finland in terms of promoting novelty generation. In both countries the trans-national European Research Council turned out to be the funding organisation by far the most dedicated to support this kind of research. However, the share of researchers that obtain ERC funding is, in particular in Finland, quite small thus limiting its role in this regard.

In summary, external (often intermediary) funding organisations are essential for the conduct of research overall and can have a decisive influence on the type of research pursued. These organisations, however, to a considerable extent depend on suggestions by and the expertise offered by the scientific community. Researchers and the funding organisations are thus not separate but closely interlinked. It was noted that no funding organisation in Finland has tak-

[3] This section draws on Pelkonen, Antti, Thomas, Duncan, and Luukkonen, Terttu, Project-based Funding and Novelty in University Research: Findings from Finland and the UK, ETLA Reports No. 29/2014. See page 31 in this report.

[4] Azouley et al. (2011) also observe that the punctiliousness of the US NIH peer review process crowds out scientific exploration as compared with the selection process of the Howard Hughes Medical Institute.

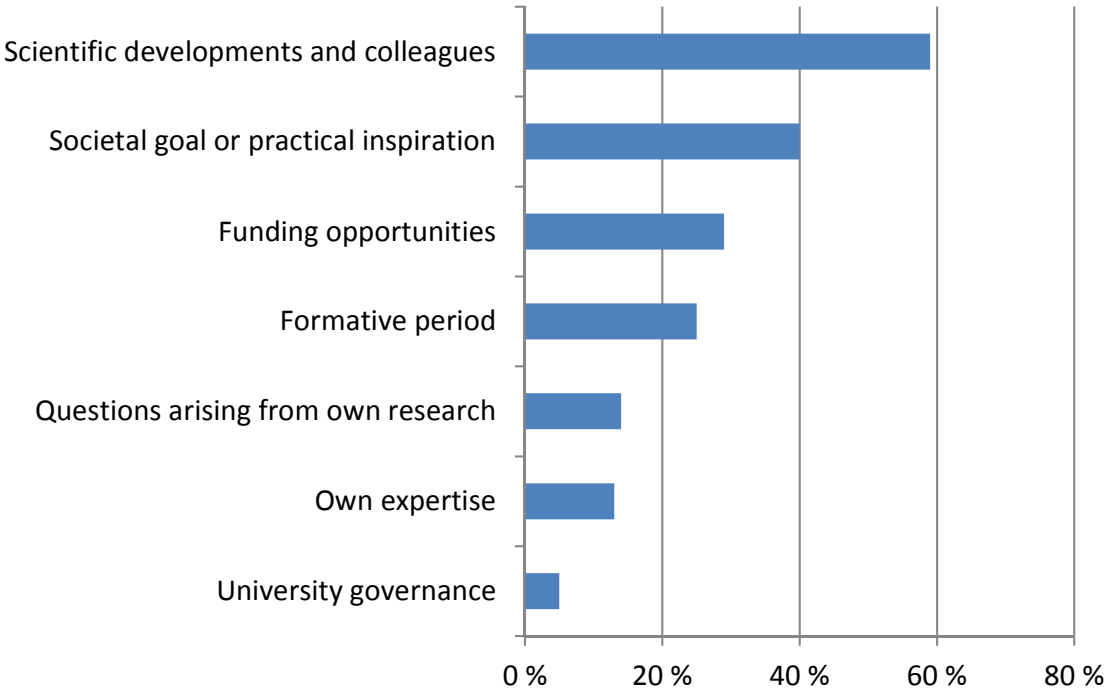
en support of risk-taking and intellectual innovation as an explicit goal or has launched specific funding schemes for this purpose, although some of them provide flexibility and leeway in the choice of research topics and pursuit of research.

6 Topic selection[5]

As already suggested, university governance and properties of external funding arrangements create important framework conditions for research topic selection, but cannot dictate the contents of research. They can encourage or discourage risk-taking and new departures in research but their role is strongly mediated by researchers' perceptions of the most fruitful research lines, research objects and methodologies (Laudel and Gläser, 2014). Researchers assess the value of potential research topics in interaction with their immediate and more distant colleagues, and relate it to the current cognitive developments in the research area, that is, to their epistemic community (Braun, 2012). This takes place irrespective of whether the researchers are mainly motivated by exciting research questions ('puzzle'), peer recognition and rewards ('ribbon') or funding and resources ('gold') (Lam, 2011; Braun, 2012).

Figure 1 shows the share of our interviewees who indicated that the respective factor played a role in their selection of research topics. Scientific (and scholarly) developments and discussions with colleagues featured most often, but also other processes internal to science matered,

Figure 1 Factors affecting topic selection as suggested by the interviewees



[5] This section draws on two presentations: Luukkonen, Terttu, Formulation of research agendas: a systemic viewpoint, paper presented at University research in the renewal of Finland's knowledge base, organised by UNI project, 15 May 2014, Helsinki; and Luukkonen, Terttu, Pelkonen, Antti, Thomas, Duncan, and Tuunainen, Juha, Effetcs of policy on topic selection by university research groups, Eu-SPRI Science and Innovation Policy Conference, Manchester, 18–20 June 2014, Manchester Institute of Innovation Research.

including questions that arose from the researchers' own research or topics adopted during the formative period, e.g., studies abroad. Nevertheless, societal goals (to cure cancer or improve environmental matters) or a practical inspiration (e.g., related to energy research) were also important. Funding opportunities played a smaller role and university governance seemed to play hardly any role at all.

It is to be noted that funding opportunities do vary by field however; in our data archaeology represented a field where the Academy of Finland and foundations were the two major funding sources whereas in the other fields, practically all possible funding sources were represented. Closeness to practical application is a factor that can increase access to multiple funding sources.

Researchers are not only passive recipients of university policies and funder preferences, but also active participants in a policy process. Earlier research has shown that researchers use different coping strategies when faced with various policy and funding requirements (Leisyte et al., 2010). They can 'comply' with requirements actively or passively, but can also appear to fulfil the requirements of a particular funder in their application texts whilst in fact conducting research of their own choosing (known as 'decoupling' or 'window dressing'; Leisyte et al., 2010). A third response type is to attempt to manipulate the policies and funding requirements by participating in policy formulation, e.g., influencing the research agenda of intermediary organisations or university policy. A recent evaluation of the Academy of Finland (Arnold et al., 2013, 53–54) noted that the research programmes of the Academy are a result of a bottom-up process. The way in which the programmes are formulated is not transparent, and apparently, individual researchers may with their own active input influence both topic selection and the formulation of the contents. Even applied-oriented programmes, such as those of Tekes or the fairly new SHOKs need an active input from the scientific community to be based on the most recent scientific knowledge. The point here is to highlight that some researchers are *active* participants in policy formulation and implementation.

It has also been noted that policy requirements do not affect all researchers equally, and that the most vulnerable are those in the middle-performing group (Gläser et al., 2010). According to Gläser et al's study (2010), top performers managed to obtain funding for their research agenda anyway, though even they might have been be hindered in their research to some degree because of difficulties in obtaining funding, while those in the lowest performing group did not conduct research and, thus, were not affected. Because of increasing competition, in our data, a failure to obtain funding had affected the research agenda of even some top-level people.

In our study we found different individual patterns in topic selection. Some examples are given below:

1. A group of research group leaders had adopted their research agenda in their formative period, either continuing to pursue a research line given to them by their professor or having adopted a research line during a post-doctoral stay abroad. In the latter example the research line often represented a highly innovative and novel research area at the time of its adoption, and in some examples, it was not easy for the researcher to gain funding support for this research at the time. Presently, however, the research line represented the mainstream. Chemistry was a field where this phenomenon was most frequent.

2. For some research group leaders, pursuit of a portfolio of several research lines was a strategy to guarantee funding for the research activities of their group. The different research lines might have different opportunities to obtain funding at a particular point of time, and thus, the multi-line strategy was found to be advantageous. It is to be noted that the research lines here refer to activity areas in which the groups pursued research over a longer time period and were not just opportunistic choices.

3. Frequent topic change was also a strategy followed. Here the change was based on the expertise areas the group represented. The choice of research topics was not based on the group's own agenda, but by contrast, on opportunities that arose in the funding environment.

4. Seizing new developments in science, including methodological advances, often based on interdisciplinary collaboration, constitutes the archetype in topic selection in basic research, and many research group leaders said they acted accordingly.

In order to explore a really novel research question, one strategy we noted was giving this highly novel, higher risk research topic to willing students interested in pursuing them as part of their doctoral theses (cf. Gläser et al., 2010).

The above strategies indicate that researchers in fact simultaneously take into account a combination of factors: the current research developments in their field, their own and colleagues' preferences in terms of research objects and approaches, funding opportunities, and institutional governance and policies.

To summarize, university governance and funding organisations have a mediated and subtler influence on research topic choice than might be expected. They, however, provide some of the essential conditions for the pursuit of research, and even though (some) researchers influence them or are part of the process that produces university and funding policy, researchers have to be able to take them into account and adjust their strategies to be able to pursue their research agendas.

7 Industrial engagement of university research[6]

A study of university governance and the funding organisations provided up-to-date information on the impacts of recent Finnish funding policy and university governance changes on university collaboration and engagement with industry. First, the analysis drew attention to the diverse forms of collaboration and engagement with industry, ranging from formal contracts to quite informal ways of interaction. This was also highlighted by the report by Kenney (2013) which argued that industry characteristics affect the nature of the engagements firms have with universities and that the scientific research field also affects the mechanisms of knowledge exchange and academic entrepreneurship.

The UNI project analysis indicated that changes in university governance and funding organisation policies did have an impact and, in some instances, conveyed conflicting messages to

[6] This section draws on Luukkkonen, Terttu and Thomas, Duncan, Industrial Engagement of University Research. ETLA Brief 20. See page 51 in this report.

researchers about university engagement with industry. For example, the new strategic goals of the Aalto University to improve the academic standing of the university had led some researchers to believe that industrial collaboration is less desirable for the labs than before. At the same time, the study highlighted that university engagement with industry and industrial collaboration and contracts can be quite diverse. Thus, industrial contracts, even though in the majority of cases are quite restricted and short-term, can at their best provide flexible and generous research support for a given research area. There also seemed to be a difference between the Finnish and UK circumstances in that UK practices gave university researchers better protection to publish scientifically from industrial research projects, and in the UK strategic alliances with firms provided a broader platform for engagement that enables longer-term relations and multiple forms of interaction.

Whether and the degree to which engagement with industry will enhance or hinder the pursuit of highly innovative and risky research cannot be answered in a simple and straightforward way. Short-term commissions and most of Tekes' industrial collaboration support draw on existing knowledge and know-how and are not intended to promote highly innovative and high-risk activities. More flexible and longer-term contracts are not likely but can in principle do so provided that the knowledge they produce will be in the public arena. That a project will produce public knowledge is an important enabler of breakthrough research since scientific breakthroughs, to bear fruit, require a great deal of further development and wide adoption of the novel concepts, methods etc by the scientific community. Thus, the requirement that industrial collaborative project publish major scientific findings is not only a matter that affects the careers of scientists but is also a matter of significance for progress in science.

8 Selection of risky research projects[7]

If a funding organisation wishes to support projects that aim to produce breakthrough research, how should it organise its award features and the selection process? Research literature suggests that long award cycles (typically renewed at least once), a review process providing high-quality feedback to the researcher, and the selection of people instead of projects are some of the features that provide incentives for breakthrough science (Manso, 2011; Azoulay et al., 2011). Also criteria used in selection matter, and breakthrough research has to be kept in focus (Luukkonen, 2012).

The fourth, Finnish-language policy brief on the funding principles of radical innovation by Eeva Vilkkumaa and Ahti Salo (2014) addressed the selection question by concentrating on a specific feature in project selection: a choice between one initial longer-term funding decision versus piecemeal decision-making whereby the first funding period is experimental and of short duration and longer-term funding is awarded only after an assessment of the first period. They focused on radical innovation which they defined as "a product, technology or service which in the longer run has positive and wide-ranging multiplier effect on society". The brief applied decision-analytical modelling to compare the outcome of these two alternative selection models.

[7] This section draws on Vilkkumaa, Eeva and Salo, Ahti, Radikaalien innovaatioiden rahoituskäytännöt, Tiivistelmä tutkimuksesta, Tekes Policy Brief No. 9/2014. See page 59 in this report.

The brief ended up with a conclusion that a decision process with piecemeal decisions is better. It enables initially to fund a larger number of smaller projects thus reducing the rate of failure to identify a potentially radical innovation project, whereas the initial long-term funding decisions have a higher risk of failing in this respect. The more uncertain the assessments based on the project proposal, the more resources one should use for the experimental phase. On the negative side, the piecemeal decision process will have more interrupted projects.

The main import of this study was to highlight the need for experimentation and failure in awarding project funding when it is a question of radical innovation and potential breakthrough science (and technology), which is highly risky. Another point to note is that the selection process for breakthrough science/radical innovation needs to be different from that used in the selection of less risky projects.

The study did not explore how long the first experimental phase should be to enable the funder to gauge its success and then to grant longer-term funding to the potentially most successful projects. Azouley et al., (2011) compared the award processes of the HHMI (Howard Hughes Medical Institute) and NIH (National Institutes of Health) whereby the first experimental period of the HHMI is usually five years. Thus, e.g., one-year long experimental period is probably far too short to gauge the value of research potentially producing radical innovations. There are a host of other questions in the review process that can be of crucial importance for the selection and review process of potentially radical innovation and will need to be addressed if a funder intends to encourage radical innovation. These include, e.g., the selection of reviewers, the way their work is organised, the criteria they use, and the feedback they provide. These were, however, outside the present study.

9 Conclusions

The UNI study could only address a few salient aspects of the university environment and their impact on intellectual innovation in research. It particularly addressed the impact of university strategic management and funding organisation policies on innovativeness in research. While these two factors are important within the framework conditions for research and can enable or hinder particular research efforts, their impact is mediated by researchers' perceptions of the most fruitful research lines, research objects and methodologies. When designing policies, it is important to bear in mind that all policy and programme objectives have to pass through the process of transformation of the policy objectives into research questions. But this is not a mechanical and easy task, and furthermore, it is dependent on the motivation and interests of the researchers to embark upon the research avenues offered. For example, this study paid attention to researchers' motivation to engage with industry and found that motivation and extent of activities are clearly linked (Luukkonen, Thomas, 2013). Thus, researchers' insights about what constitute the most fruitful research lines, research topics, and methodologies - developed in interaction with their scientific and scholarly colleagues - are an important 'passage point' for the transformation of the policy objectives into research activities (Callon, 1986; Braun, 2012; Laudel, Gläser, 2014). Tartari et al. (2014) argued that academic engagement with industry is also driven by the local environment and the behaviours of colleagues. Our study further noted that the researchers are not passive recipients of policy imperatives but can more or less actively resist or influence policies.

An answer to the question of whether the recent changes in the framework conditions of university research in Finland have influenced innovativeness and intellectual innovation in university research would be that, so far, there has not been considerable impact. University governance influences research content very indirectly and is mediated by other factors. As far as research funding organisations are concerned, the major problem is that Finland does not have a funding organisation that would encourage risk-taking and intellectual innovation in research. The situation was not ideal to start with and recent policy changes have not fundamentally altered or improved it (short-term orientation of SHOKs and the general principles of Tekes' support to university projects). The recent strategic openings of Tekes are so far very few and have predefined topics, and thus, cannot act as a counterbalance for the other systemic features. With regard to the UK, the most ominous factor in discouraging risk-taking seems to be the drive towards ever more and more intrusive performance measurement which narrows both accepted standards of performance and notions of appropriate research content, thus limiting variety (Nedeva et al., 2012). This phenomenon is further developed in the UK, but Finland seems to be 'catching up'.

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Appendix: Methods and data collection in the UNI interview study

Data selection

This appendix reports the data collection methods used in the interviews which gave major data for the first three policy briefs described in this report. However, these briefs also used documentary and statistical material as well as other relevant studies.

The interviews were semi-structured and conducted with research group leaders at universities in Finland and the UK. The project targeted research group leaders, senior researchers, who in the majority of cases were, but not exclusively, university professors with 'tenure' or similarly secure employment contract conditions. Our findings may have to some extent been affected by the fact that our study population was in this respect skewed, namely, targeting researchers who had already been quite successful in the academic environment and had survived and advanced to their present positions. They thus represent top achievers who, according to Gläser et al. (2010) are likely to be best able to cope with university and funding policy changes. Some of them are also likely to influence university and funding policies themselves and thus be able to turn situations to their advantage. The findings might thus possibly downplay the impact of the systemic factors.

However, two points are to be noted. The rationale for the selection of this group was to have informants who had experience of applying for funding to several different funding sources and who were well-informed about university governance and policies. Furthermore, the researchers interviewed were in a position in which they secured funding for more junior researchers in their own group, and therefore could report about more general experiences in pursuing research lines over a longer period of time.

In total, the number of research group leader interviews was 80 of whom 59 were in Finland and 21 the UK. In addition, the research team interviewed 20 representatives of university administration and funding organisations in Finland, two in the UK, and four in the United States. Overall, thus the study data consist of 106 interviews. In addition, as indicated, we used documents, reports, statistics, and scholarly papers pertaining to the study topics and questions.

In Finland interviews with research group leaders were conducted in six fields and seven universities, and in the UK two fields and two universities.

The following table indicates the distribution of the interviewed research group leaders by field, university, and country.

The small number of interviewees in nanomaterials was due to the fact that these interviews were conducted during the exploratory phase of the project and in the end, the nanomaterials field was not selected for the study but these interviews were also used in the analysis. The general aim was to find approximately ten interviewees per field, and this was achieved in all fields other than archaeology. Efforts were taken to acquire a larger number of cases from the universities other than Helsinki, Aalto and Turku, but this could not be achieved in the fields selected. Overall, 29% of the potential interviewees contacted did not participate in the study (either did not respond to repeated attempts to contact them or did not find time for the interview). The percentage was somewhat higher in the UK compared to Finland: 34% versus 26%.

Appendix table **Recorded, transcribed and coded Interviews with leaders of research groups**

	Computer science	*Chemistry*	*Cancer research*	*Energy*	*Urban studies*	*Archaeology*	*Nano-materials*	*Total*
Aalto	3	2		5			2	12
UH	3	3	5		5	4		20
UJ	2	3						5
UEF		3						3
UO	3					2		5
UT			5		5			10
LUT				4				4
Total Finland	**11**	**11**	**10**	**9**	**10**	**6**	**2**	**59**
Imperial College	5			5				10
University of Leeds	5			6				11
Total UK	**10**			**11**				**21**
Grand total	**21**	**11**	**10**	**20**	**10**	**6**	**2**	**80**

Explanation of the university abbreviations: Aalto: Aalto University; UH: University of Helsinki, UJ: University of Jyväskylä, UEF: University of East Finland, UO: University of Oulu; UT: University of Turku; LUT: Lappeenranta University of Technology

With the exception of archaeology, replacement interviewees were found in the same field and university. In archaeology, overall, the number of senior researchers corresponding to group leaders was so small that it was not possible to find a sufficient number of interviewees that could be contacted and were available. In this field, one of the interviewees was selected to represent the University of Oulu, but the person had moved to Helsinki and was classified accordingly in the above table. 16 of the interviews were conducted on the phone or using Skype; all the rest were face-to-face interviews.

Field selection

In terms of scientific fields, the project selected one field per each major branch of science. In the selected fields researchers had a need to obtain external research funds in order to conduct empirical research, and thus, the researchers were expected to have experience of different funding schemes. In each selected field, we wanted to have a sufficient number of interviewees preferably from several, but at least from two universities. This was not always easy to fulfil since the scientific and scholarly fields are structured differently from university to university. In some universities, departments or equivalent entities are multi-disciplinary and/or field-specific units tend to be quite small. We had therefore to define the fields in a slightly broader manner than originally envisaged. For instance, originally, we would have wanted to include organic chemistry, but in the end, included chemistry more broadly.

Interview technique

In the interviews we used semi-structured interview guidelines. The following list includes the topics that were covered by the interviews and further elaborated. The interviews were all recorded and transcribed.

UNI project interview topics:

1. **Background information about research projects:**
   a. Size, no. of researchers, funding (major sources and approximate size or approximate shares of funding from each source)

2. **Topic-related questions:**
   i. The major research topics the interviewee is working on
   ii. Significant topic-related changes
   iii. Influences on and limitation of topic selection
   iv. Nature of research in terms of promoting 1) intra-scientific knowledge interests and 2) societal/economic/clinical/political goals
   v. Major novelty in research topics

BREAKTHROUGHS IN THE FIELD:
   v. Significant scientific breakthroughs in the field (in the world) in recent years
   vii. The contribution of Finnish scientists to this breakthrough

3. **Resources for research:**
   i. The resource-intensity of the field (need of equipment, assistants etc.)
   ii. Most important national and international external funding sources of research in the past five years?
   iii. Each of the funding sources in terms of providing for/:
      a. Leeway to define the research problem/area
      b. Stability (continuity, security) and length of funding
      c. Allowing researchers to apply for a move into a new field in the proposal stage (track record)
      d. Starting research lines new to the field
      e. The time and effort needed to major changes in the course of the project

4. **Utilisation**
   i. The groups/organisations that (potentially) utilise /commercialise the research findings
   ii. Major routes for the commercialisation; time scales required
   iii. Challenges in the process
   iv. Provision of support and resources by the university or funding organisations

5. **Networks and collaboration**
   i. Collaboration partners
      a. industry, large or small and medium-sized enterprise
      b. world leaders (scientists, scholars) in your field
      c. public sector organisations or civil society actors
      d. other
   ii. Rationale for collaborating with them
   iv. Stability of collaboration with these partners

Analysis

In the analysis of the transcribed interview material attention was paid to thematic entities. These were structured qualitatively by reading the texts, coding without any analysis toolkit, and transferring the data into excel. Some of the features were categorized and simple frequency distributions and cross-tabulations calculated. Some of the coding also used ATLAS.ti qualitative data analysis software. The way in which thematic entities were analysed in more detail was very much an inductive process whereby different topics emerged from the interviewed persons' narratives.

No. 7/2014

Policy Brief:
Systeeminen muutos ja innovaatiot

Strategic Research Management and Intellectual Renewal of University Research

What main mechanisms are used in universities for strategic steering of research activities?

How do they affect the innovativeness of scientific research?

Name of the Project:
Universities, Funding Systems, and the Renewal of the Industrial Knowledge Base

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The Finnish university reform of 2010 was designed to increase the capacity of universities to steer themselves in a changing operational context. Universities became independent legal entities and started to improve their capacities in, e.g., research profiling. According to an assessment report in 2012, the strategic management of universities has been strengthened, with only a minor role left for lower level employees in steering university activities. Motivated by this apparent change, this brief examines the current status of strategic research management in two Finnish universities, the University of Helsinki and Aalto University, based on an analysis of interviews conducted with 32 research group leaders in the fields of information science, chemistry, cancer research, energy research, urban studies and nanomaterials. The report also makes use of 21 interviews in energy research and computer science in two UK universities, Imperial College London and the University of Leeds, to provide a comparative perspective to the Finnish case examples.

Strategic research management emerges as a combination of multiple but only partially interconnected processes. External and internal research funding sources and intra-scientific developments remain important as means for the local research community to define their research agendas in various ways. Strategic research management is not simply top-down or bottom-up, as some previous research has claimed but rather is interactive and intermediated by various parties. It affects innovativeness and the intellectual renewal of scientific research in perhaps hard to predict and diverse ways; the very same management instruments when used in different contexts may simultaneously both advance and hinder novel and original research. Strategic research management thus is context-dependent. The usefulness of its tools must be assessed by looking at the entire research funding system, although generally speaking it appears that measures allowing more leeway for university departments and researchers are advantageous in increasing the innovation system's flexibility and capacity to react to changing conditions.

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Strategic research management here means the formulation and implementation of a university's main research objectives. It addresses university resources and monitoring of internal goals and the external operating environment. **Top-down strategic management** comprises the main goals and initiatives taken by top management university actors. **Bottom-up management** refers to objectives and measures defined and implemented at department level and in collaboration with professors, research group leaders and other senior faculty members.

Tekes
Ohjelmatoiminnan strateginen tuki

Tekesin Ohjelmatoiminnan strateginen tuki -yksikkö tuottaa innovaatioympäristöä palvelevaa tutkimusta teemakohtaisilla hauilla.

Introduction: University Reform

University reforms have recently taken place in many countries. In Finland, the reform was motivated by an attempt to diversify the funding base of universities, to increase their research cooperation, to strengthen their role in the national innovation system and to encourage universities to allocate resources to top-level research and strategic focus areas. A new law separated the universities from the state and made them independent legal personalities as either public corporations or private foundations. The reform also gave universities more power to steer themselves, to pursue independent human resources policies and to manage their finances.

Strategic management has been strengthened in Finnish universities.

Responding to these changes, universities have started to improve their research management capacities. A recent report on the main changes caused by the reform suggests the role of internal Executive Boards in running Finnish universities has indeed strengthened leaving only a minor role for lower-level employees and units in steering university activities (Niinikoski & al. 2012). If this is true, it might create tension, as universities in Finland have traditionally featured relatively independent departments and faculties with consensus-oriented academic self-governance at all levels. This brief aims to take a closer look at the current status of strategic research management in Finnish universities, and its effects on the conduct of university research with comparative perspective from the UK.

Research Goals and Data

The report analyzes strategic research management in two universities with different approaches to strategic management.

This policy brief is one of the outputs of a project exploring the ways in which changes in external research funding enable or hinder the renewal of university research.[1] It examines how universities strategically steer their research activities, and how this affects innovativeness in scientific research, with a particular interest in the University of Helsinki and Aalto University due to their differing strategic research management approaches. The University of Helsinki is the oldest and largest public university in Finland with the widest range of disciplines. Aalto University is a public foundation established in 2010, bringing together three antecedent universities (a business school, a university of technology and a school of art and design). From our current understanding, Aalto uses top-down steering methods for strategic research management whereas the University of Helsinki has more bottom-up participation.

The study is based on thematic interviews with research group leaders working in multiple disciplines.

In addition to 32 interviews with research group leaders at Aalto and the University of Helsinki, to provide a broader basis data was also collected on five other Finnish universities, and two in the UK. The UK data (21 interviews) in particular will be used to provide an additional perspective to the issues highlighted by the Finnish case examples. A limitation of interviewing group leaders (professors holding permanent positions) was that this provided viewpoints from experienced and established scientists, with fewer views from younger scholars.[2]

Top-down and Bottom-up Strategic Research Management

The effects of the university reform in Finland are significant in the area of university management: it has been claimed that strategic steering by the Executive Boards has strengthened, while the role of lower-level units and personnel has remained weak (Niinikoski & al. 2012). This suggests top-down strategic management has become dominant, with only a minor role for bottom-up processes. Our current findings contradict this claim, however:

The assessment of the university reform claims that strategic management has been strengthened in the universities, while the role of university personnel has remained weak.

strategic research management appears as a complex, multilayered process that cannot be characterized so simplistically. It encompasses a variety of relatively independent management measures, only some of which are decisive from the point of view of the research group leaders, and can only rarely be understood as a linear process of cause and effect. Management processes are often mediated by department heads, local research communities and their cultures of practice, and research group leaders all of whom may interpret strategic goals in different ways.

Two major strategy profiles are discernible: top-down research management in Aalto University and a more bottom-up discretion in the University of Helsinki.

We addressed top-level strategic steering mechanisms, but first here we explore how research management was understood by research group leader interviews. We asked whether or not strategic research management directed research agendas at research group level. 17 out of 20 group leaders from the University of Helsinki had a view on this; 10 (59%) stated that research management did not influence research agendas; seven felt it did (41%). At Aalto seven out of 10 group leaders believed strategy influenced topic selection and only three said it did not. We also looked at whether research group leaders felt that research management took place at the level of the university's central administration or in the university department. At Helsinki, only three out of 20 research group leaders claimed the university had top-down research management; whereas for Aalto the share was a much higher, nine out of 12 professors. Thus, despite the limited number of interviews, we suggest these two universities have discernible strategy profiles: at Aalto University, top-down research management seems relatively strong; the University of Helsinki has an opposing, more laissez-faire approach.

Despite their differences, both universities are engaged in bottom-up strategic research management.

When it comes to the bottom-up management, eight out of 20 respondents in the University of Helsinki and six out of 12 in Aalto believed that formulation of research priorities was practiced at the lower levels of organization, i.e., in departments and other units. This bottom-up research management was not totally void of organizational impetus, however: interviewees noted that grassroots research profiling was, in fact, influenced by larger organizational processes, such as research assessment exercises. Overall then, strategic research management seems more complex and multifaceted than suggested by Niinikoski and others (2012).

Research Management Processes

According to research group leaders, major top-down research management instruments include human resources policies, university's research funding programmes, funding of independent research institutes and networks and the university's internal financial systems. In addition to these, also bottom-up management processes exist.

The major measures by means of which universities steer their research activities ranged from formal definition of strategic goals by university central administration to the ongoing collective direction and redirection of research at the grassroots level of university departments. The specific management instruments we discuss here were mentioned by research group leaders, and include: 1) human resources policies, 2) the university's research funding programmes, 3) funding of independent research institutes, centres and networks and 4) the university's internal financial systems. In addition to these top-down management methods, group leaders underlined that 5) research agendas were often formulated by the departmental research communities, rather than by top university managers.

1. Human Resources Policies

Human resources policies were a major tool for strategic research management in Aalto University. In Finland, Aalto is the only university that has extensively used a tenure track system to improve the quality level of its research. Although the establishment of tenure track posts was prepared at departments, central administration played a key role in deciding where these were allocated: proposals were evaluated for how well they suited the university's strat-

egy. The major criterion for allocating the posts was, at least in the set-up phase of the system, how close the given research area was to the research frontier internationally.

One of the most important strategic research management measures in Aalto University is the tenure track system.

Only two out of 12 Aalto research group leaders commented on the tenure track system, and how it unfavourably skewed the structure of research personnel, gave rise to discontinuities in career development and caused problems in financing departments. Firstly, one research group leader pointed out that those selected for the tenure track positions were more interested in "selfish" career advancement rather than in contributing to department activities. Taking an example from soccer, the interviewee maintained that if a team only consisted of strikers it was not likely to succeed – a team also needs players in supportive roles. One group of researchers in such a supportive role seemed to be those who had "sacrificed" their academic careers by focusing on industrial collaboration. They were unable to compete in the new tenure track system and eventually forced to leave the university, apparently undermining Aalto's ability to collaborate with industry.

Aalto research group leaders believe that young international scholars are favoured in recruitment decisions.

Secondly, many researchers in Aalto were working on temporary, externally-funded research projects and the tenure track system was supposed to allow these researchers to get more secure appointments. In practice this did not happen; young international scholars were instead favoured in recruitment decisions more often than not. A significant proportion of Aalto's researchers were thus in an insecure situation without clear career prospects.

A significant proportion of internal funds in Aalto University are allocated on the basis of tenure track positions.

Thirdly, the allocation of financial resources within the university was related to tenure track positions. Aalto's internal resource allocation model meant that most of the block funding granted to schools (70% in total) was determined on the basis of tenure track positions[3], 20% on the basis of results achieved in research and teaching, and 10% on strategic initiatives, such as internal research funding programs. Tenure track positions being granted to schools and departments by the central administration meant that this funding model was an effective management instrument strongly affecting research conditions on the ground in different organizational units. One research group leader interviewed, for instance, worked in a department with no granted tenure track posts, in spite of results achieved in research and teaching. Without tenure track posts, and with high student numbers, professors in this department were overburdened with teaching so research conditions were limited.

2. Research Funding Programs

Large, thematic funding programmes are important research management measures in Aalto University.

Thematic research funding programmes were also an important management measure in Aalto University, where university funded research was typically supported through large, thematic funding programmes, lasting several years and needing collaboration between the involved research groups.[4] All the Aalto research group leaders who commented on internal funding programs received funds through such programmes.

Respondents saw the internal funding programs in a positive light, valuing their long time frames, flexibility and freedom. They maintained that such programmes significantly contributed to developing scientific expertise and to increasing internal understanding of areas where Aalto was particularly strong. Sometimes these funds also provided a backbone to a research group's work from which they could then compete for additional external funding.

Aalto group leaders also revealed conflicting views about the impacts of the university's funding programmes for novel and innovative research, with some questioning their value for

The internal funding programmes are regarded as significant and important from the point of view of the reforming of scientific research, but when allocated in a top-down manner, they received criticism as well.

scientific innovation and intellectual renewal. They considered internal funding top-down instead of bottom-up in steering the selection of research topics. A professor working in the field of energy technology, for instance, was not convinced that the thematic funding programmes were the right way to bring about innovation in research, given that new ideas commonly arose at grassroots level. The University of Helsinki also had internal research funds, but of a smaller size and allocated on the basis of open calls. These were mostly directed to researchers about to establish themselves as independent researchers but who had not yet received significant external funding; established group leaders did not have much experience in using them, but when they did, also felt they very "free" and suitable for "creative basic research".

Overall the universities' internal funding programmes were regarded as significant and important for renewing scientific research but, when allocated in a top-down manner, were also criticised for overly steering topic selection.

3. Funding of Independent Research Institutes, Centres and Networks

At the University of Helsinki, funding of independent research institutes was regarded as an important research management method.

Whilst internal funding programmes were not a significant strategic research management instrument at the University of Helsinki, funding of independent research institutes was precisely that. Here we consider five independent institutes and inter-university networks that were mentioned by group leaders: the Helsinki Collegium for Advanced Studies (HCAS), Institute of Biotechnology (IB), Biocentrum Helsinki (BH), Institute for Molecular Medicine Finland (FIMM) and Helsinki Institute for Information Technology (HIIT).

Independent institutes were relevant to strategic research management because first, they offered positions and research grants for senior researchers on a competitive basis and, second, they coordinated and provided access to research infrastructures, especially in biosciences. For researcher positions, the membership of senior researchers in these organizations was based on open, international competition and external peer-review of applications. Positions were usually fixed-term employment contracts, continued conditional on scientific evaluation. Some researchers being willing or forced to leave the institute under these fixed-term conditions opened up possibilities for future recruitment.

The ongoing turnover of research groups in internal institutes, their research funding and research infrastructures foster collaboration and scientific renewal.

Ongoing employee turnover in research institutes also guaranteed continuous renewal of the institutes' research agendas. First, new researchers entering the institute brought particular scientific backgrounds, fusing their area of interest with that of the institute, creating a new synthesis and fostering intellectual renewal. Second, when many research groups started anew due to turnover, collaboration was easier than in more stable organizations with established research groups. Turnover of researchers was thus important for multidisciplinarity and cross-fertilization of ideas.

Grants offered by internal research institutes support new scientific openings.

The independent institutes and networks also offered grants to scientists working under their auspices. This money came from institutes' budget where a buffer was held for starting grants of newly recruited scholars as well as for balancing the fluctuating nature of external competitive funding. Usually these grants were small (around 70,000 euro) but could also be substantial. These funds did not have too many strings attached, meaning they could be used flexibly both from the institutes' and researchers' points of view. These funds could support new scientific openings that otherwise might have been abandoned.

In biosciences, internal research institutes provide access to research infrastructures and thereby open up possibilities to scientific renewal.

Finally, the independent institutes, especially in biosciences, provided access to research infrastructures. Thus, in addition to offering intellectual environments that partially directed research, they opened up possibilities for scientific renewal by making it possible for researchers to use specific instruments. Sometimes such devices could be acquired as a part of a new researcher's starting package or they might be available at the institute. Access to instruments and related technical capabilities were an important way of directing research.

In the UK, it is increasingly common for universities to create research centres addressing multi-disciplinary topics of societal rele-

Interestingly this autonomous and bottom-up strategic research management role of the independent research units inside the two Finnish universities was also seen in the UK at Imperial College London and the University of Leeds. It appears increasingly common for UK universities to create research centres addressing multi-disciplinary topics of societal relevance. Their existence signals to academics and non-academics that relevant capability exists in that university, and signals a desire to engage with related policy, industry and other users. At the same time variations are possible in how these multi-disciplinary centres are structured that allow for more or less top-down strategic research management from central university leadership and administration. For instance Imperial's Energy Futures Lab (EFL) has been allocated central funds but university senior leadership are unlikely to be involved in day-to-day research management decisions and steering of research topics because the EFL is a loose, 'virtual' set-up without much in the way of central capital investment in dedicated buildings or facilities. Researchers from existing faculties and schools are nominated or self-selected into the centre and carry out bottom-up research coordination, without central university steering of the intellectual field matters, such as human resources, publication patterns, selection of research funding sources and so forth. By contrast, Leeds' Centre for Integrated Energy Research also draws upon capacity from existing schools and faculties but has a dedicated building and faculty members specially recruited or seconded for a period of years, allowing for a stronger top-down steer of its research direction tied to these conditional resources.

4. Measures Associated with Internal Financial Systems

An important way to put strategy into practice is to use the university's internal funding formulas.

One way in which universities may put strategy into practice is by using internal funding formulas. In Aalto University, the internal funding allocated to schools comprised three components: 1) block funding (70% of the total funds), 2) results-based funding (20%) and strategic funding (10%). In block funding, the most important funding criterion was the number of tenure track slots, as already noted. The results-based funding, on the other hand, consisted of six parts each based on different criteria, such as degrees, publications, study credits and other key performance indicators. Finally, strategic funding (10%) included significant initiatives related to research, education, infrastructures and internationalization, including the above-mentioned university's internal research funding programmes.

In addition to the university's internal funding formulas, universities in Finland have applied Full Economic Costing (FEC) to external research funding since 2009. In FEC, a project's budget includes all direct (e.g., salaries, travel and materials) and indirect (e.g., facilities and administrative services) costs that ensue from a project. A certain percentage rate of the effective working time is defined for each. Typically 60–70% of all costs are covered by external research funding and 30–40% by the university. Because the model includes contribution by the university, a researcher must agree with the research site about the support that the site will provide for the project if it gets funded.

Research group leaders at Aalto University believed that the university prioritized academic funding sources over applied and industrial funding.

Because these financial systems were complex and new to the university, the research group leaders seemed to misunderstand some of their characteristics. For instance, six Aalto interviewees claimed that the university favored certain funding agencies over others either by defining different overhead rates for different funders or by prioritizing certain funders calculatively by using key performance indicators. This was true only to the extent that 10% of the total share of the results-based funding (which in turn covered 20% of all funding) was allocated on the basis of the amount of external competitive research funding, i.e., funding received from the Academy of Finland and European Research Council. Furthermore, some group leaders also referred to public statements by top-level Aalto managers who had said that the university wanted to upgrade the quality of its research by increasing the funding from competitive academic sources. All this indicated, in the words of the interviewees, that the university had made academic funding more desirable to departments than applied funding. This alleged condition set by the internal financial system created anxiety among the group leaders who claimed that the policy distanced the university from applied industrial research which used to be a strong area in technical sciences for Aalto. The undesirability of applied projects prompted a belief in the group leaders that projects funded by Tekes, The Finnish Funding Agency for Innovation, should be applied "only for special reasons".

No comparative conclusion was drawn by group leaders at the University of Helsinki. Only one person commented on this issue by saying that the department did not want Tekes projects, because Tekes's funding had fallen from 70% of the project costs to 60. According to Tekes, the 10% difference was designed to be covered by funding acquired from the knowledge users which apparently had not materialized here and therefore the department did not have money to bear the increased self-financing costs of the project.

The research group leaders fear there will be "fewer new openings" for novel research if the universities start to delimit and direct topic selection.

One way of steering research via FEC was through the requirement of a commitment by the research site, usually signed off by the department head, to new project proposals. When giving such commitments, the head typically paid attention to the financial viability of the project from the department's perspective but might also look at its content. Only four group leaders across our two case universities paid attention to this matter, but all claimed this policy had led to a situation where the department delimited and directed research topics pursued. Although strategic research management by this mechanism was underlined by a minority of the group leaders, it was generally believed that research agendas would be more directly defined by the strategic focus areas of the university in the future. Half of the interviewee sample claimed topic selection at the department was not delimited currently but the other half maintained that it either was limited or would be limited in the future. For the innovativeness of the research, the latter condition created anxiety on the part of some group leaders, who feared there might be "fewer new openings" for novel research.

5. Formulation of Joint Departmental Research Agenda

In addition to top-down research management, departments also profile their research through bottom-up processes to create synergies between research groups.

Compared to the above mainly top-down instruments, formulation of a department's research agenda was a bottom-up process. Research profiling of this kind was both a reaction to changes in organizational conditions (such as research assessment exercises) and a spontaneous outlining of strategic focus areas by the departmental research community. As reform processes were still in their early stages, group leaders could not always take a clear stand about effects. However, research profiling at department level was generally seen to create synergy between professors and their research groups, rather than delimit possible research topics or methodological approaches.

Research profiling at departments follow those lines of research that are able to attract external funding.

Without external research funding there would not be much in a department to profile. Profiling therefore quite naturally followed those lines of research able to attract external funding. Once some focus areas had been defined, one was free to pursue research so long as money would flow into the department and links were developed to the department's existing focus areas. This kind of development could, however, narrow possibilities for those researchers not in the focus areas.

Local human resources policies defined by departmental work communities also affected the definition of research priorities in departments. Sometimes they were linked to the strategic goals of the department and were taken into account in recruitment decisions. A particular kind of research community therefore evolved in departments that created informal pressure and affected the choice of research topics, as noted by a research group leader at the University of Helsinki.

Finally, research profiling at departments was related to scientific advancements, aiming, in the words of one professor, to make "multiple professors work in the same direction" rather than having each pursue their separate lines of research. The call for more collaboration among senior faculty was motivated by conditions set by scientific advancement: necessitating cooperation and forming larger research groups.

At the departmental level, research profiling in both universities is embedded in multiple social, management and financial processes that are connected to one another in complex ways.

Thus, rather than hierarchically controlling science, research profiling in departments was embedded in multiple social, management and financial processes interconnected in complex ways. Sometimes these processes extended outside the walls of departments and were influenced by advancements in sciences or research funder decisions. Sometimes they were mediated by earlier decisions by the department concerning whom to hire, for instance. An important characteristic of the research management at the department level was, however, the interpretative work done by the members of the local research community, for instance, in determining whom to hire, what sorts of projects to apply for and how to articulate links between research projects and a department's focus areas. Thus, instead of speaking about research management *per se*, or direct influence on research profile by managers, it seems more appropriate to speak of an evolving web of multiple, relatively independent processes tied together by formal linkages and local interpretations. A department's research profile at any given time was the end result of this kind of complex interplay.

In the UK, research assessment is being done by a wide community of academics outside the boundary of the university and has led to stronger internal profiling of individual researchers and research groups than in Finland.

Compared to Finland, the UK case demonstrates a more mature and increasingly pervasive (or "intrusive") research profiling approach that affects strategic research management at universities. The UK began external, academic peer-based, thematic profiling of research quality with its first Research Assessment Exercise in 1986 (then repeated in 1989, 1992, 1996, 2001 and 2008) and its successor Research Excellence Framework (2014). RAE/REF scores are linked back to block grant funding allocations to the universities and affect the universities' profile among peers. Although the profiling is effectively done by a wider, more distributed community of academics outside the boundary of the university, the nature of the exercise has increasingly led to stronger internal profiling of individual researchers and research groups. Although controversial in some places, these internal profiling exercises can have implications for top-down and bottom-up strategic research management by affecting human resource practices, research group survival, research topic selection and so forth.

Conclusion

Universities in Finland are in the midst of a process where they are becoming managed entities with hierarchical decision-making structures and formally defined organizational goals. This policy brief aimed at shedding light on this timely topic, with special emphasis put on the strategic management of research.

From the point of view of scientific renewal, those strategic management measures that allow wider leeway for departments and researchers seem to be advantageous as they increase the flexibility and capacity of the innovation system to react to changing conditions.

We have suggested that strategic research management in university departments is a combination of multiple and only partially interconnected processes. The role of external research funding and scientific advancement is strong, as is the work by the localised research community in simultaneously defining and re-defining research agendas. Strategic research management at departmental level is thus interactive rather than a simply top-down or bottom-up process of causes and effects. Furthermore, strategic research management is a context-dependent process that plays out in different ways in different departments; it cannot be characterized by uniform, one-size-fits-all attributes.

At present strategic research management appears to have diverse effects on innovativeness and the intellectual renewal of scientific research in universities, particularly in our two case study organisations, Aalto University and the University of Helsinki. The very same management instruments, such as university research funding programmes, may simultaneously advance and hinder scientific renewal. Whilst certain management methods may be politically expedient their suitability must be assessed from the point of view of the entire research funding system, given the potential for uneven and unpredictable effects. However measures that allow more leeway for grassroots research management by university departments and researchers do seem to be more advantageous, as they increase the flexibility and capacity of the innovation system to react to changing conditions.

Policy Challenges and Opportunities

Policy influence on science

- How science, technology and innovation policy and university management influence the content of scientific research at the grassroots level of universities is discontinuous, context-dependent and variously intermediated. This seems to support the relative independence of science from direct policy influence and protect research activity from unintended consequences.

Internal research funds of universities bring flexibility and stability into the funding system. They also support research career development and are, therefore, more important than their volume may imply.

Research funding

- Internal research funding by universities can increase the flexibility of the research funding system, an advantage for scientific renewal. At the same time, funds allocated to established researchers may act as a conservative means to support research that is already mainstream. It may therefore be worth considering directing internal funds to researchers in earlier career stages or those who are re-defining their research agendas.
- The major funder of academic research, the Academy of Finland, has funded fewer research projects and researcher positions, thus, university research groups are experiencing volatility from fluctuating external funds. Internal research funding by universities and their sub-organization units could balance this situation and create more stability in the overall research funding system.

Tekes
Ohjelmatoiminnan strateginen tuki

Tekesin Ohjelmatoiminnan strateginen tuki -yksikkö tuottaa innovaatioympäristöä palvelevaa tutkimusta teemakohtaisilla hauilla.

Research infrastructures are an important precondition of novelty in many research areas, and because of this their development and joint use should be secured.

Research infrastructures

- Research infrastructures are an important precondition of novelty in research in many areas. There is a constant need to fund and develop them through national policy measures and collaborative efforts by universities. Joint use of research infrastructures by many universities should be promoted.

University-industry interface

- Possible prioritization of academic research funding organizations over applied, industrial funders may result in the loss of important knowledge and know-how related to the university-industry interface (see also Luukkonen & Thomas 2013).

End notes

1. The project was conducted by Terttu Luukkonen (Research Institute of the Finnish Economy), Juha Tuunainen (University of Helsinki), Antti Pelkonen (VTT Technical Research Centre of Finland), Ahti Salo (Aalto University), Eeva Vilkkumaa (Aalto University) and Duncan Thomas (University of Manchester).

2. For the overall project interviews were conducted with 80 research group leaders in seven Finnish universities and two universities in the UK: University of Helsinki (20 interviews), Aalto University (12), University of Turku (10), University of Jyväskylä (5), University of Oulu (5), Lappeenranta University of Technology (4), University of Eastern Finland (3), University of Leeds (11) and Imperial College London (10). The research areas covered in Finland were computer science science, chemistry, cancer research, energy research, urban studies, archaeology and nanomaterials, while in the UK only computer science and energy research were covered.

3. Aalto University's internal block funding included four components: tenure slot funding, additional funding for infrastructures, additional funding for service teaching and additional funding for transition period 2013-19. Of these allowances, the funding based on tenure track positions was the most significant.

4. An example was the Aalto Energy Efficiency Research Programme, an interdisciplinary effort that combined several research projects on improving energy efficiency in society, with more than 20 million euro allocated to nine research projects for four years (with a possible extension for three years).

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Project-based Funding and Novelty in University Research

Findings from Finland and the UK

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This report relates findings of a project entitled "Universities, funding systems, and the renewal of the industrial knowledge base" and funded by Tekes from its innovation research instrument. It has partners from ETLA, VTT, University of Helsinki, Aalto University, the University of Manchester, UK, and University of California, Davis. The project ran from 2012 to 2014.

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Project-based funding and novelty in university research – Findings from Finland and the UK

Abstract

While societal expectations for university research have grown, university research has become more and more dependent on external funding sources. External funding has substantially increased at Finnish – and also UK – universities, and currently in practice a major share of university research is conducted with external funding. This report relates the main findings of a study that analysed the use of project-based research funding instruments at universities, most of which are external. The main focus in the study is on the aspects of novelty and creativity in research and the question of the extent to which different research funding instruments promote these aspects of research. This report draws on different data sources, but mostly on the UNI project (Universities, funding systems, and the renewal of the industrial knowledge base), funded by Tekes innovation research instrument.

The major findings include an observation that Finnish research funding system lacks a funder that would strongly encourage risk-taking and novel approaches. Discontinuity and instability of research funding appears as a major challenge for research. There seems to be an overall increase of thematically predefined funding vis-à-vis free researcher-driven funding and close attention should be paid to this balance. Differences between Finland and the UK in terms of novelty generation turned out to be smaller than originally expected.

Key words: Funding, university research, novelty

JEL: JEL O38, O39

Projektirahoitus ja tutkimuksen innovatiivisuus yliopistoissa – Tutkimustuloksia Suomesta ja Iso-Britanniasta

Tiivistelmä

Samalla kun yhteiskunnalliset odotukset yliopistojen tutkimustoimintaa kohtaan ovat kasvaneet, yliopistotutkimus on tullut aiempaa riippuvaisemmaksi ulkoisista rahoituksen lähteistä. Ulkoinen tutkimusrahoitus on kasvanut merkittävästi sekä suomalaisissa että Iso-Britannian yliopistoissa, ja käytännössä valtaosa yliopistotutkimuksesta tehdään ulkopuolisen rahoituksen turvin. Tämä raportti kohdistuu siihen, missä määrin tutkimuksen rahoitusinstrumentit, jotka ovat valtaosin projektilähtöisiä ja ulkopuolista rahoitusta, edistävät luovuutta ja tutkimuksen innovatiivisuutta uutuusarvon merkityksessä. Raportti käyttää useita lähteitä, mutta enimmäkseen se pohjautuu Tekesin innovaatiotutkimuksesta rahoitettuun UNI-hankkeeseen (Universities, funding systems, and the renewal of the industrial knowledge base).

Tutkimuksen tärkeimpiin havaintoihin kuuluu se, että Suomen rahoitusjärjestelmästä puuttuu rahoittajia, jotka tukisivat riskinottoa ja uusia lähestymistapoja. Rahoituksen katkonaisuus ja epävarmuus vaikeuttavat tutkimuksen aihealueiden pitkäjänteistä työstämistä.

Temaattisesti määritelty tutkimusrahoitus on kasvanut vapaan ja tutkijalähtöisen tutkimuksen kustannuksella, ja se on seikka, johon rahoittajien kannattaisi kiinnittää jatkossa huomiota. Suomen ja Iso-Britannian väliset erot tutkimuksen rahoitusjärjestelmien suhteen olivat pienempiä kuin alun perin odotettiin.

Asiasanat: Rahoitus, yliopistotutkimus, tutkimuksen innovatiivisuus

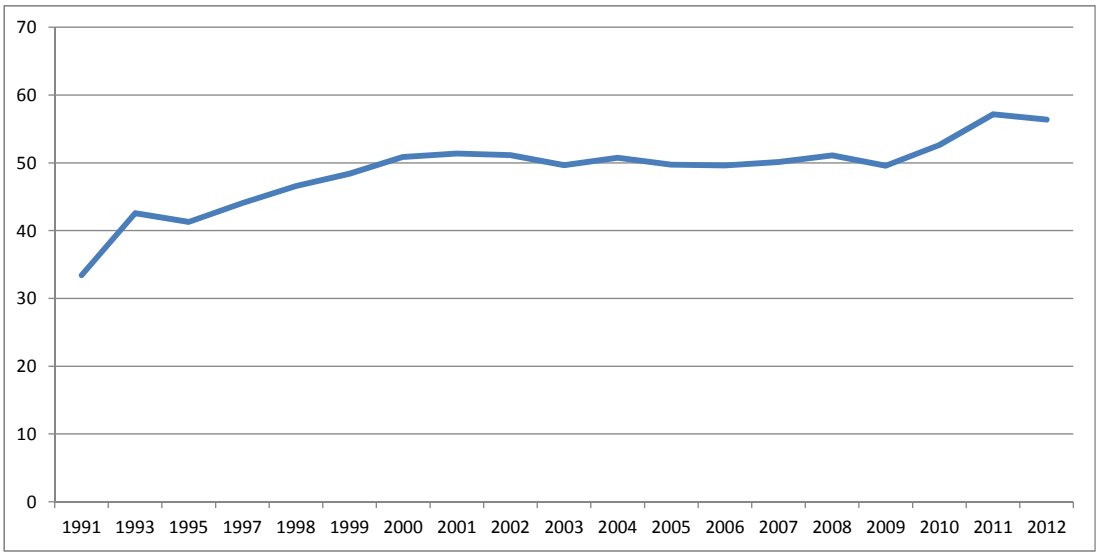
JEL: JEL O38, O39

1 Introduction

In the knowledge-based economy, the role of universities as central knowledge-producing organisations has become increasingly salient (e.g. Mintrom, 2009). While universities' traditional main functions relate to education of future generations and knowledge production through basic (and applied) research, now wider expectations are being placed on universities. On the one hand, universities face the requirement of scientific excellence: attainment of world class excellence and production of 'ground-breaking' or 'frontier research' (OECD, 2014; Langfeldt et al., 2013). On the other, universities are increasingly also expected to contribute to economic growth through commercialisation, entrepreneurship and industry collaboration (e.g. Etzkowitz, 2013). These trends have been strongly affected by growing global economic and scientific competition.

While societal expectations for university research have grown, university research has become ever more dependent on external funding sources. External funding has substantially increased at Finnish – and also at UK – universities. Currently in practice a major share of university research is conducted with external funding. Between 1991 and 2012 the share of external research funding of all research funding at Finnish universities grew from 33 per cent to 56 per cent (Figure 1).[1] This implies that the research funding system has been developed into an increasingly competitive mode (Auranen, 2014). The availability and conditions of external research funding instruments thus potentially strongly affect the nature of the research that can be conducted at universities.

Figure 1 Share of external research funding of all research funding at Finnish universities, 1991–2012 (%)



Source: Statistics Finland (http://193.166.171.75/Database/StatFin/ttt/tkke/tkke_fi.asp)

[1] In 1991 external research funding at Finnish universities was 239 million euros while in 2012 it was 549 million euros (Statistics Finland).

This report relates the main findings of a study that has analysed the use of primarily external project-based research funding instruments at universities. The main focus here is on aspects of novelty and creativity in research and on how different research funding instruments promote these aspects. We seek to answer the following questions: How and to what extent do different research funding instruments enable, facilitate or encourage research that can lead to discoveries with important industrial, economic or social implications? To what extent do the studied funding instruments promote highly innovative ideas in research?

Following the insights of previous studies on highly innovative research, such research entails new avenues of inquiry, it is unexpected, and, at least at first, it can create controversy. There may be a high risk of not achieving what is expected, unconventional ideas and even speculative elements (e.g., Travis and Collins, 1991; Grant and Allen, 1999; Heinze, 2008; Luukkonen, 2012). Interdisciplinary research is often regarded as highly innovative and entails much risk (Laudel, 2006). In order for research funders to support such efforts, they need to provide funding that allows researchers to embark upon new lines of research in new research areas, and because of the associated high risk, to make changes in their research plans, and to have time to pursue novel ideas until they become sufficiently stabilized and more widely accepted.

Accordingly, we defined the following aspects of funding sources as vital to assess their support for highly innovative research:

- **The leeway** the funding source provides to the researcher to define the research problem and to make changes during the project,
- **Stability**, i.e., the length and volume of the funding and possibility to renew the grant,
- The possibility to **move to a new research field** (in which the researcher does not have previous activity), and
- The possibility to open up completely **new research lines** in the field (novel approaches, risk-taking).

In this study, the main focus is on the major research funding sources/schemes in Finland. Data from the UK is also reported to provide comparison. The following national and European-level research funding sources (organisations) are studied: Research Councils that fund basic research (Academy of Finland and seven national Research Councils in the UK), bodies funding applied research (Tekes in Finland and the Technology Strategy Board in the UK), European Union Framework Programmes, the European Research Council, industry, foundations and universities' own (internal) funds.

2 Data

The principal data for this study consists of 80 thematic interviews with research group leaders at universities in Finland (59) and the UK (21). In Finland interviews were carried out in six research fields (computer science, chemistry, cancer research, urban studies, energy research and archaeology) and seven universities (Aalto University, University of Helsinki, University of Turku, University of Jyväskylä, University of Oulu, Lappeenranta University of Technology, University of Eastern Finland). In the UK, interviews were conducted with research group

leaders in two areas: computer science, energy research, and in two universities: Leeds University and Imperial College. In addition, research policy-makers and representatives of university administration were interviewed in Finland (20) and in the UK (2). Additionally statistical information and documents have been used in the analysis.

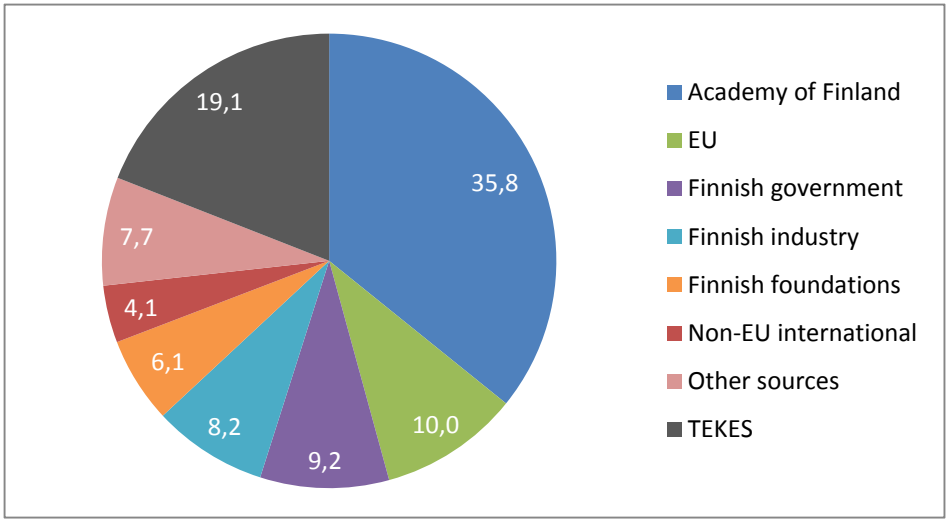
3 Research funding sources in Finland and the UK

Both in Finland and in the UK, the university research funding system operates via two main channels, one providing funding for universities' basic functions and infrastructure and one providing research funding for projects and individuals. In Finland, basic funding for universities is allocated by the Ministry of Education and Culture. Currently this covers around two thirds of universities' total funding (1,8 billion euro in 2012; Ministry of Education, 2013). This funding is allocated through a funding model with indicators in three broad domains of education (41%), research (34%) and other education and science policy goals (25%). In the UK, regional Higher Education Funding Councils (HEFC, for England, Northern Ireland, Scotland and Wales) provide the underpinning infrastructure for research. In 2013–14 HEFCE allocated £1.6 billion to universities for quality-related (QR) research funding. These amounts are determined on the basis of periodic research quality profiling that has operated in the UK since 1986, originally known as the Research Assessment Exercise (last conducted in 2008) and from 2014 replaced by the Research Excellence Framework (REF).

With respect to research funding for projects and individuals, the traditional research council funding is the most important in both countries (Figures 2 and 3; Hughes et al., 2013). These funds are allocated by peer reviewed competitive calls and administered in Finland by the Academy of Finland, and in the UK by seven national Research Councils (RCs). In 2012, Finnish universities received funding of 251 million euros from the Academy which covered 36 per cent of all external research funding at universities (Figure 2).

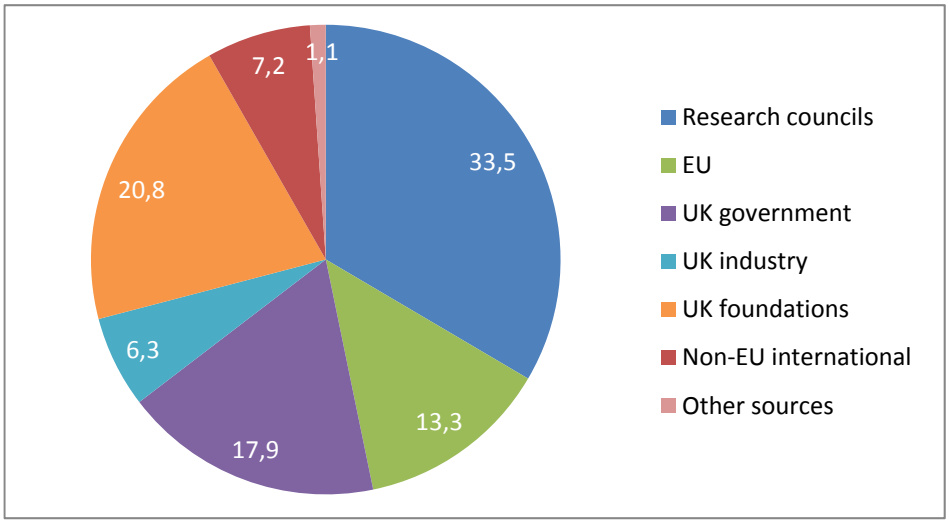
In the UK the seven Research Councils have an overall annual investment in research of around £3 billion (3.65 billion euros) and this covers around one third of all external research funding at UK universities (Figure 3). The biggest difference in the research funding systems, however, is in the area of applied research and development and collaborative R&D. In this area, Tekes is a very important funder for Finnish universities while the Technology Strategy Board is not as significant a funder for UK universities; its funding is in the order of magnitude of around 1% of project-based university funding. Furthermore, funding from charities seems more important in the UK than in Finland. Both in Finland and in the UK the funding systems are increasingly competitive and in international comparison both countries have a high share of university funding via external sources (see e.g. Auranen & Nieminen, 2012).

Figure 2 Project-based research funding at universities in Finland by source of funding, 2012 (%)



Source: Statistics Finland.

Figure 3 Project-based research funding at universities in the UK by source of funding, 2011 (%)



Source: Universities UK.

4 Project-based funding sources and novelty in research

4.1 Basic research council

In Finland, the main funding organisation for basic research is the Academy of Finland while in the UK funding for research for projects and individuals comes from seven national, thematic Research Councils.

The Academy of Finland has several funding instruments with different purposes, intended for researchers at distinct career stages. This funding is highly competitive and the interviewed group leaders considered that competition for Academy funding had recently become increasingly tight and "extremely competitive". This was often associated with the introduction of the full economic cost model in 2009. The model has increased overhead costs in Academy projects and thus increased the budgets of individual projects whilst the total sum of funding available for distribution by the Academy has not increased. Accordingly the number of projects granted funding has slightly decreased. Also the overall success rate of Academy applications has dropped from 40.5% (in 2008) to 30.8% (in 2011) (Arnold et al., 2013). In the latest Academy call in 2013 the success rates for some funding schemes were very low, e.g. for the Academy Research Fellows it was below 10%. Many group leaders interviewed also felt that younger researchers have lost out in this change: as competition increases funding is more likely to go to researchers with more experience and accolades.

In terms of researchers' leeway to define the research problem, Academy funding is considered very free. Furthermore, it is widely seen that the follow-up and monitoring during the project is very loose thus allowing redirection of the research during the project if necessary. This "fund and forget" type of approach to research funding is generally described as very good although some group leaders felt that it leads to a lack of interaction between projects funded by the Academy. In terms of length of Academy funding (normally 3–4 years, some instruments 5 years), it is regarded as relatively good although some group leaders considered there should be longer term funding to allow real risk-taking, failures and redirecting research on that basis. In principle Academy funding has provided continuity for some (most successful) researchers in terms of successive grants but given growing competition for Academy funding, this may only continue to be possible for fewer researchers in future.

Moving into a new research field appears to be very difficult through Academy funding. This is due to the strong emphasis paid to the track record of the researcher in the evaluation of project proposals. With respect to allowing researchers to start completely new research lines to the field, there are diverging views whether (and to what extent) Academy funding would allow that. In practice, evaluators of project proposals are in a key role and many research group leaders interviewed felt that it depends on who happens to be the evaluator.

In the UK, responsive mode research funding for projects and individuals provided by the UK Research Councils was generally seen as a way to have independence and leeway to define one's own research topic and to move into new fields. However due to the discipline-based and consensus nature of the peer review for RCs, novelty generation is limited where grant applicants lack track record in a new field or attempt to move to a different discipline. RC fellowships were perceived as the most attractive, flexible and novelty-supporting funding stream

in the UK. Once again though these are time-limited, as in Finland, and it is unusual for one individual to receive successive support in a fellowship mode. Due to the strategic steer from government, RCs also prioritise particular research themes for several years at a time; these themes may not be relevant to some researchers at one time, and support may dry up for a field at an early stage of development that may take a long time to mature.

4.2 Applied research funding body

In Finland, the main funding body providing funding for applied research and development is Tekes and in the UK the corresponding body is Technology Strategy Board (TSB, funded by the Department of Business Innovation and Skills, BIS).

Recently Tekes funding has been strongly restructured. Among the most important changes have been the establishment of SHOKs[2] (which covered 15 per cent – 85 meur – of all Tekes funding in 2013; Tekes, 2014), closing down of open research calls and initiation of strategic initiatives. Requirements for funding inputs and content steering by companies have also considerably increased. As a result, the conditions, terms and orientation of Tekes funding has changed with important consequences for university researchers. In short, Tekes funding appears to have become more company-relevant, but at the same time, more short-term, less flexible and perhaps less supportive of risk-taking.

Tekes funding appears increasingly company-driven which is particularly visible in the operation of SHOKs. Many researchers feel that in SHOK projects companies are more in charge of defining goals and university researchers need to refocus their own activities into more short-term issues. Furthermore, in other Tekes funding modes firms' influence seems to have increased due to recent changes such as the requirement to have proportionally more company funding in a project. Although there would in principle be leeway for university researchers to define the research problem, the onerous requirement of higher company funding than previously was the case, in practice limits this freedom. This is a significant contrast as compared with the earlier situation when only small 'seed money' was required from companies. This provided university researchers more leeway and allowed them to carry out also more academic projects with Tekes funding. Some group leaders also see that the current situation leads to less risk-taking and more 'conventional' projects as companies are not inclined to invest heavily in higher risk Tekes projects. In practice this means research problems have to be defined from the outset to be most amenable to the companies.

Moreover, interviewed group leaders felt widely that current requirements concerning company funding presented major practical challenges to set up new Tekes projects. It appears very difficult to involve several (at least three) (non-rival) companies and to make them invest in Tekes projects. This seems to be a challenge regardless of the research field.

Tekes funding also seems to have become more thematically predefined and more programme-oriented. This is particularly related to the closing down of open research calls (responsive mode funding). Up until 2012, Tekes had open calls for researchers in public research organi-

[2] SHOKs are Strategic Centres for Science, Technology and Innovation, established as a policy concept in 2007as public-private partnerships which prepare their strategic research agendas and implement research programmes. Major public funding to SHOKs comes from the budget of Tekes. See Lähteenmäki-Smith et al., 2013.

sations where topics were not thematically pre-defined and the requirement for funding contribution by companies was not too significant. Previously many interviewed researchers had strongly appreciated the open calls as they allowed researchers to propose whatever topic they considered important. The increasingly strong thematic and programme orientation is also now reflected in the fact that Tekes funding is widely considered as discontinuous: one theme is funded under one programme then the theme "is shut down". Moreover, also SHOK-funding is described as relatively short-term and as not allowing much longer-term research.

Yet, although researchers' leeway in defining the research problem seems more limited, Tekes funding may provide flexibility by allowing researchers to move into new research fields. This is because (research) excellence and previous publications are not (key) criteria when Tekes applications are evaluated. For starting new lines of research, the strategic initiatives and the FiDiPro[3] projects are regarded as potentially positive funding opportunities and yet researchers currently have little experience with these instruments to confirm whether this is the case. The requirement of company funding was seen as an obstacle in pursuing risky research in Tekes projects. SHOKs were seen as particularly problematic in terms of pursuing novel lines of research.

In the UK, TSB funding was seen as heavily constrained in terms of research topic selection and for composing one's chosen research group. Interviewees were also sceptical of the scientific quality of TSB research, due to the strong steer towards near-term applied research topics from the industry interests involved (and potential policy steer on the industry themes being addressed). A number of respondents also criticised the level of bureaucracy involved in working with TSB funding.

4.3 European Union (Framework programmes)

Much criticism was expressed about the bureaucracy involved in EU projects. Many group leaders have decided not to participate in EU projects any more – or are very critical of participating – due to the heavy administrative procedures and management involved. This view is accompanied by a rather critical perception of the scientific potential and overall benefits of participating in EU projects. Furthermore, the proposal stage in EU projects is considered to be very heavy, work-intensive and requiring resources while at the same time competition is very hard and funding is difficult to get. However, while EU funding is criticised, many group leaders feel that the importance of EU funding is going to increase in the future. This is due to the fact that national R&D funding may decrease while changes in universities' strategies will increasingly highlight the role of EU funding (for instance at Aalto University).

Overall, in EU projects researchers' leeway to define the research problem is considered to be limited: the theme is predefined and call texts create clear limits for setting the research problem. Especially more academic and scientific-oriented researchers feel the original (scientific) research idea sometimes needs to be 'masked' in order to fit the call theme. Some even consider that in EU projects the results have to be "known beforehand" when the project proposal

[3] Finland's Distinguished Professors programme (FiDiPro) is intended to attract top-level researchers from abroad to come to Finland to conduct their research for a longer time period than 'normal' research visits would allow. It is directed at both top-level Finnish researchers working outside Finland and foreign researchers. In practice, it is an instrument for Finnish universities and research institutes to hire top-level researchers from abroad for a fixed period of time. http://www.fidipro.fi/pages/home.php

is being written, directly contradicting the idea of creative, scientific and innovative research. Yet, whilst general leeway is limited in EU projects, it is acknowledged that project coordinators apparently have more possibilities to affect the overall direction of the project whereas partners' clout is substantially smaller in this regard. However, interestingly a few group leaders regard projects funded from EU structural funds as having provided them with significantly more leeway to develop their own ideas and to open up new lines of research.

EU projects are regarded as very strict also in terms of redirecting the research during the project. The projects are tightly structured with often large numbers of milestones and deliverables defined at the start of project. Many researchers feel that the original plan needs to be followed even if difficulties arise that would be better served by redirecting the project in some other way. In this regard, EU projects rather resemble research contracts where project content is predefined and implemented regardless of what happens afterwards.

The possibility for scientific breakthroughs in EU projects is generally considered low. Many researchers question whether anything 'reasonable' can be attained. In particular, large EU projects are considered problematic: consortia are so large that the focus of the project is easily lost and the research effort becomes diffuse. Furthermore, often a large number of (sometimes competing) companies are involved; are they able to participate fully and openly in creative research in this type of setting?

For the UK there were mixed views about the potential for EU FP funding to permit novel research lines and to allow leeway in research topic selection and re-orientation (when needed). Given the applied nature of the fields explored in the UK (multi-disciplinary energy areas, and computer science) some research groups had been successful in winning EU FP funding and the view was that EU FP funding had its place in terms of assisting in finding new international partners, and in accessing research ideas from and sharing research findings with non-academic partners. Like TSB funding in the UK however, where there is non-academic steer of research priorities, UK researchers were sceptical of the scientific quality of EU FP research (and critical of the levels of bureaucracy).

4.4 European Research Council (ERC)

Of all the sources of funding, grants from the ERC were most rarely used among the interviewed researchers: only seven out of 80 interviewed research group leaders reported that someone form their group had received funding from the ERC. This is because ERC funding is very competitive and difficult to get. It also reflects the fact that Finnish researchers have not been very successful in ERC calls: until 2012 the success rate of Finnish applicants was 6 per cent while for the most successful countries the success rate was 23 (Switzerland) and 16 (France and Israel). Out of 29 countries, 14 had better success rates than Finland (Freund, 2012). However, some research groups appear to have been very successful in ERC calls: for instance, one research group in cancer research had over 50 per cent of their funding from the ERC.

Among the interviewed research group leaders, ERC funding is considered very attractive: it is researcher-driven and completely free in terms of defining the research problem. Some consider ERC funding as "the best funding one could get". ERC funding is also considered suitable for starting new research lines, as by definition, ERC is intended for funding risky, break-

through research. It is in practice required that completely new perspectives are probed in order to get funding from the ERC (cf. Luukkonen, 2012).

Many of the UK researchers we talked to had been very successful in winning the full gamut of ERC research funding, with some research groups holding starting, advanced, and synergy grants at the same time. Similar to views in Finland, UK researchers held ERC funding in high regard, believing it permitted work of high scientific quality, that its administrative aspects were light and amenable to mid-project course changes, and that there was leeway to define more 'frontier' research topics for investigation. However a few UK interviewees were sceptical of the potential to get truly novel – and in particular heavily cross-disciplinary – lines of research through current ERC peer review processes.

4.5 Company funding

The availability and use of company funding appears to divide the research fields very clearly. It is very important in chemistry, energy and computer science where most of the interviewed research group leaders had received funding from industry. By contrast, in urban studies and archaeology, industry funding has been practically non-existent. Furthermore, company funding appears to be very prominent in certain fields (and groups) in certain universities: for instance in the energy field in some research groups, even a large part of the PhD theses have been carried out within company projects. Industry funding is considered important in these fields in many respects: it is crucial in that university researchers keep up-to-date with industry developments for instance. Company projects also provide good feedback for university groups, subjects for masters theses, and material for teaching.

Company funding also appears important to provide opportunities for completely new perspectives and initiatives for university researchers. This has been the case, for example, for computer scientists as they cooperated with Nokia during its rise to global market leader in mobile phones. At that time, Nokia continuously faced completely new issues and problems that nobody had resolved before. Collaboration with Nokia brought these issues to the collaborating university researchers, which opened up new research lines in scientific terms. Similarly in energy research and chemistry, company projects bring up issues that are very valuable in scientific terms and may open up new research lines. Some interviewed researchers feel that company projects are far more risk-taking and adventurous than publicly funded projects.

Industry projects are also important in that they are fully-funded by the company. In practice, some surplus may be left in the project which may then be used for other purposes. In this way, "extra" money is poured into the research group through company projects. This extra funding may then be freely used for equipment, travelling or salaries, for instance. In some research groups this "additional" funding from company projects is significant. As a matter of fact, company projects are considered the only type of projects that bring in additional funding and, interestingly, in some university departments, this funding has been crucial for the overall operation of the unit. However, at present the situation is changing as, for example, in Aalto University, university management and the current policy is seen to have taken a negative stand towards company projects. Especially for some industrially-oriented research groups and departments this is particularly contradictory: those projects that bring them additional resources are discouraged by university policies.

Through the additional surplus company projects also provide leeway and flexibility for research groups that have such funding. Yet, in the company projects the researchers' leeway is usually very limited: the funding company also defines the objectives and dictates what will be done and studied. Furthermore, the smaller the company, the more concrete are the needs and the less leeway there is for researchers. Yet, there are some exceptions to this: in some cases, there have been company projects where the company has only provided a broad framework for the project and thus allowed substantial leeway for researchers to operate. Many researchers also highlight that they engage with company projects only if they have a scientific and research-based interest in the topic. Some researchers regard company projects as the most flexible in the sense that companies are interested in the results and are not interested in the way in which the money is actually spent so long as results are delivered.

Yet, for university researchers academic publishing is a challenging aspect in most industry projects. As there is increasing pressure for publishing in all fields, university groups also wish to publish scientific papers on the basis of company projects. Company projects are often short-term, have a quick tempo, and short in duration. This poses challenges for university researchers. Yet, in some cases longer-term company funding has allowed the preparation of PhD theses, particularly in energy research.

In the UK, research funding from industry had some polarised features. On the one hand, interviewees felt there was little to no leeway to define the research topic and, in particular, to have any leeway over the deadline for delivery of research outputs. Industry research topics were also seen to be far shorter-term and applied than those associated with other funding sources. At the same time, similar to this aspect in Finland, industry research funding could have few strings attached when it was in the form of almost honorarium-type support to a particular school or faculty. Use of these funds, albeit small, could then be at the total discretion of a research group leader who could use them to start novel and risky new lines of research, in particular, via one or more PhD students under their supervision. Finally, industry research funding was seen as a way to stay in contact with the state-of-the-art of research applications, and as a source of intellectually stimulating and socio-economically relevant research problems.

4.6 Foundations

Funding for foundations is most important in biomedicine (cancer research) and archaeology where all the interviewed group leaders had had funding from foundations. By contrast, in particular in energy research, the importance of foundations is very limited. A large part of the funding provided by foundations are personal grants or scholarships in which the basic terms and conditions for the researcher (in terms of salary and pension for instance) are worse than in other types of project funding. This is why funding from foundations is not always attractive from the researcher's point of view. As funding from foundations is generally in the form of personal grants and scholarships, especially for PhD candidates, it is relatively small in volume. However, in cancer research there seems to be a different situation as there are larger foundations (e.g. Juselius Foundation) that fund larger longer-terms projects (not individual scholarships). These may be up to 2–3 years, and in some foundations, even five years. The five-year grants are considered very good to allow some stability for the research. Especially in cancer research, foundations provide stability also in the sense that it is possible to obtain

continuation for the project. In some cases, foundations have become very long-term funders for some research groups.

In projects funded by foundations, researchers' leeway is very high. Each foundation normally has its broad focus and relevance areas and perhaps some other conditions, but once the research fits into that area and related basic conditions, foundations tend to provide full academic freedom in terms of the research topic. Thus in principle, foundations are suitable for very risky and novel approaches and may provide funding for completely new research lines. In terms of the flexibility of redirecting the research during the project and other changes in course of the research, foundations have widely varied conditions and practices: some foundations are very flexible whereas others are stricter.

For the UK, at least in the two fields of energy and computing science studied, funding from charities and foundations did not represent a significant proportion for any of the research groups interviewed. However in isolated instances, particular researchers were very satisfied with the significant leeway allowed by even small budgets from foundations, as there were few conditions attached to the funding, and there had been leeway to re-orient the work to account for scientific developments and career progression matters. In other cases, funding from foundations and charities in the UK was viewed in a light similar to support from industry – i.e. applied research topics that needed to be dealt with within a short-term delivery window with little leeway in terms of topic selection or how to specify outputs and deadlines.

4.7 University funds

Universities' internal research funding was used relatively evenly in all the studied fields except for urban studies where its importance was lower. Its significance, however, varied across the universities and it was particularly important at Aalto University and especially in the field of energy research. In practice, universities' internal research funding takes different forms in different universities and at least four funding models can be discerned: 1) large-scale, long-term (5–7 years) research funding programmes such as Aalto Energy Efficiency (AEE) and Multidisciplinary Institute of Digitalisation and Energy (MIDE) programmes at Aalto University, 2) shorter-term (3 years) funding programmes (projects), researcher positions and individual grants, 3) research institutes and centres such as Biocentrum Helsinki or Institute of Biotechnology at the University of Helsinki, 4) 'support packages' for individual researchers.

All forms of universities' internal research funding are considered to be very free and flexible and allowing researchers to follow their own scientific interests. The large-scale funding programmes at Aalto have, however, been thematically restricted to certain fields or topics (e.g. energy, digitalisation). Within these limits, they are regarded as allowing completely free research. Moreover, the large-scale research funding programmes appear particularly important as it is long-term academic funding without heavy reporting and administration duties. Several group leaders described this type of funding as the most important and best funding that is available. While leeway is equally high in other types of internal research funding, they are clearly of smaller volume and shorter term.

While long-term, large-scale funding programmes are typical of Aalto University, the University of Helsinki has tended to support certain research fields by establishing research institutes

and centres (see Tuunainen, 2014). The research institutes provide additional stability and leeway for its staff as their operational model differs from normal university departments. For instance, in the institutes there may be some 'buffer funding' for the research groups: if one group is lacking funding, other groups support it collectively for some time. Institutes also provide new researchers with starting support funds which are completely free and flexible to use.

Many researchers consider that universities' internal (strategic) funding could be the best funding particularly for risky projects, which may not be obtainable from other sources. For example, the Aalto Energy Efficiency Programme is described as a good example of programme that encourages breakthrough research and completely novel approaches.

At the two UK universities studied, basic infrastructure funding for research had been allocated by HEFCE. This provided possibilities for some strategic research management in the form of centrally-determined, internal support for multi-disciplinary, coordination and outward-facing research centre ventures (energy-related research centres at both universities). This block grant derived internal funding can also fund small-scale research by individuals as 'seed corn' support for them to move into new fields. Both of these funding avenues provide leeway for researchers to select their topics and limited possibilities to move into new research fields. With the multi-disciplinary centres this may more likely result in coordination or better exploitation of existing theoretical models and research findings (and these internally-funded centres are time-limited entities unless their budgets are renewed or become self-sustaining from external funding sources).

5 Summary and conclusions

The two following tables summarise the main findings of this study in terms of the different research funding sources and their potential to promote novelty in Finland and in the UK. The tables should be understood as tentative summaries and rough characterisations based not only on the interviewees' accounts, and not as definitive judgements of the different instru-

Table 1 Research funding sources and their potential to promote novelty in Finland

	Leeway		*Stability*	*Move to new field*	*Open new research lines*
	Problem setting	*Redirecting*			
Academy of Finland	++++	+++	+++	+	++
Tekes	++	++	++	++++	++
EU FP	+	-	++	++	+
ERC	++++	++++	++++	++	++++
Company funding	+	-	+	++	++
Foundations	++++	++*	+*	++	+++
University funds	++++	+++	+++*	++	+++

Scale: - = Not at all ... ++++ = Very much.
* = A lot of variation among the funders / instruments.

Table 2 Research funding sources and their potential to promote novelty in the UK

	Leeway		*Stability*	*Move to new field*	*Open new research lines*
	Problem setting	*Redirecting*			
Research councils (c.f Academy of Finland)	+++ ↓	++++ ↑	++ ↓	+	++
TSB (c.f. Tekes)	++	++	+ ↓	+ ↓	+ ↓
EU FP	+	+	++	++	+
ERC	++++	++++	++++	++	++++
Company funding	+	-	+	+ ↓	++
Foundations	++ ↓	++*	+	+ ↓	+++
University funds	++++	++++ ↑	+++	++	+++

Scale: - = Not at all ... ++++ = Very much.
* = A lot of variation among the funders / instruments.
↑↓ = UK differences compared to the respective funding source in Finland.

ments. The most significant difference in the funding sources concerns applied research funding where Tekes is very important in Finland whereas the role of Technology Strategy Board in the UK is insignificant. Furthermore, Tekes funding seems to be more prone to promote novelty whilst the TSB funding is not highly valued in this regard. Another difference concerns the funding from foundations which appear more suited to novelty generation in Finland than in the UK. However, this is probably due to the research fields studied: in the UK only computer science and energy researchers were interviewed and the role of foundations was not that important for those two fields. In this respect the picture may be different if, for example, biomedicine would have been included in the UK data.

On the basis of this study, the following observations can be made concerning the current status of the Finnish research funding system in terms of creativity and novelty in university research:

- **Discontinuity and instability** of research funding is a major challenge for research group leaders. Even the most successful and undoubtedly 'world-class' researchers may face situations where they lack funding and may have to close down their research group.
- The Finnish research funding system **lacks a funder that would strongly encourage risk-taking and novel approaches**.
- The overall **availability of research funding** and different types of funding varies considerably across research fields. For example, archaeology is a field where there is high dependence on only two funding sources quite opposite to other fields. It is to be noted, however, that suitable funding sources per field may vary over time, e.g., a rapid change in the industrial landscape in telecommunications area has reduced opportunities to industrial funding in computer science.
- There seems to be an overall increase of **thematically predefined funding** vis-à-vis free researcher-driven funding. Close attention should be paid to this balance. In certain research fields and universities, it is felt practically impossible to obtain funding for "free", researcher-driven research.

– Research at universities is **practically only conducted through external funding**. Research group leaders have to use increasing amounts of time and energy for securing funding for their groups. In some cases external research funding is also used to support teaching. We could ask whether this situation is sustainable and optimal from the perspective of research groups' possibility to carry out high-level, world-class research.

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Industrial Engagement of University Research

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This brief is about changing expectations on publicly-funded university researchers to contribute to socio-economic goals primarily through commercialisation, such as the creation of spin-out companies. Based on our research in the UK and Finland we argue that this kind of 'commercialisation' is only one, often minor, aspect of how researchers and their research in reality engage with industry such that a more nuanced treatment of the wide variety of 'engagement' approaches could lead to more effective science and research policies. This brief draws on different data sources, but mostly on the UNI project, funded by Tekes innovation research instrument.

Introduction

Universities have a central role in our knowledge system. Two major functions of universities in our society are education of the skilled labour force and conduct of research. The third task of the universities concerns the utilisation of university research in all spheres of life including knowledge transfer to and engagement with industry.

In recent years, there have been increasing expectations in most developed countries concerning the role of universities to help improve the competitiveness of a country's industries and thus to promote economic growth. In the UK, the recent Witty Review[1] (October 2013) advocated that "universities should assume an explicit responsibility for facilitating economic growth, and … to develop and commercialise technologies which can win in international markets … universities should make facilitating economic growth a core strategic goal" (p. 6). In Finland, public policies have emphasised both academic engagement with industry and academic entrepreneurship through start-ups. University-industry collaboration has been an important condition for university researchers to obtain Tekes funding.

Here we focus on the ways in which university researchers engage with companies, how their research activities contribute to industry, and the extent to which researchers are engaged in entrepreneurship, e.g. the creation of spin-out companies. Current literature on university-industry relations distinguishes between academic *engagement* with industry and *commercialisation* (Perkmann et al., 2013). Academic engagement with industry involves multi-directional knowledge-related collaboration via such formal activities as collaborative research, contract research, and consulting, and informal activities such as networking and exchanges at conferences and other forums (Perkmann et al., 2013). Commercialisation, by contrast, involves the patenting and licensing of inventions and academic entrepreneurship. We aim to clari-

fy the working of these processes and to argue against simplified interaction models.

In Finland, research policies have acknowledged that multiple ways of engagement exist including commercialisation activities and interaction through collaborative R&D. Examples include the traditional support by Tekes for industry-university R&D cooperation and the various institutions and funding schemes which promote spin-out formation and the provision of early and growth stage venture funding. However, collaborative R&D support has become more short-term in its emphasis. The UK Government has also promoted both entrepreneurship and university-industry collaboration through various funding programmes. However as the above-mentioned Witty Review indicates there is a climate of increasing pressure towards the commercial utilisation of academic research. This is reflected also in the UK's new Research Excellence Framework (REF)[2] that includes an unprecedented 20% weighting for the demonstration of the impacts and use of research results by people outside academia (and which the Witty Review suggests should weight such 'impact' even higher in future).

We prefer to talk about 'engagement' rather than knowledge or technology transfer since the latter implies a one-way process whereas current research literature highlights the multi-directional, interactive nature of industrial engagement (Kenney, 2013; Perkmann et al., 2013). Industry can provide stimulating research questions, instruments and other resources for university research and vice versa.

Industrial funding of university research

To illustrate the order of magnitude of these activities, we can use available statistical data on some of the formal ways of interaction, in particular the share of industrial funding of university research. In Finland in recent years, this has varied around the OECD and estimated EU28 averages but in 2011 it was lower than the average, namely 5,5% (Table 1). According to the newest data issued by Statistics Finland for 2012, the share was the same in 2012[3]. The downturn in industrial funding probably reflects the effects of the financial crisis amplified by Nokia's downfall. However the financial crisis has reduced the share of industrial funding to universities in all major reference countries, as reflected in the average figures, although the UK figures do still indicate a sharper downfall. The magnitude of industry funding of university research in Finland was around 78,7 million euro in 2011 (the respective figure for the UK in 2011 was 284 million GBP, with an additional 229 million GBP spent by firms for public research institutes; ONS, 2013).

These monetary figures alone do not reveal the full extent of university-industry interaction. Only part of this interaction takes place through formal contracts, and much R&D collaboration takes place within publicly-funded research programmes, where direct industrial payments of university research are only part of the picture.

Table 1 Percentage of higher education expenditure on R&D financed by industry

Country	*2000*	*2007*	*2009*	*2011*
Finland	**5,6**	**7,0**	**6,4**	**5,5**
Sweden		4,9	4,5	4,1
Netherlands		7,5	8,2	
Denmark	2,0	2,1	3,6	3,2
Germany	11,6	15,5	14,2	
Switzerland	5,1	8,7 (2006)	6,9 (2008)	9,1 (2010)
UK	7,1	4,5	3,9	4,6
USA	7,1	5,5	5,6	5,0
EU28 (estimate)	6,3	6,9	6,4	6,4 (2010)
OECD total	6,4	6,6	6,3	6,0 (2010)

Source: OECD Main Science and Technology Indicators Volume 2013/1.

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Forms of university-industry interaction

Reviewing university-industry interactions over the past decades Kenney (2013) argues that prevailing policies are too much based on academic entrepreneurship or what he calls the 'biotechnology model'. This model entails a university first patenting its research findings, then licensing the knowledge to a small venture-capital financed firm; the firm is often established by a university researcher or student. Alternatively the university knowledge is patented then licensed to a large existing pharmaceutical firm (p. 4). This basically linear model has underpinned a lot of policy action, particularly in the USA. Kenney further argues that industry characteristics affect the nature of the engagements firms have with universities so a one-size-fits-all model is not sufficient to cover these varied relationships (p. 6; he examines the wine industry, electrical engineering and computer science industries, scientific instruments and mathematics and statistics). Besides industry characteristics, the scientific research field also affects the mechanisms of knowledge exchange and academic entrepreneurship. Kenney provides plentiful evidence of both *formal* and *informal* ways in which university researchers engage with industry: the ways in which they interact, transfer knowledge and resources back and forth, including a transfer of knowledge through students and extension courses (pp. 6–13).

Our UNI project data[4] revealed that there are indeed multiple ways of university-industry interaction and commercialisation routes (Figure 1). We interviewed research group leaders in seven universities in Finland and in two universities in the UK. Our analysis here looks at computer science, chemistry, cancer research, and energy research. These are all research fields with important commercial potential. Chemistry research can be utilised in many different industries including in the chemicals industry, pharmaceuticals, pulp and paper, energy, biotechnology, and cosmetics.

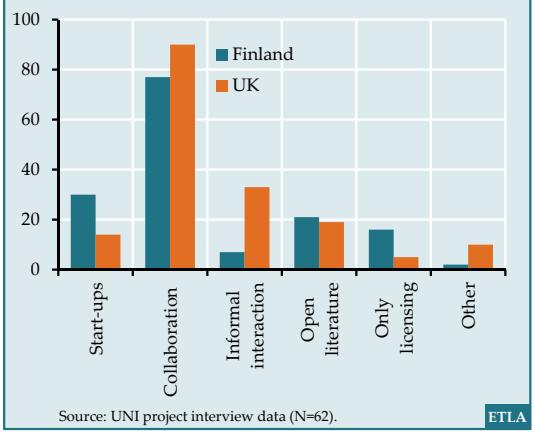
Our data showed that the vast majority of the interviewees both from Finland and the UK had R&D 'collaboration' with existing firms (to be elaborated in the next section). Relatively few researchers were involved in academic entrepreneurship and commercialisation of research findings through start-ups (this agrees with an earlier study with UK researchers where almost half in the physical and engineering sciences were engaged in collaborative research with only 12% engaged in academic entrepreneurship and 22% in patenting; D'este and Perkmann, 2011). Our study suggested that academic entrepreneurship and deep engagement with a start-up firm was often seen as a hazardous route where a researcher 'might lose both money and touch with the research forefront to the point of jeopardising their future research career', as one of the UK interviewees put it. Pursuit of the full commercialisation process is time-consuming and the death rate of start-ups is high. Because our data are limited we cannot judge whether the difference in start-up experience between Finnish and UK research group leaders reflects a more general trend[5].

Interestingly informal interaction with industry was mentioned more often in the UK than in Finland. This could to some extent be related to the existence in the UK of strategic university-industry alliances which provide platforms for multiple types of interaction (see more in the next section).

Producing open-access research literature that can be read by industrialists (and others) is an option for researchers in fields other than energy research (energy research is already quite applied and the most closely engaged with industry out of the fields we explored here). For example, analytical chemistry researchers can publish their findings on methods and techniques in open scientific literature. Firms can

1 Forms of commercialisation and engagement with industry

Share of interviewees who used the respective form



Source: UNI project interview data (N=62). ETLA

pick up the research insights then conduct the necessary additional development to commercialise the findings in an equipment or device. This does not lead to direct financial returns to the scientists, but they can often buy devices derived from their findings either free of charge or at a discount from the developing firm. 'Licensing' in Figure 1 indicates cases where licensing was the only form of interaction (patenting and licensing could also play a role in connection with other collaboration forms).

Our UNI data also enables us to have a closer look at the forms of R&D collaboration with existing companies (Figure 2).

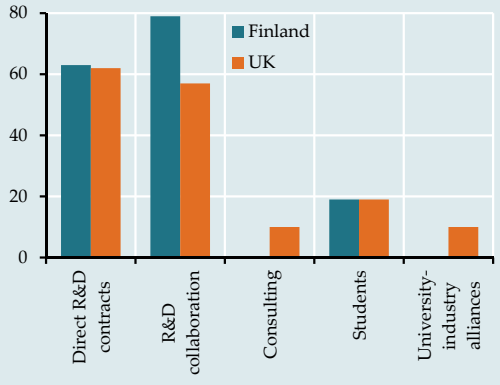
Direct subcontracting by firms for university researchers to conduct R&D was a major interaction form (60% of interviewees in both countries). Subcontracting restricts the researchers' choices most since the subcontracting company defines the task in detail and a major motive for researchers to be engaged in it is the money. There are, however, notable exceptions where the interests of the subcontracting firm and the researcher merge or are complementary. In general, R&D collaboration is more based on mutual interests. In Finland R&D collaboration was more common than in the UK, though in the latter, it was also still quite common. In both countries, R&D collaboration is typically mediated by public funding agencies through their R&D programmes. 'Students' here refers to students conducting their diploma or Masters thesis research on a topic supplied by, funded by and often conducted within a firm.

Finnish researchers did not mention 'consulting' at all, raising the question of whether they do not do it at all, or for reasons unknown, did not mention it. 'University-industry strategic alliances' in the UK are long-term partnerships across a number of the university departments or disciplines, usually lasting far beyond single research project contracts. These alliances are managed so that they are open for multiple types of interaction including staff exchange, undergraduate recruitment, and student prizes or endowments, thus embracing actions that in the Finnish context are instead pursued as separate activities. Such alliances normally involve a large multinational company and a prestigious university. They provide an opportunity for conducting perhaps longer term, fundamental research that is still relevant to a specific industrial context.

Drawing upon a wider dataset, Figure 3 shows findings from an Etlatieto Ltd survey (2012) with 725 research group leaders' responses to a question about the extent and nature of their contacts with companies in the past five years.

The major import of Figure 3 is that there are multiple contact forms, varying by the intensity of contact. Conferences and seminars are the most frequent, though all forms have a fairly low average rating (lying between 'not at all' and 'to some extent'). These survey respondents also reported engaging in consulting, public R&D programmes, and contract research involving firms.

2 Forms of collaboration with existing companies



Note. In Finland, 20% of the interviewees had R&D collaboration with SMEs, while in the UK collaboration with SMEs was insignificant. N=62.

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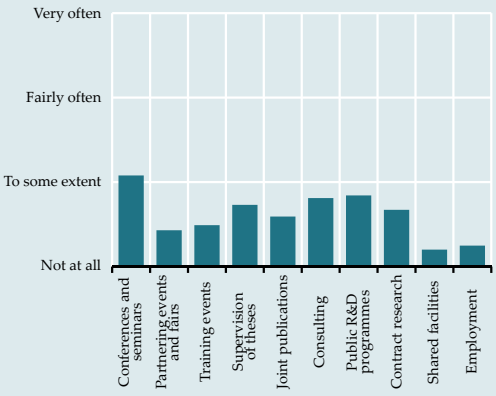
3 Extent of contacts with companies; research group leaders



Source: Etlatieto Ltd survey of 2012 by Tuomo Nikulainen & Antti Tahvanainen. N=725.

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Factors affecting interaction: researcher motivation and orientation to engage with industry

Many factors affect individual university researchers' engagements with industry. First, it varies by scientific field and research nature, in that there are fewer opportunities and interests for industrial engagement for social sciences and humanities research or if the research is very fundamental in nature. How researchers' define their role and their task motivations are also important.

Adapting Lam (2011) we defined three types of researcher industry engagement orientations:

1) *Reluctant commercializers* are traditional scientists. For them academic/peer recognition is mainly obtained through scientific publications so these are most important to them. If they participate in commercialisation, they do so "mainly to obtain much needed funding for research in an increasingly resource constrained environment" (Lam, 2011, p. 1357).

2) *Pragmatists* are motivated not only by the research funding that industrial engagement provides but also by advancing knowledge in the context of interesting research questions/puzzles that can be provided by firms, and they are interested to make knowledge more socially relevant.

3) *Committed commerzialisers* are most entrepreneurial and define their research task as industrially-oriented: they are interested in co-production of knowledge with industry, and take pleasure in participating in commercial activities.

The traditional/reluctant scientists are motivated by 'puzzle' (exciting research questions) and 'ribbon' (peer recognition and rewards), pragmatic scientists by 'gold' (funding and resources) and 'puzzle', and committed commercializers by 'puzzle' (co-production of knowledge with industry) and 'gold'.

We applied this classification of researcher orientations to our UNI data[6] as shown in Figure 4 (covering the four fields we explored where commercialisation was a possibility, namely, computer science, chemistry, energy, and cancer research).

When researcher value orientation was cross-tabulated with their reported R&D collaboration with industry, it can be seen that it was only the reluctant/traditional scientists who were not engaged with industry (even though over half of this group were engaged). Significantly, the rest were all engaged with firms (NB. our result reflects the specific fields under study, which are all industrially relevant, and, as a cautionary note, the 'reluctant' and 'committed' groups were quite small in absolute terms).

Institutional and policy context for engagement

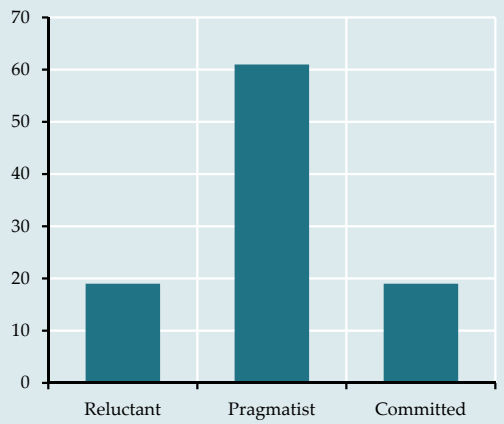
University-industry engagement and academic entrepreneurship, and possibilities for industrial engagement and commercialisation, were also found to be mediated by the support and encouragement that the university environment provides, the conditions public R&D programmes set, and importantly, the industrial structure of the country.

Table 2 R&D collaboration with firms by orientation

	Reluctant	*Pragmatic*	*Committed*
Yes	58 %	100 %	100 %
No	42 %	0 %	0 %
	N=12	N=38	N=12

ETLA

4 Researcher orientation in UNI data



Note. N=62.

ETLA

Universities attempt to promote academic engagement and commercialisation by creating support structures (such as technology transfer offices, incubators, licensing services etc.). These face great challenges since the range of scientific fields, potential markets and potential application areas for university research findings can be broad indeed. To succeed, intermediary organisations promoting commercialisation need to know about potential utilising companies in all application areas around the world, since in a small country, domestic industry is not comprehensive enough to provide candidates for commercialisation in all areas. This is some task and so, not surprisingly, our research uncovered widely differing views about the efficiency and competencies of university technology transfer services. These services were seen to be of help where research findings were believed to be capable of leading to patentable discoveries and/or to give rise to licensing agreements. It was mainly in these instances where the technical information and competencies of the offices were fit for the task and were usually appreciated. General conclusions about the efficiency of these services would, of course, require a more comprehensive study but nonetheless studies conducted elsewhere do indicate that the existence of formal technology transfer mechanisms is generally positively related with commercialisation but not with academic engagement with industry (Perkmann et al., 2013). Academic engagement is instead more dependent on the networks and contacts of individual researchers, and thus has less to gain from the help of internal intermediary organisations.

Universities can also affect academic engagement and entrepreneurship via internal resource allocation and reward systems. Collaboration with firms can delay scientific publishing (say, by having to wait for filing the patent application). Our Finnish interviewees at Aalto University voiced concerns about the impacts of their industrial engagement on their performance in the university's new reward and resource allocation systems, especially in the case of contract research with industry. This is a result of the recent policy change in the university and its implications for the researchers' publication behaviour. Aalto University is undergoing radical changes after the merger of three distinct university organisations, and researchers are receiving conflicting signals about the kind of research they are expected to conduct. Aalto aims to become an excellent research university as measured by scientific publications; subsequently, researchers are expected to conduct research that leads to scientific publishing but at the same time researchers reported to us that their engagement with industry was less likely to lead to prolific scientific publishing.

UK examples indicated that research contracting practices with industry have adapted to the UK's strong and growing emphasis on prolific scientific publishing expectations by normally ensuring that academic researchers have a right to publish their findings in scientific literature, and with as minimal a delay as possible in cases where pre-publication comments and/or approval was required from firms (we should note that evidence from other countries does provide somewhat conflicting evidence of this issue of the impact of industrial engagement for researchers' scientific publishing patterns; see Perkmann et al., 2013).

University full economic cost models can affect industrial engagement if higher overhead percentages apply (i.e. the rates transferred to university central administration) to industrial contracts or Tekes funding than to projects funded, e.g., by the Academy of Finland. There is evidence of this practice at Aalto University, apparently as part of an aim to improve its quality and rate of scientific publishing.

This situation is aggravated by the new Tekes policy that expects more rapid utilisation of research findings and so academic researchers hoping to obtain Tekes-funded projects have to engage with firms – preferably several at a time and quite intensively[7]. This tends to make these researchers' projects more short-term and to decrease or delay opportunities for scientific publishing. This clearly discourages industrial engagement. The recent change in Tekes funding conditions for public research, taken together with concurrent SHOK policies, mean that Tekes funding to universities is more closely linked to short- to mid-term objectives and the current agenda of firms. Short-termism was not originally the objective of SHOKs of course, although as evidenced by the recent SHOK evaluation (Lähteenmäki-Smith et al., 2013) the programme's implementation has indeed caused a drift in its overall orientation and is making it less attractive to scientists.

Tekes' condition to have business partners in a project also restricts its funds to university researchers who can attract business partners and excludes researchers who cannot find firms that are currently pursuing their research topic; furthermore, in many applied research areas there simply are *no relevant firms* with which to collaborate. Large firms are the best partners for commercialisation and knowledge utilisation (they have more resources to take commercialisation further) but there are many application areas with no relevant firms in Finland. Small countries are therefore in a much more difficult position than larger ones (like the UK). The telecommunications industry and Nokia in particular is a good example of an area where, as a result of rapid change, an important, dominant business partner effectively disappears from the market. In computer science and related areas, Nokia – and earlier teleoperators – used to be highly important partners and heavily networked with university research. In a very short time Nokia has virtually disappeared from collaborative R&D so university researchers have difficulty in finding industrial partners for their research. Thus, the existing industrial landscape can affect the potential for engagement.

Tekes' funding condition requirement for domestic industrial partners is understandable and was hoped to benefit domestic industry within a short time frame. Our research would suggest that it may, however, close down lines of research that could later prove to be important for emerging or existing firms – research that should not be left underdeveloped simply due to a lack of available business partners.

Conclusions

Finland and the UK have a strong policy emphasis on the third mission of universities, and in particular, on the utilisation of scientific knowledge to promote domestic industrial competitiveness. Our research findings highlight the importance of developing policies that incentivise both academic entrepreneurship and *multiple other forms* of university-industry engagement and that take into account the interests and motivations of both parties. Academic entrepreneurship and university-industry engagement are both important ways of using academic knowledge. Academic engagement with industry may be the more mundane, and overlooked activity, but we suggest it is the more frequent one and deserves more commensurate policy attention.

For research funding agencies in both countries, creating funding conditions that expect quick returns may be counterproductive where these conditions are hard to fulfil or lead to research projects that are unrewarded/sanctioned by the university. Our study data indicated that researchers at Aalto University are constrained by the somewhat conflicting requirements of Tekes and the university. Further, when defining performance measurement and objectives for their activities, universities should remember that the networks researchers have created with industrial partners are an important resource that may be lost if not actively maintained for example, because the university does not reward such activity. Research contracting practices could be improved – e.g. as in the UK where scientific publishing is increasingly protected and strategic alliances with firms providing a broad platform for engagement enabling longer term relations and multiple forms of interaction. In such a case, both parties could benefit, allowing the academic world to contribute to the industrial knowledge base while, at the same time, maintaining and improving its academic credentials and competencies.

Endnotes

1 https://www.gov.uk/government/consultations/universities-and-growth-the-witty-review-call-for-evidence; this review was led by Sir Andrew, CEO of GlaxoSmithKline and Chancellor of the University of Nottingham.

2 http://www.ref.ac.uk/panels/assessmentcriteriaandleveldefinitions/; the 2014 REF replaces the previous Research Assessment Exercise (RAE) last undertaken in 2008 that did not include assessment of 'impact cases'.

3 http://tilastokeskus.fi/til/tkke/index.html

4 UNI data were collected in 2012–2013; in Finland the number of interviewees was 59 covering computer science, chemistry, cancer research, energy research, urban studies and archaeology, in the UK the number of interviewees was 21 covering only computer science and energy research. The data analysed here includes in Finland the first four of the above fields, in the UK the two, computer science and energy research. The number of interviews analysed here was 41 in Finland and 21 in the UK. The interviews were semi-structured and explored various factors that affect innovativeness of research. All interviews were recorded and transcribed.

5 It is also to be noted that our interviewees were senior researchers, most often professors, who have stayed in the academic career and have made choices accordingly.

6 We classified the interviewee statements on the basis of their responses to questions concerning industrial collaboration, extent and nature of funding from firms and overall their comments on commercialisation and utilisation of research findings.

7 Tekes new funding instruments include strategic openings, which was launched in 2012. It does not require collaboration with companies. It is, however, still new and does not concern many areas of research, and thus, few researchers have experience of it. A link to the terms of this instrument in 2014 is the following:http://www.tekes.fi/nyt/hakuajat-2013/strategiset-avaukset-2014/ (only in Finnish).

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No. 9/2014

Policy Brief:
Systeeminen muutos ja innovaatiot

Radikaalien innovaatioiden rahoituskäytännöt

Tiivistelmä tutkimuksesta

Millaisilla rahoituskäytännöillä voidaan parhaiten tukea radikaalien innovaatioiden syntyä?

Miten resurssit tulisi jakaa kokeilevan ja pitkäjänteisen rahoituksen kesken?

Radikaalilla innovaatiolla tarkoitetaan täysin uudenlaista tuotetta, palvelua tai teknologiaa, joka parantaa olemassa olevia toimintamalleja merkittävästi (Schilling 2008). Koska radikaalit innovaatiot tekevät aiemmista toimintamalleista vanhentuneita, ne vähentävät näihin liittyvää osaamistarvetta sekä heikentävät niiden varassa toimivien yritysten menestysmahdollisuuksia. Pitkällä aikavälillä radikaalit innovaatiot kuitenkin hyödyttävät yhteiskuntaa uudistamalla tietopohjaa, luomalla markkinoita ja vauhdittamalla taloudellista kasvua (Tellis et al. 2009, Harris & Albury 2009). Yritysten tutkimus-, kehitys- ja kaupallistamistyö sekä riskipääomasijoitustoiminta ovat avainasemassa radikaalien innovaatioiden synnyttämisessä. Julkinen sektori voi puolestaan edistää radikaalien innovaatioiden syntyä yliopistoissa, tutkimuslaitoksissa sekä myös t&k-intensiivisissä kasvuyrityksissä, joiden verrattain suuret alkuvaiheen rahoituskustannukset saadaan vain osin katettua tulorahoituksella ja riskipääomalla (Hall & Lerner 2009).

Pelkän hanke- tai liiketoimintasuunnitelman perusteella on käytännössä mahdotonta tietää, johtaako esitetty hanke radikaaliin innovaatioon. Siten on tärkeää tutkia, millaisilla rahoituskäytännöillä radikaaleja innovaatioita saataisiin syntymään mahdollisimman paljon rajallisten resurssien puitteissa. Tutkimuksessa on kehitetty päätösanalyyttinen malli erilaisten rahoituskäytäntöjen vertailemiseksi asetelmassa, jossa radikaalien innovaatioiden arvioidaan todennäköisimmin syntyvän poikkeuksellisen tuloksellisissa hankkeissa. Erityisesti on vertailtu seuraavanlaisia käytäntöjä:

1. *Pitkäjänteinen rahoitus,* jossa alustavien arvioiden perusteella parhaille hankkeille myönnetään pitkäaikainen rahoitus.
2. *Vaiheittainen rahoitus*, jossa kokeilevaa, lyhytaikaista rahoitusta myönnetään monille hankkeille, mutta pitkäaikaiseen jatkorahoitukseen sitoudutaan vain niiden osalta, joilla kokeilevan rahoitusjakson perusteella on potentiaalia johtaa radikaaliin innovaatioon.

Mallin tulosten valossa vaiheittainen rahoitus näyttää tuottavan enemmän radikaaleja innovaatioita, sillä (i) kokeilevan rahoituksen myöntäminen monille hankkeille pienentää riskiä jättää radikaaleja innovaatioita rahoittamatta, ja (ii) päätös pitkäaikaisesta jatkorahoituksesta voidaan tehdä tarkemman arviointitiedon valossa. Vaiheittaiset rahoituskäytännöt ovatkin parantaneet yritysten innovaatiokykyä (O'Connor et al. 2008, Tellis et al. 2009, Klingebiel & Rammer 2011), ja ne ovat laajalti käytössä riskipääomasijoitustoiminnassa (Tian 2011, Li & Chi 2013). Toisaalta mitä useammille hankkeille myönnetään kokeilevaa rahoitusta, sitä vähemmän resursseja jää hyvien hankkeiden pitkäjänteisen jatkorahoituksen varmistamiseen. Täten innovaatiotoiminnan haasteena on löytää tasapaino kokeilevan ja pitkäjänteisen rahoituksen välillä.

KÄSITTEET

Radikaalilla innovaatiolla tarkoitetaan tässä tuotetta, teknologiaa tai palvelua, jolla on pitkällä aikavälillä myönteisiä ja laaja-alaisia kerrannaisvaikutuksia yhteiskuntaan. Esimerkiksi mikroprosessorin keksiminen 1970-luvulla mullisti yhteiskuntaa nopeuttamalla edullisten kotitietokoneiden ja matkapuhelinten kehitystä.

Hankkeen nimi:
Universities, funding systems, and the renewal of the industrial knowledge base

Tekijät:
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Prof. Ahti Salo
Aalto-yliopisto

Aalto University
School of Science

Tekes
Ohjelmatoiminnan strateginen tuki

Tekesin Ohjelmatoiminnan strateginen tuki -yksikkö tuottaa innovaatioympäristöä palvelevaa tutkimusta teemakohtaisilla hauilla.

Johdanto

Radikaalit innovaatiot uudistavat tietopohjaa ja vauhdittavat taloudellista kasvua.

Radikaalit innovaatiot hyödyttävät yhteiskuntaa uudistamalla tietopohjaa, luomalla uusia markkinoita ja vauhdittamalla taloudellista kasvua (Tellis et al. 2009, Harris & Albury 2009). Ne voivat tuoda merkittäviä parannuksia nykyisten toimintamallien tai teknologioiden suorituskykyyn ja kustannustehokkuuteen tai luoda kokonaan uusia (Sharpe et al. 2013). Täten radikaalit innovaatiot ovat keskeisiä etsittäessä ratkaisuja niin kutsuttuihin 'suuriin haasteisiin', kuten ilmastonmuutokseen ja väestön ikääntymiseen.

Yritysten tutkimus-, kehitys- ja kaupallistamistyö sekä riskipääomasijoitustoiminta ovat avainasemassa radikaalien innovaation synnyttämisessä. Julkinen sektori voi puolestaan toimia radikaalien innovaatioiden rahoittajana yliopistoissa ja tutkimuslaitoksissa sekä t&k-intensiivisissä pienissä innovatiivisissa kasvuyrityksissä, joiden verrattain suuria rahoituskustannuksia saadaan vain osittain katettua riskipääomalla (*venture capital*; Hall & Lerner 2009). Eräs argumentti julkisten t&k-tukien puolesta onkin, että moni radikaaliin innovaatioon johtava idea jäisi muuten rahoittamatta (Kanniainen 2011).

Koska radikaaleihin innovaatioihin liittyy suuria epävarmuuksia, kokeilevasta rahoitusjaksosta voi olla hyötyä.

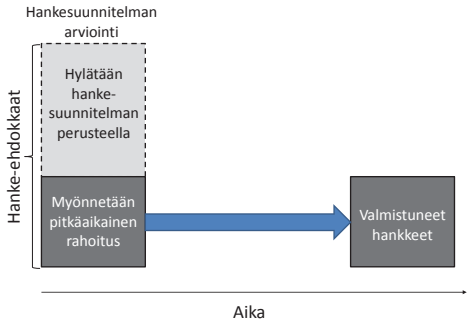
Pelkän projekti- tai liiketoimintasuunnitelman perusteella on käytännössä mahdotonta tietää, johtaako esitetty hanke radikaaliin innovaatioon. Tällöin saattaa olla hyödyllistä myöntää hankkeille ensin lyhytaikaista, kokeilevaa rahoitusta. Kokeilevan rahoitusjakson perusteella voidaan paremmin tunnistaa ne hankkeet, joilla on paremmat edellytykset johtaa radikaaliin innovaatioon. Myöntämällä jatkorahoitus vain näille hankkeille saadaan rajallisesta budjetista vapautettua resursseja uusien, lupaavien hankkeiden käynnistämiseen. Tällaisten vaiheittaisten rahoituskäytäntöjen on havaittu parantavan yritysten innovaatiomenestystä (O'Connor et al. 2008, Tellis et al. 2009, Klingebiel & Rammer 2011), ja ne ovat laajalti käytössä myös riskipääomasijoitustoiminnassa (Tian 2011, Li & Chi 2013). Tekesissä vaiheittaisia rahoituskäytäntöjä sovelletaan muun muassa julkisen tutkimuksen strategisissa tutkimusavauksissa.

Tutkimuksessa kehitetty analyyttinen malli auttaa vertailemaan eri käytäntöjä radikaalien innovaatioiden rahoituksessa.

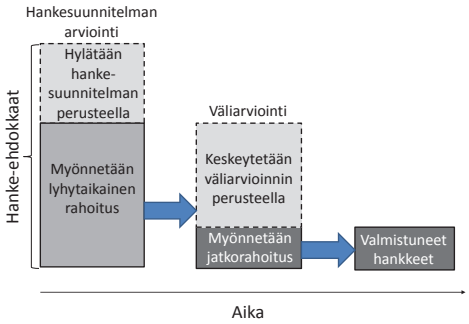
Tutkimuksessa on kehitetty päätösanalyyttinen malli, jolla voidaan tarkastella radikaalien innovaatioiden rahoituskäytäntöjä. Mallissa radikaaleja innovaatioita ovat vain kaikista parhaat, kokonaisarvoltaan suurimmat hankkeet, joskin tähän arvoon liittyy suuria epävarmuuksia. Malli ei oleta, että radikaalien ja inkrementaalisten innovaatioiden syntyprosesseissa olisi laadullisia eroja, eikä se myöskään ota huomioon eri tieteen- tai teollisuudenaloille ominaisia epävarmuustekijöitä ja aikajänteitä. Analyyttisella mallilla voidaan kuitenkin periaatteellisella tasolla vertailla, kuinka seuraavat käytännöt toimivat radikaalien innovaatioiden rahoituksessa (ks. kuvat 1 ja 2):

1. *Pitkäjänteinen rahoitus,* jossa alustavien arvioiden perusteella parhaille hankkeille myönnetään pitkäaikainen rahoitus,
2. *Vaiheittainen rahoitus*, jossa kokeilevaa, lyhytaikaista rahoitusta myönnetään suurelle määrälle hankkeita, mutta pitkäaikaiseen jatkorahoitukseen sitoudutaan vain niiden hankkeiden osalta, joilla on kokeilevan rahoitusjakson päätteeksi tehdyn väliarvioinnin perusteella potentiaalia johtaa radikaaliin innovaatioon.

Malli kuvaa yleisesti tilanteita, joissa pyritään tuottamaan arvoa asetelmassa, jossa valintoja on tehtävä epävarmuuden vallitessa ja rajallisten resurssien puitteissa. Täten mallin tulokset ovat soveltuvilta osin tulkittavissa myös yksityisten rahoittajatahojen näkökulmasta, joskin keskitymme tässä vahvemmin julkiseen sektoriin.



Kuva 1. Pitkäjänteinen rahoituskäytäntö



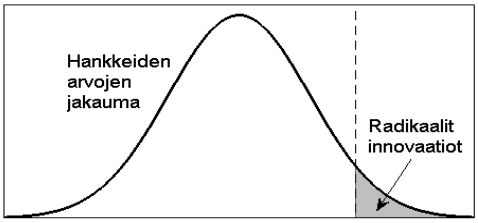
Kuva 2. Vaiheittainen rahoituskäytäntö

Tutkimus on tehty osana Tekesin ajalle 2012-2014 rahoittamaa innovaatiotutkimus-projektia ”Universities, funding systems, and the renewal of the industrial knowledge base”. Projektissa työskentelee tutkijoita Etlasta, Helsingin yliopistosta, VTT:ltä, Aalto-yliopistosta sekä University of Manchesterista. Aalto-yliopiston osaprojektissa on syntynyt kaksi tieteellistä artikkelia (Vilkkumaa et al. 2014a,b) sekä yksi väitöskirja (Vilkkumaa 2014).

Aineisto

Radikaalien innovaatioiden rahoituskäytäntöjä tutkittiin simuloimalla.

Mallissa hankkeen tuloksena syntyvää kokonaisarvoa (esimerkiksi tulosten kaupallinen arvo sekä liiketoiminta- ja työllisyysvaikutukset) kuvataan satunnaismuuttujana. Radikaalit innovaatiot tulkitaan hankkeina, jotka kuuluvat hankkeiden arvojen jakauman parhaimmistoon, esimerkiksi yhden prosentin häntään (ks. kuva 3). Tämä kuvastaa sitä, että vain varsin pieni osa on hankkeista voi johtaa radikaaleihin innovaatioihin (esim. 1 %). Toisaalta radikaalien innovaatioiden arviointiin liittyy epävarmuuksia, joiden takia rahoitettaviksi ei onnistuta valitsemaan arvoltaan suurimpia hankkeita. Näitä arviointiepävarmuuksia mallinnetaan siten, että päätöksentekijä ei tiedä hankkeen tulevaa todellista arvoa, vaan hänen on tehtävä päätöksensä sellaisen arvion pohjalta, joka poikkeaa tästä arvosta normaalijakautuneen satunnaisvirheen verran. Mallissa arvio tarkentuu hankkeen edetessä.



Kuva 3. Hankkeiden arvojen jakauma ja radikaalit innovaatiot

Rahoituskäytäntö määrää, miten rajalliset resurssit jaetaan kullakin rahoitusjaksolla (i) kokeilevan rahoituksen, (ii) pitkäjänteisen rahoituksen ja (iii) väliarviointien hankkimiseen liittyvien kustannusten kesken. Mallin avulla simuloidaan erilaisia rahoituskäytäntöjä ja tutkitaan, millaisilla käytännöillä radikaaleja innovaatioita saadaan rahoitettua mahdollisimman paljon. Erityisesti vertaillaan pitkäjänteisen (kuva 1) ja vaiheittaisen rahoituskäytännön (kuva 2) vaikutuksia rahoitettujen radikaalien innovaatioiden määrään.

Tulokset

Kokeilevaa rahoitusta kannattaa myöntää suurelle määrälle hankkeita, mutta jatkorahoitusta vain niille hankkeille, joilla on potentiaalia johtaa radikaaliin innovaatioon.

Mallin tulosten perusteella vaiheittainen rahoituskäytäntö on radikaalien innovaatioiden kannalta pitkäjänteistä käytäntöä parempi, sillä (i) kokeilevan rahoituksen myöntäminen suurelle määrälle hankkeita pienentää riskiä jättää radikaaleja innovaatioita rahoittamatta, ja (ii) päätös pitkäaikaisesta jatkorahoituksesta päästään tekemään tarkemman arviointitiedon valossa. Mitä epävarmempia hankesuunnitelmaan perustuvat arviot ovat, sitä enemmän resursseja kannattaa käyttää kokeilevaan rahoitukseen joko (i) pidentämällä kokeilevaa rahoitusjaksoa, jos arviot tarkentuvat hitaasti (esimerkiksi innovaatioprosessin alkuvaiheen hankkeissa) tai (ii) käynnistämällä useampia hankkeita, jos arviot tarkentuvat suhteellisen nopeasti (esimerkiksi kaupallistamisvaiheen hankkeissa).

Vaiheittaisessa rahoituksessa moni hanke keskeytetään, mikä osaltaan alentaa hankkeista saatavaa kokonaisarvoa. Tämä keskeyttämisiin liittyvä riskinotto on kuitenkin tarpeen, jos tavoitteena on luoda edellytyksiä lukuisten hankkeiden alkuvaiheen rahoitukselle, jotta kokeilevan rahoitusjakson piirissä on enemmän potentiaalisia radikaaleja innovaatioita. Jos hankkeita käynnistetään vain vähän, on todennäköistä, että radikaaleja innovaatioita jää rahoittamatta. Jos taas hankkeita käynnistetään paljon, niistä suuri osa on myöhemmin keskeytettävä resurssien rajallisuuden takia. Kanniainen (2011) toteaa, että radikaalien innovaatioiden ”astronomisista tuotoista” johtuen riski jättää hyviä hankkeita rahoittamatta on kohtalokkaampi kuin riski rahoittaa jonkin aikaa sellaisia hankkeita, jotka eivät lopulta johda radikaaliin innovaatioon.

Mitä hitaammin arviot hankkeiden potentiaalista tarkentuvat, sitä pidempi kokeilevan rahoitusjakson tulee olla.

Mitä enemmän resursseja käytetään kokeilevaan rahoitukseen, sitä enemmän hankkeita saadaan käynnistettyä, mutta toisaalta sitä vähemmän resursseja on käytettävissä parhaiden hankkeiden pitkäaikaisen jatkorahoituksen varmistamiseksi. Kuitenkin juuri pitkäkestoinen rahoitus on edellytys radikaalien innovaatioiden syntymiselle (Heinze 2008, Azoulay et al. 2011). Innovaatiotoiminnan haasteena onkin löytää tasapaino kokeilevan ja pitkäjänteisen rahoituksen välillä. Tämä tasapaino riippuu kulloinkin tarkastelun kohteena olevan hankkeen epävarmuustekijöistä; erityisesti siitä, kuinka epävarmoja hankesuunnitelmaan perustuvat hankkeen arvoa koskevat arviot ovat ja miten nopeasti nämä arviot tarkentuvat. Päätöstä hankkeen keskeyttämisestä ei ole kannata tehdä ennen kuin arviot ovat kyllin tarkkoja. Joissakin tapauksissa lupaavia tuloksia voidaan odottaa jo esimerkiksi puolen vuoden kuluttua, mutta toisinaan tässä voi kestää useita vuosia. Täten tarkempien toimenpidesuositusten laatiminen vaatii tuekseen laajempaa empiiristä analyysia.

Pitkäkestoisten hankkeiden tavoitteet tulisi määrittää joustavasti.

Mitä hitaammin arviot hankkeen potentiaalista tarkentuvat, sitä pidemmäksi ajaksi rahoitusta tulisi myöntää. Tilanteissa, joissa arviot tarkentuvat erittäin hitaasti (esimerkiksi täysin uudenlaisia ideoita ja lähestymistapoja kokeilevissa tutkimushankkeissa), onkin syytä soveltaa pitkäjänteistä rahoituskäytäntöä. Tällaisissa tapauksissa voi olla perusteltua myöntää rahoitusta ei niinkään hankesuunnitelman vaan hankkeen toteuttajien aiempien ansioiden perusteella, joista on usein saatavilla enemmän tietoa. Vaiheittaista resurssienjakokäytäntöä voidaan tällöin soveltaa yksittäisen hankkeen sisällä (i) testaamalla hankkeen alkuvaiheessa monia erilaisia lähestymistapoja ja (ii) luopumalla nopeasti sellaisista lähestymistavoista, jotka eivät osoittaudu hedelmällisiksi. Tällaisen toimintatavan soveltaminen edellyttää, ettei hankkeen toteutustapaa ole hankesuunnitelmassa lyöty liian tiukasti lukkoon.

Edellä kuvatun kaltaista rahoituskäytäntöä sovelletaan esimerkiksi biolääketieteelliseen tutkimukseen erikoistuneessa Howard Hughes Medical Institutessa (HHMI). HHMI-hankkeissa syntyykin merkittävästi enemmän tieteellisiä läpimurtoja kuin tutkimushankkeissa keskimäärin, mikä heijastuu esimerkiksi tieteellisten huippujulkaisujen (eniten viittauksia saanut prosentti) keskimääräistä 96% suuremmassa lukumäärässä (Azoulay et al. 2011). Hankerahoitusperiaatteiden, joissa uusien lähestymistapojen testaamiseen rohkaistaan ja alkuvaiheen epäonnistumisia siedetään, on osoitettu luovan kannustimia tieteellisten läpimurtojen löytämiseen myös peliteoreettisten mallien valossa (Manso 2011).

Innovaatiopolitiikan haasteet

Tärkeää löytää tasapaino kokeilevan ja pitkäjänteisen rahoituksen välillä

- Tasapainon löytäminen kokeilevan ja pitkäjänteisen rahoituksen välillä.
- Eri teollisuuden- ja tieteenaloille ominaisten epävarmuustekijöiden ja aikajänteiden kartoittaminen.
- Kokeilevan rahoitusjakson sopivan pituuden määrittäminen tapauskohtaisesti.
- Kokeilevaan rahoitukseen sopivien, kevyiden hallinnollisten prosessien kehittäminen.

Toimenpide-ehdotukset

Pienimuotoista, joustavaa rahoitusta tulisi olla saatavilla.

Kaikkia resursseja ei kannata sitoa pitkäkestoisiin hankkeisiin

- Pienimuotoista, kokeilevaa rahoitusta tulisi olla saatavilla kevyillä hakuprosesseilla.
- Kokeilevan rahoitusjakson pituus tulisi määrittää siten, että päätökset hankkeen rahoituksen jatkamisesta tai keskeyttämisestä perustuvat kyllin tarkkaan tietoon hankkeen potentiaalista.
- Lupaaviksi osoittautuville hankkeille tulisi pystyä takaamaan pitkäkestoinen rahoitus.
- Pitkäkestoisten hankkeiden tavoitteet tulisi määrittää joustavasti siten, että uuteen tietoon ja muuttuviin olosuhteisiin kyetään reagoimaan ketterästi.
- Kaikkia resursseja ei kannata sitoa pitkäkestoisiin ohjelmiin tai hankkeisiin.

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