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Industrial Engagement of University Research

Terttu Luukkonen is Chief Research Scientist at the Research Institute of the Finnish Economy (terttu.luukkonen@etla.fi).

Duncan A. Thomas is Research Fellow at Manchester Institute of Innovation Research, Manchester Business School, University of Manchester, UK (Duncan.Thomas@mbs.ac.uk).

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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).

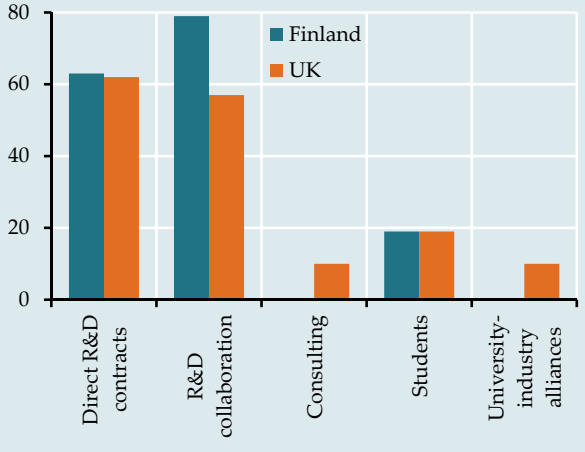
Direct subcontracting by firms for university researchers to conduct R&D was a major interaction form (60% of interviewees in both countries). Subcontracting restricts the researchers' choices most since the subcontracting company defines the task in detail and a major motive for researchers to be engaged 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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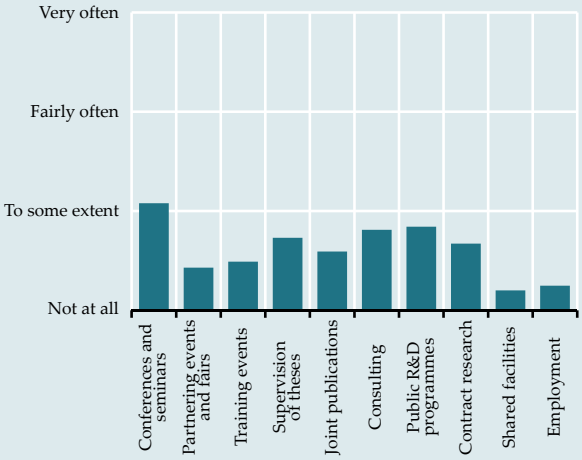
3 Extent of contacts with companies; research group leaders



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

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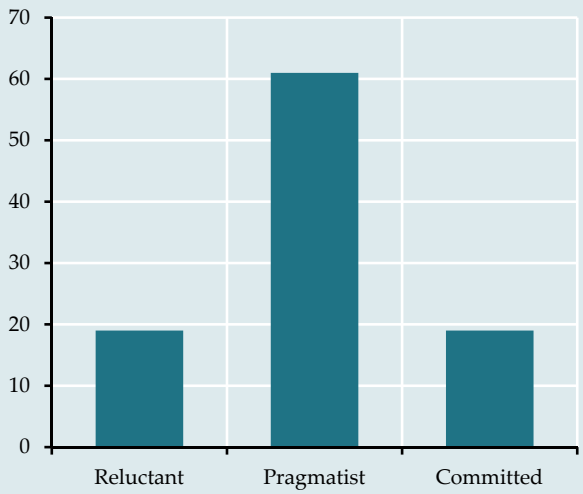
4 Researcher orientation in UNI data



Note. N=62.

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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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