

Theme 4. Universities as interactive partners

Far from an Ivory tower: Researchers as enablers of commercialization

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Introduction:

Academia's changed role has been widely discussed after the introduction of 'the third mission'¹. Going from a provider of education and research to actively cooperate with actors in society has put new pressure on universities. New expectations have evolved of universities as 'engines of innovation' (Lester, 2005) contributing to future economic growth. This new role has challenged 'the Ivory tower', a common metaphor for an isolated academia conducting "blue sky" research disconnected from practical use (e.g. Etzkowitz et al. , 2000). Instead concepts like 'academic entrepreneurship', 'the entrepreneurial university', 'triple helix' and 'the knowledge triangle' have become of vital interest.

Despite many diverse ways for academia to cooperate with society and utilize research (Jacobsson and Perez Vico, 2010) commercialization has generally been interpreted as the university's new mission and future challenge. University-spin offs, patenting and licensing have been emphasized, while less visible commercial use of university knowledge has received little interest so far. According to Rasmussen, Moen and Gulbrandsen (2006) one of the main reasons for the focus on university spin-offs (USOs) is that they represent a visible output of university activity. Start-ups are to some extent possible to measure in terms of frequency, outcome and employment figures. Especially the ones emerging within the universities' formal innovation support systems (ISS) are visible and often promoted as success stories. USOs are obviously one of the universities' few evident receipts for their contribution to economic development.

¹ sometimes called "third task"

In Sweden, with the Teacher's Exemption², an invention at university is owned by the researcher, and consequently the option to commercialize it is the researcher's not the university's. Researchers holding patents, or making use of research results in other ways, have no duty to inform their university. Commercialization of academic research is thus partly out of the Swedish universities' control. The American model is in contrast very different, with the Bayh-Dole Act giving universities ownership of intellectual property arising from federal government-funded research. With universities directly responsible for the commercialization of their research findings as in the US, the possibility to be aware of the commercial outcome from research increases. Notwithstanding, Fini, Lacetera and Shane (2010) found in their large survey of university professors in the US that 2/3 of academic entrepreneurship took place outside the intellectual property system and was therefore unknown. Consequently, the depth and breadth of academic entrepreneurship is underestimated. Markman, Gianiodis and Phan (2008) found that 42 % of the scientists had bypassed their institutions at least once and many technologies are therefore "going out the back door". Accordingly, knowledge about the commercial outcome from academic research is limited and also when direct involvement of the university is regulated it partly takes place outside the system.

The Swedish Academic Paradox holds that relatively large investments in academic research do not sufficiently contribute to innovations, economic growth and competitiveness (Bitard, Edquist, Hommen and Rickne, 2008). The relevance of the paradox has however been questioned pointing out that the utilization of research is too narrowly measured in patents, licensing and spin-off companies (Jacobsson, Lindholm-Dahlstrand and Elg (2013); Lindholm Dahlstrand (2008) and Jacobsson and Rickne, 2004). By studying Swedish biotech cases,

² also named the Professor's Privilege

Nilsson, Rickne and Bengtsson (2009) tries to uncover the “grey zone”, concluding that the ways and reasons academic research is transformed to society are much more diverse and multifaceted than is usually measured. Within nanotechnology, Perez Vico and Jacobsson (2012) identified a range of ways academic R&D indirectly influenced commercialization.

Despite increasing interest in the payoff from academic research to society there is still a gap in research regarding a broader range of commercial effects generated from academic research. So far research has focused on researcher’s USOs and IP-rights (e.g. Rothaermel et.al, 2007) probably in part due to the difficulty to capture and measure other outcomes.

There are therefore reasons to believe that the commercial effects of academic research are understated. In Sweden with Teacher’s exemption the ownership and responsibility to commercialize is relying on the individual researcher, therefore her/his view upon utilisation and commercialisation becomes vital for if, how and by whom research should be commercialised. This might provide a broader variety of possibilities of commercialization than when universities have ownership and are responsible for the commercialization. This study will contribute to fill the gap in research by visualizing other less obvious ways of commercializing than is usually in focus. The gap in existing research of indirect commercialization will be reduced and our understanding of the payoff from academic research increased. The purpose of this study is to explore and visualize how and by whom academic research can come to commercial use without researchers’ direct involvement in the commercialization.

The remainder of this paper starts with a brief literature review divided into the concepts of utilization, collaboration and commercialization. After a description of the chosen method, the results from the interviews are presented. My findings are structured into three parts; influence from a university culture of collaboration, views upon utilizing versus commercialization, and last a diversity of indirect commercialization ways are described. This

is followed by discussion and conclusions including some directions for further research.

Policy implications finish the paper.

State-of-the art

Utilization

From a national policy level it is a natural choice turning to academic research when looking for growth, renewal and competitiveness. Universities host valuable assets of new ideas and highly educated people (Lester, 2005). Preferable within the technology area, research has shown to be a main source of innovations (Blanco, 2007). But not until it is used, exploited and diffused, will employment and economic growth be created (Robert and Easley, 2009). Policy-makers in Sweden as well as in many other countries have therefore taken initiatives aimed to increase the rate of commercialization of university technology. Innovation support system (ISS) and Technology Transfer Offices (TTOs) have appeared around universities. Focus has so far almost exclusively been on supporting University Spin-Offs (USOs) or Intellectual Property Rights (IP). Academic research can however come to commercial use in a diversity of ways not necessarily by researchers' direct involvement in the commercialization.

The spin-off phenomenon is accordingly just one out of many ways to be entrepreneurial at the university and one out of many ways to commercialize academic research. Klofsten and Jones-Evans (2000) make broad definition of academic entrepreneurship meaning that all commercialization activities outside of the normal university duties of basic research and teaching could be named entrepreneurial, including all other external contacts with the industry. Jacob et al., (2003) suggest that the concept of academic entrepreneurship can be used more widely than to describe academics commercializing the knowledge they produce through a start-up. However, academic entrepreneurship is often understood as: *'Development*

and commercial exploitation of technologies pursued by academic inventors through a company they (partly) own' (Perkmann and Walsh, 2007, p. 262).

Not only at a policy level but also research about “the entrepreneurial university” has mainly focused on comparably easy measurable interactions such as researchers patenting, licensing and researchers’ USO (e.g. Rothaermel et al., 2007). Other forms of collaboration and the outcomes of it have been left in the background. Even if academics collaboration with industry is not a new phenomenon the discussion about it has become of renewed interest after the introduction of “the third mission”. In Sweden, The Higher Education Act of 1997 gave universities “the third mission” to promote knowledge dissemination to the general public. Naming this desired cooperation the ‘third mission’ gave the impression that this was something new that should be added to the traditional tasks of education and research, which might hence have hindered the intended interaction with society (Wahlbin and Wigren, 2007). Thus, a pure responsibility to communicate research results from university to society and industry has been translated too narrowly and interpreted as engaging in commercial activities (Jacob et al, 2003).

Universities as organizations have accepted their new task and embraced economic and social development as a new mission (Etzkowitz et al., 2000). Ocular evidence is innovation support systems created at universities in the last few decades aiming to promote commercialization, foremost in terms of USO. Eager to show result of their new task successful USOs are lifted forward, which generate goodwill that will benefit the university in the future (Sine et al., 2003; Rasmussen et al., 2006). Sine et al. (2003) show how prior success stories are important for institutional prestige as well as for future actions. Incidences of successful commercialization demonstrate feasibility and provide role-models (Wright, Birley and Mosey, 2004). Role models can inspire others and are known to be of catalytic importance for new start-ups. However, one main reason for a university to focus on commercialization in

terms of USOs instead of collaborating with existing firms, is that USOs constitute a visible output of university activity (Rasmussen et al., 2006). Yet, universities can only keep record of the USOs inside the formal ISS system. There are reasons to believe that many start-ups take place out of universities control whether the Bayh-Dole Act (i.e. Fini, Lacetera and Shane, 2010; Markman, Gianiodis and Phan, 2008) or Teacher's exemption are valid.

Visualizing other ways to communicate research results from university to society is more difficult. Jacobsson and Perez Vico (2010) describe seven activities from academic research: only one of these directly includes commercialization. The other six activities are conducting research, scientific publishing, educating, providing direct guidance, providing research infrastructure and networking. Among the 19 specified sub-activities they mention three are connected to commercialization namely a) creating new firms, b) patenting and licenses and c) creating new products, processes and services in existing firms without a patent or license agreement. All of the other activities can however indirectly influence commercialization.

Knowledge diffusion is hard to follow, and many existing firms are influenced from more than one knowledge source why establishing the connection can be more or less impossible. Perkmann, Neely and Walsh (2011) discuss the difficulty in measuring the performance of university-industry alliances due to a) outputs are often intangible and hence not amenable to direct measurement b) project outputs are likely to be complex c) benefits may be realized only over a long time horizon d) there is a problem of deciding how performance should be judged and compared in terms of reference values or targets.

Although universities' collaboration with industry and society not are a new phenomenon, the expectations of academic entrepreneurship as an outcome are. Calling upon academic researchers to take direct part in commercializing their research has been questioned and caused discussion within academia. Views reaching between a united entity and close ties of

universities, industry and government (Etzkowitz and Leydesdorff, 2000) to academic–industry involvement that restricts academic freedom and autonomy, or academic research that should be curiosity driven without commercial gain. Rarely a more nuanced picture of a two-fold beneficial cooperation is discussed.

Collaboration

Collaboration with industry is regarded as important for academic entrepreneurship by linking academics to business environment. Research conducted in collaboration with industry is therefore regarded as a potent source of innovation. The individual researchers' motive to interact with industry is however different since they often collaborate to benefit their research instead of having potential own commercialization in mind. D'Este and Perkmann (2010) examined what motivates academics, within physical and engineering sciences in UK, to engage with industry. The large sample of researchers' main reason was to further their research, while to commercialize their knowledge was considered least important. All three main interaction channels namely a) collaborative research, b) contract research and c) consulting, were found to be motivated by research related motives. From their engagement with industry academics gain learning opportunity, new insights, receive feed-back on research and access to new knowledge as well as securing funds for graduate students. In Lam's (2010) study researchers' reported expected outcome from interacting such as; increase research resources, exploit research results, create opportunity for knowledge transfer, build networks, enhance the visibility and at far last, increase personal income. Perkmann and Walsh (2009) found that applied projects in engineering enable exploratory learning, lead to new ideas and new research projects. Engaging in multiple relationships with industry and close collaboration was especially favorable. Joint research resulted in academic publications and the academic researchers were often able to benefit their production of scientific research.

By studying the actual “give-and-take” outcomes between university faculty members and industrial firms, Lee (2000) reports significant support from scientists for industry collaboration. The scientists’ reason was mainly to get new insights into their own research. Academics especially in engineering and the applied sciences have been found to be keen on technology transfer activities but less on commercial activities such as start-up (Lee 1996). In Wahlbin and Wigren’s (2007) survey where close to 10,000 respondents at 19 Swedish universities participated, most faculty members reported a positive effect on their careers from cooperation with surrounding society. Wigren-Kristoferson et al, (2011) conclude that a group of high-performing researchers engage in research, commercialization and public dissemination activities to a higher degree than the rest of the sample. The reason for this was to further their research activities, a sense of duty and because they enjoyed it and felt a responsibility to diffuse knowledge and not because of commercial or financial reasons. Some disseminate knowledge by working with policy advisors. A virtuous cyclical model was understood where excellence production and diffusion of academic knowledge are interconnected (Wigren-Kristoferson et al, 2011).

The most significant benefit for industry is an increased access to new university research and discoveries, which is usable in e.g. developing new products / processes / patents, solving technical problems, improving product quality, reorientation of R & D agenda, recruiting students (Lee, 2000). Perkmann, Neely and Walsh (2011) suggest that companies engage in collaborative research with universities because they a) seek to leverage their R&D funding, b) are keen to access basic scientific knowledge c) aim to improve their problem-solving capability through university advice and assistance in ongoing R&D programs d) capture new techniques and instruments that enable industry to develop new technologies. Perkmann and Walsh (2009) study conclude that collaboration is favorable for both industry and academia but not necessarily concerning commercialization of university-developed technologies

converted into commercial applications in new products. In most of the cases academics was instead contributing to already ongoing projects within firms, providing industry with input to commercial problems without any own commercial interest in the innovations. Interaction resulting in mutual learning opportunities and a fruit-full cross-fertilization can very well result in commercial outcome even if that is not the academics motives for working with industry. The pure fact that industry does maintain their relationship with universities and engage with academia is certainly proof that they are commercially gaining from it. Besides, it is not only industry that will be influenced by academia but the role of the university system will in turn be renewed and also affected by feedback loops from industry and society (Rothaermel et al., 2007).

Commercialization

Engagement in collaboration is far more frequent than in academic entrepreneurship. Startup activities is still a relatively marginal phenomenon among academics (D'Este and Perkmann, 2010). Universities' efforts to promote direct USOs might cause changes in the local university culture but there is little evidence for this so far since it is a long term process to change norms, attitudes and values. Eventually, a more positive attitude towards entrepreneurship can be expected when an accelerating number of role models will be present. Bercovitz and Feldman (2008) point out the importance of local entrepreneurial norms in the close work environment and the importance of engagement from the chair of the department. Observing other faculty members taken active part in commercialization is important and show how individual actions influence organizational change. The likelihood of knowledge transfer is partly explained by the social context. Using social ties between actors help to overcome problems, enhance trust, and facilitate information transfer. Not only work values but also group norms are important and an enterprising faculty means more than formal

university policy actions. The likelihood for faculty's commercialization increase therefore at institutions that have a long established and successful technology transfer. Individual behavior will be influenced by prior learning but even more by physical or professional proximity within the existing organization (Bercovitz and Feldman, 2008).

Most studies use university level factors to explain why academics engage in entrepreneurial activity (Clarysse et al., 2011). According to Shane, (2004) research has identified characteristics of universities that influence the rate of spin-off formation across universities. These include the university culture, the presence of entrepreneurial role models, the intellectual eminence of the institution and the source and nature of research funding. On an organizational level universities seems to cope with the ambidexterity and the dual focus and demands of academic research respectively commercialization (Ambos et al., 2008).

Conflicting goals that should be handled at the same time can be managed by dual structures separating the tasks and allowing people to work single minded. Ambos et al., express however concerns that universities as organizations manage to balance the delicate matter of conflicting demands more effectively than the individual. Individuals do not respond uniformly to institutional changes in their environment (Lam, 2010).

The researcher's individual motivation to engage in commercial activities is vital (Ambos et al, 2008) and should not be forgotten when universities are busy responding to new expectations. No matter how many business opportunities academic research provide, or massive support system created at universities, first and foremost the individual plays a crucial part. People's willingness to become entrepreneurs cannot be neglected (Locke, 2000), especially not in Sweden with Teacher's Exemption. Lundström and Stevenson (2002) argue that not only opportunity but also motivation and skills are needed for start-up. Certainly, motivation can be influenced; skills can be learned, but there will always be individual differences in the decision to exploit entrepreneurial opportunities (Shane and Venkataraman,

2000, Aldrich and Zimmer, 1986, Shane, Locke and Collins, 2003). It is essential to consider both the presence of opportunities as well as enterprising individuals willing to exploit the opportunities. The individuals' desire to become involved in commercialization must be taken into account. A reluctant entrepreneur pushed by organizational expectations will probably lack the entrepreneurial passion that is needed. Klofsten and Jones-Evans (2000) question the academics desire to learn the new competences required to manage a spin-off instead of using their existing skills and experience in the context of industry. Clarysse, Tartari and Salter (2011) conclude individual-level attributes such opportunity recognition capacity and prior entrepreneurial experience as being the most important. Social environment surroundings also plays an influencing role, existing TTOs are however of less importance for starting new ventures. They question universities using a lot of resources on ISS but not much effort on recruiting entrepreneurially oriented individuals to an academic career.

Entrepreneurship is not only firm creation, but it can also occur in existing organizations. Opportunities can also be transferred to other individuals or organizations. Franklin, Wright and Lockett (2001) show that universities with a positive attitude to surrogate (external) entrepreneurs show most start-ups. Sometimes individuals outside the university might be better suited to exploit the opportunity than the academic first identifying the innovative opportunity. That person might lack the skills and resources necessary for commercializing the project. Franklin et al. suggest a combination of academics and external entrepreneurs as the best approach. Also Wright, Birley and Mosey (2004) question to what extent researchers themselves in general are equipped to identify market opportunities irrespective of how entrepreneurial they can be in identifying new research areas and source of funds. People engaging in commercialisation have a different mind-set from those who are accustomed to produce academic outcome. Researchers, used to work and think academically and thus differing from the market's demands on customer focus, might be disadvantaged in becoming

entrepreneurs. They might lack the skills and endurance needed for pursuing commercial output.

Locke (2000) points out that human action is a result of motivational but also cognitive factors like ability, and skills. Creating an independent company is complicated and a serious challenge with a long time horizon before possibly positive cash-flow. Jain et al. (2009), studying role identification among academics involved in commercialization, conclude that it is important for academics to continue to identify themselves first and foremost as academics even after an entrepreneurial experience. They will normally continue with the research, sometimes having a consultancy arrangement with the commercial company (Wright, Birley and Mosey, 2004).

According to Lam (2010) the role of the individual and their diversity and has been neglected in earlier research. In the societal and organizational process the individual researcher is assumed to have accepted an inevitable process towards an entrepreneurial university, but most scientists are trying to shape their own boundary between science and business. Not only traditional orientated academics but also entrepreneurial types have always existed within universities but the recent changes in society and legitimacy are influencing the old values. Most academics are trying to bridge across positions, handle both the contradictory roles, cope with institutional pressure and expectations and are influenced by changing values. After investigating these “new school” entrepreneurial scientists, Lam (2010) points out, that academics are anxious to create relationships between business and science in order to balance their new role identities.

Methodology

This study uses Chalmers University of Technology as a case. There were several reasons for this. First of all, Chalmers is known for its long tradition of close cooperation with industry and society. Secondly, Chalmers has been acknowledged as being in the front line in Sweden for entrepreneurial activities, for example through Chalmers School of Entrepreneurship.

Thirdly, Chalmers has a long history of distinguished technological research, which provides good opportunities for commercialization. Finally, since 1994 Chalmers has been a private university (owned by a foundation) with increased freedom and action space compared to in Sweden traditional public-owned universities.

On one hand, a university of technology provides homogeneity apart from universities with a larger variation among disciplines. On the other hand, the prerequisites are quite different at the 17 departments of Chalmers not only in the share of research compared to education but also in how to cooperate with the surrounding society. Some departments can be regarded as more likely to commercialize their research findings than others with different alignment.

Two of the 17 departments were chosen for an in-depth study namely the department of Energy and Environment respectively Civil Environmental Engineering. Neither of them is known for commercial activity, which is suitable when the aim is to capture less obvious commercial effects of research. Choosing extreme cases is appropriate in an open-ended exploratory study (Seawright & Gerring, 2008).

To meet the aim of this paper, in-depth detailed information was required in trying to capture less obvious indirect commercial effects from research why interviews were considered as the best way. After an initial pilot interview, seventeen individuals in various positions at Chalmers were chosen for interviews. As a first stage eight key persons involved in the formal Innovation Support System were interviewed in November and December 2009. In the next step nine interviews were performed between May to November 2010 including heads of the

two departments and researchers. Most individuals were identified with a snowballing technique, each respondents being asked about other suitable individuals to interview. The interviews were made face-to face, except one made by telephone. Most interviews took place on the premises of Chalmers and lasted between one to two-and-a-half hours. The interviewer documented the event in detailed notes, which were later the same day written up into minutes.

The data collection relies mainly on a mix of semi and non-structured interviews. Intending to explore new information of the commercialization phenomenon, the interviewees were allowed to speak rather freely. Each interview started with an open question; how research was commercialized at Chalmers. The respondents gave in general an impression of being notable familiar and engaged in the issue and eager to pass on their views, that appeared to be well thought-out and usually at great length. After that, more detailed questions were supplemented like: their knowledge of how their own and/or colleagues' research had come to use in industry or society, if they could give concrete examples of this, their knowledge of USOs at the department or by others like students, consultancy activity and, their view of utilizing, collaboration and commercialization, etc.

By my participation in events like the Chalmers Energy Day, there became opportunities to ask questions to representatives from industry about their brief perspective on their collaboration with Chalmers and their benefits from Chalmers' research. They were also asked about the reason for their participation at the present occasion. My presence at coffee table discussions and informal conversations at the two departments made it possible to bring up the question about commercialization and capture additional valuable information.

Findings and interpretation

A culture of collaboration

The university culture at Chalmers is characterized by a long tradition of cooperation with industry. From the very beginning (founded 1829) it was natural to serve industry, illustrated with the following quote:

“By tradition the professors in the old days were functioning as consultants through their socializing in town” said the former president Sven Olving, himself a board member of several large companies during his presidency (1974 -1989).

Or as one researcher at the Department of Energy and Environment expressed it;

“We are as far from an Ivory Tower as possible”

The history has formed the foundation. From the very beginning it was a clear intension that science should be useful for enterprises. Chalmers has still this friendly view upon commercialization and an unusually close collaboration with the business world. This strong tradition to cooperate with industry imbues the university, many respondents are, eager to point out the reciprocity, that cooperation with industry are mutual beneficial and involves both giving and taking.

Some comments captured at the interviews about the academic benefits were that:” *it brings the creative eye of others from outside*”; *“helps to find new solutions”*; *“it gives suggestions to new research idea”*”; *“ help us to define research projects”*; *“gives synergies into our research”*; *“gives attention from media which strengthens our trade mark”*; *“they inspire to research ideas that are relevant in society.”*

The collaboration being mutual beneficial was described as:

“It’s important that our work comes to use, have relevance, are carried out in a context, it is about give and take”

“Companies do participate in research fund applications and projects, this alone is a proof on that they are gaining”, as one researcher stated. Another said:

“The collaboration companies get the advantage of having access to new knowledge before other companies”.

It is evident that companies taking part in collaboration belong to the network.

”Everything happens in the network, creating new relations take too long time”

The alumni network around Chalmers is known for being unique. Chalmers’ Alumni Association have over 35 000 members from students of today to former ones who are still identifying themselves as “Chalmerists”. Many have today prominent positions in society and industry and are natural collaboration partners. “Chalmerists” are sharing the same educational back-ground, are colored of the same university culture, and are ‘speaking the same language’ which facilitate trust and favour interaction.

It was found that arrangement and events at Chalmers are functioning as a meeting-place where former students tend to return. At Chalmers Energy Day researchers within the energy area present their research for participants from industry and society. When asked about their reason to attend, three main answers appeared; a) to keep up with the latest research, b) to keep the channels to the university open in order to know where to call and c) to maintain their alumni net-work. These questioned listeners from industry also testify that they often are alone in their professional position at their companies and therefore needed to meet colleagues for mutual learning. The interviewed researchers at Chalmers verified that Alumni employed in industry as well as from public authorities frequently called with questions and in this way

got access to new knowledge and free guidance. Alumni are beneficial also for their old university and are used in the organization as important links to collaborating companies, in research projects, supervising PhDs and employers of students. Alumni keeping in contact with their old university are of mutual benefit and both parts seem anxious to maintain the strong ties between industry and university facilitated through former students.

Utilizing vs. Commercializing

Chalmers University of Technology might appear as homogeneous, the main discipline being engineering science, which is usually connected to a pragmatic view. The strong belief that research should be utilized is clearly a part of the university culture as following quote from the interviews witness:

“That research should come to use in society was clear from the very beginning”.

Other explanations to the strong tradition of utilization were: the industry anchorage, the view from a pragmatic engineering school, the focus on solving problems and, on relevance.

Despite this dominant characteristic of utilizing, different views on commercialization of research were captured:

” When we publish more people can benefit from the research. Commercialization can limit the utilization.”

“It’s not only about commercialization, research influence society; we can contribute in other ways.”

“Utilization of research is so much more than commercialization. Also other ways are valuable, not only USOs”.

“Researchers are inspired to find useful solutions to problems, their reward are the interplay with industry/reality. They do not think of business as in the US, they do not think of commercialization, they want to conduct research and publish”.

“To commercialize through our cooperating companies are all right as long as it comes to everyone’s good. We shouldn’t restrict our results for the broad mass of people, which often happens at commercialization. Research should be to the benefit of all of us.

“Our research is used as a base for new products in big companies. Chalmers’ tradition of collaboration is long and close”.

“Researchers are driven by developing knowledge, not doing business.

As the above quotations show, utilizing appear to be extremely important for the respondents, collaboration found as mutual beneficial, own commercialization seemed of little interest, others’ accepted it if it didn’t limit the benefit of the broad mass in society. As long as the research comes to use in society it didn’t really seem to matter by whom. The academics interviewed showed little desire for entrepreneurship, letting the collaboration companies use the new knowledge as they liked. Some expressed that far from everything was possible to commercialize in a new company, that there were other more suitable ways like in already existing companies. With utilizing in focus for the researchers, they gladly shared their knowledge to others which enabled them to commercialize.

How and by whom - A diversity of ways

Despite a variety of possible ways to commercialize academic research two was dominating during the interviews, namely through start-ups within the formal ISS at Chalmers and through established collaboration companies.

“Chalmers’ tradition to help and serve industry is used to get free help and advice”..

“Companies don’t want to pay for research in Sweden. They are surprised that research costs. Industry is not used to pay for research close development in Sweden.”

PhDs financed from industry was described as “internal missionaries” and for industry an effective channel to get access to research possible to apply. Some respondents put into words that commercialization often happened through industry ‘pinching’ university staff. That many develop their competence at university and then take the step out in industry or consultancy. After a research project the senior researchers usually went back to academia while the PhD student became employed as project managers in the company after having completed their PhD. Doctoral students financed from industry are common at Chalmers and a way to combine excellent research with application. Besides, industry gets access to equipment in the labs.

“They gladly fetch PhD students but they do not want to pay for research and service from the academia. They have direct channels in. This is NOT bad business for industry!”

Indirect commercialization, no matter how frequent, is diffuse and delicate to prove. The respondents at first hand associated commercialization with direct commercialization in USOs equivalent to the usual translation in research and policy. Above all, the front figures and some success-stories within the formal ISS were well-known as well as and Chalmers School of Entrepreneurship (CSE), where research ideas are linked to student entrepreneurs. Beyond that, the knowledge of other start-ups outside the ISS was limited.

One explanation for the shortage of USOs at the two studied departments was the source and nature of research regarded as not being possible to ‘productify’. It was pointed out that other departments had other prerequisites more suitable for start-ups and that some others also interacted more directly with industry. The Department of Energy and Environment is

working closely with authorities, developing standards and regulations. For the Department of Civil and Environmental Engineering trade associations and institutes are important collaborators. Some respondents lifted forward that different departments have different views on commercialization and utilizing. At some departments it is tradition to utilize through industry but at Energy and Environment the drive to improve the environment is dominant. At Civil and Environmental Engineering the research comes to use in society indirectly through the trade associations passing it forward to members. Notwithstanding, research comes to commercial use in existing companies and thereby contributes to growth and renewal, rather than giving birth to new start-ups. Companies' involved in research projects get the advantage of new knowledge before competitors.

Another way to enable and facilitate for existing firms in their commercialization is through consultancy firms. Examples of how research had spun off and given birth to external consultancy firms were given. Faculties own consultancy firms emerged eventually, due to if they were regarded as 'private business' or consultancy not being counted for as commercialization is hard to say. Another possible reason might be that staff is insecure about what is eligible and beyond departments' normal service of providing free advice or direct guidance. The researchers had clearly influenced each other's consultancy start-ups in the close working environment.

Not only difference in the nature of research influence but also norms in the close working environment. Both heads of the departments recollected a few old USOs originating from their departments. One meant that today there wasn't time for creativity outside demanding academic positions. In case it still existed, it belonged to the employee's private sphere. The other head of department was anxious to separate utilizing from commercializing. Utilizing regarded as a very strong drive at the department, commercializing as restricting the benefit of everyone.

The researchers showed some confusion with respect to their own possible commercialization. Not only was it about how to prioritize their time for the different tasks but also if engagement in commercial activities might compete with their employment or would pay-off in their careers. What was permitted and eligible from the organization seemed unclear resulting in individual confusion on how to handle the demands on commercialization. A general positive attitude to commercialization is present but without direct encouragement from department management or visible entrepreneurial role models in the close working environment, the choice to let others do the commercialization is natural. Researchers are well aware of that their competence and desire are different.

The researchers appeared satisfied in knowing that they created value for society. They seemed well aware and united in that the societal benefits from research were so much more than creating USOs. Their research came to use in a variety of ways. Sometimes it was implemented in established industry, where their advices played a crucial part when new products were created and thereby they indirectly created employment opportunities. However, they couldn't give details about exactly how and to what extent their research was used since the later internal development processes in the companies were not known by the researchers.

It is striking that so few of the interviewed mentioned under-graduated students as possible actors in the commercialization process (apart from students at CSE). Students outnumbered faculty and have many years ahead to diffuse their knowledge as employees or by starting new ventures. On the other hand, Alumni are out of universities control and examples of students making use of research are not visible for the respondents. Students were briefly mentioned:

”Excellent research is internally transferred to teachers, who transfer to students, who transfer to companies. Knowledge is passed forward in the organization and spills over.”

“The important technology transfer is through students to industry, what was developed this morning should be home by night”.

“How could the benefit of a text book written by one of our researchers, used by students and having influence all over the world, be measured?”

The importance of undergraduate students for industry were expressed by an industry representative at the Energy Day at Chalmers, stressing that Chalmers had no idea of the students importance, not only in regional development but worldwide.

Discussion and Conclusions

Recent research on academic entrepreneurship has focused on USOs and IP-rights. Although this has enhanced our understanding, there are others less obvious ways to make commercial use of academic research. The aim with this study is to visualize more indirect ways of how and by whom academic research is commercialized.

The overall view in the departments was that research should be utilized in society and that it was mutually beneficial to cooperate with industry. Sharing research results with industry and thereby enabling others to take commercial advantage of their findings is one way to fulfill the researchers’ strong drive for utilization. Traditionally strong ties with industry make this more or less natural. Most of the respondents stressed the very importance of research coming to use in society, but by whom, was considered less important. The researchers appeared satisfied in knowing that they created value for society. They seemed well aware of that the effects from research were much more than was usually counted for. Their research is

implemented in established industry, their advices play a crucial part when new products are created and thereby they indirectly contribute to growth and employment opportunities.

Even if there surely also at Chalmers are differences in opinions, the focus on research coming to use in society is since long dominant at the university. Chalmers cooperation is one of the most frequent among universities in Sweden (Wahlbin and Wigren, 2007). This university culture is developed by the pragmatic view of an engineering school, early pioneer and a long tradition (Berggren, 2012). When it comes to commercialization, a positive attitude can be understood as long as it does not limit the benefit of the public at large. The researchers' driving force of making good for society through furthering their research is different from that of exploiting innovations on a market. Well aware of that their competence and desire are aimed at science they enable others to make commercial use of their research findings. In the two studied departments at Chalmers, researchers functioned as interactive partners to industry and thereby indirectly supported existing companies. Hereby researchers' strong drive to utilize research was fulfilled and they could acknowledge themselves to contribute to renewal in society. Commercialization in existing companies is one way to utilize, that demonstrates researchers' daily efforts being of benefit to the public.

Chalmers intensive collaboration and strong tradition to serve industry makes it natural to first and foremost enable existing large companies to take advantage of research findings. Through close cooperation with industry, multiple channels are available for transferring academic knowledge. Research findings are for example diffused in joint research projects, through doctoral students with projects in industry, by alumni keeping in touch with Chalmers and shopping for new ideas. Conferences and other events arranged by Chalmers are functioning as important meeting-places and a way for industry (preferably alumni) to get access to latest research. Their sheer attendances being prove of their gain and their urgency to keep the beneficial channels to university open. Direct advices and guidance are often provided for free

when companies are calling with questions. Consultancy companies' origins from academic research findings are another channel, both side-line and external firms were found in this study. PhD students involved in industry projects are known to frequently leave for employment in industry after their graduation to continue with the development of their projects. The without doubt largest group to distribute current research to industry is students, when being employed or when working in close cooperating with industry in master projects. Given what was found in the study research is spun out from universities to a much larger extent than what is usually focused.

In the unique case of Chalmers with its history of industrial engagement utilization of research was found to be very important but the researchers did not show much interest for commercializing themselves. In lack of this desire they left the commercialization to others, as one way to fulfill their strong drive for utilization. Enabling industry's use of academic research is one way to contribute to the development of society but it is not one-sided beneficial. In this study the mutual outcome from collaboration with industry was high-lighted in the interviews. Back-effects like obtaining funds, financing PhD students, feed-back on research directions was pointed out. Collaboration with industry ensured academic research to be relevant for society, which at Chalmers without doubt appeared far more important than being a curiosity driven blue sky researcher. The beneficial mutual exchange of knowledge was highly valued and the fact that the knowledge flow between university and industry was in both directions was constantly under-lined. Some insecurity by a few academics of being too service-minded and dependent of industry could be imagined but the common feature was positive to the intense collaboration.

Knowledge acquisition is known to be positively related to the level of interaction. Taking into account the high level of collaboration at Chalmers the outcome from it can consequently be expected high. However, the value of the extensive collaboration is more or less

impossible to measure in any direction. Although Perkmann, Neely and Walsh (2011) have tried to develop a performance measurement system for university-industry alliances with main points on papers published and patents, the measurement problem remains. Some components might be possible to value, but how can cross-fertilization of ideas and mutual inspiration be measured? Measurable pay off in existing industry can be anticipated to be just the tip of an ice-berg. Much of the outcome is diffuse and blurred, resulting in the imbalanced focus on USOs and IP rights (e. g. Nilsson et al, 2009). Even if academics do start new ventures far more than the national average in the Swedish population (Wahlbin and Wigren, 2007) far more of their research are presumably commercialized by others than the academics themselves. Research becomes commercialized to a much larger extent than is immediately visible and one way does not fit all. Further research in this area is needed in order to,

The nature of the research at the two studied departments being difficult to 'productify' was the main reason given for not having current USOs to show off at the two departments. This indicates the strong product focus of Chalmers, especially as the existing consultancy firms, which provided service, were hardly counted for. Possible to 'productify' or not, not all kind of research is suitable to be commercialized in new start-ups. A large amount of academic research conducted is not possible to apply commercially at all. Sometimes academic research is adapted for improving existing products or is just a seed to become an innovation. Anyhow, academic research is far from ready for market introduction, a long time of further development remains (e.g. Mansfield, 1998). This long process will sometimes need the resources and competence of an existing large company already in the business, with experience, established market channels etc. For this reason it sometimes is more realistic to turn to existing companies to make use of research. New USOs as a possible channel for successful commercialization is presumably only suitable for a minor part of ideas originating from academic research. Not only disadvantages in terms of ordinary liability of newness

exist, but also the complexity of advanced high tech niche ideas should be considered, like demanding international launching and creating new customer needs.

The well-known success-stories of USOs at Chalmers might not only inspire as role models, but also clarify the long, complex and resource demanding process of a research based start-up. The step for a researcher towards a completely new career is huge, especially as most lack business skill and are driven by other motives than those of business. Academics are motivated by finding solutions to interesting problems rather than pursuing economic opportunities and might lack risk-taking propensity. For researchers used to being prominent within their area, a possible failure in risky new business attempts would be a prestige loss. For researchers well aware of their core competence and dedication the choice to leave commercialization to others with business competence seems natural.

Bearing in mind that, in Sweden, Teacher's Exemption is in force, with subsequent ownership and responsibility to commercialize relying on the individual researcher her/his desire becomes even more decisive. Entrepreneurship involves the action and passion of people, which at least to some extent can be influenced by e.g. role models, entrepreneurship education etc. Trying to change reluctant researchers to split their focus might not be the most efficient use of resources when others are willing to commercialize research and researchers are willing to share their knowledge.

In conclusion, the results show that the choice to visualize the most successful USOs at Chalmers' filters away other ways to commercialize academic research. This is not only conserving the belief in an academic paradox when a lot of utilizing happens noiseless in existing industry, but it also reduces the range of different role-models. Not only excellence but also breadth and variation can inspire to future commercialization. Universities being keen

on showing off a few successful USOs can however reinforce the picture of USOs as the only way to commercialize academic research.

Policy implications

Which role models to emphasize is a delicate matter. It is a well-known fact that what is possible to measure gets the attention while other essential data is filtered away. By only counting the stars, other less measurable commercial use of academic research gets less attention. By neglecting the existence of other possibilities (maybe less prestigious and more difficult to measure) the breadth of the phenomenon becomes restricted.

By putting the focus on research being commercialized, instead of researchers' own commercialization other possibilities show up. It can be important to acknowledge the diversity instead of reproducing one way as the only one. Researchers as enablers for others commercialization are also indirectly supporting growth and renewal.

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