TRAMES, 2013, **17**(**67/62**), 3, 215–241

THE CHANGING APPROACH IN ACADEMIA-INDUSTRY COLLABORATION: FROM PROFIT ORIENTATION TO INNOVATION SUPPORT

Aleksei Kelli[1], Tõnis Mets[1], Lars Jonsson[2], Heiki Pisuke[1], and Reet Adamsoo[1]

[1]University of Tartu and [2]Uppsala University

Abstract. The transformation of a country into a knowledge-based economy has a considerable impact on the role of a contemporary university. The question is whether the university should assume the role of an entrepreneur itself or whether it can continue to be a traditional university – i.e. focusing on teaching and research – with some additional functions for supporting innovation. The article analyzes innovation support systems at Uppsala University, the University of Tartu and the Tallinn University of Technology and focuses on the measures how universities can enhance academia-industry collaboration and improve innovation. The authors state that the development of collaborative arenas for actors from academia and industry is just as important as the efficient and sustainable management of knowledge transfer. Successful interaction between academy and industry requires the knowledge how to act in a proper manner but also financial resources. This may vary between different universities and different settings.

Keywords: innovation, knowledge transfer, academia-industry collaboration, intellectual property, technology transfer, professor's privilege, institutional ownership

DOI: 10.3176/tr.2013.3.02

1. Introduction

The transformation of a country into a knowledge-based economy (KBE) is equally important to modern Western countries as well as to the countries of Eastern and Central Europe, which radically changed their political and economic order at the beginning of the 1990s. It is accompanied by a considerable impact on the functioning of society. At the EU level, KBE describes "economic activity that relies not on 'natural' resources (like land or minerals) but on intellectual resources such as know-how and expertise" (COM (2008) 466:3). According to the Organisation for Economic Co-operation and Development (OECD), the concept of KBE describes "economies which are directly based on the production, distribution and use of knowledge and information. This is reflected in the trend in OECD economies towards growth in high-technology investments, high-technology industries, more highly-skilled labor and associated productivity gains" (OCDE/GD (96) 102, 1996:7). It is true that "[o]ne of the characteristic features of the knowledge economy is that universities and public research organizations are becoming increasingly engaged in the utilization of research" (Ulf Petrusson 2011:73). Therefore, the development of efficient academia-industry collaboration is a key issue in a well-functioning knowledge-based economy (Kelli and Pisuke 2008:223–238). In this article, the terms 'academia' and 'university' are used in the broad meaning, including universities and other research organizations.

The Europe 2020 Strategy underlines that education, research and innovation are key drivers for competitiveness, jobs, sustainable growth and social progress. It also requires promoting and reinforcing cooperation between academia and industry at the EU and national levels (COM (2010) 2020:13). The "People" Programme of the Seventh Framework Programme (2007 to 2013) contains "Academia-Industry Pathways and Partnerships" activity as one of the Marie Curie Actions. The aim of the activity is to enhance the human capacity of industry-academia cooperation in the fields of research training, career development and knowledge sharing, taking also into account the protection of intellectual property rights (C (2011) 5033:4). Therefore, the stakeholder organizations are expected to develop and implement structured programs to increase mobility between academia and industry (COM (2012) 392). The Draft Horizon 2020 – the Framework Programme for Research and Innovation (2014–2020) – also supports research and innovation cooperation between universities, research institutions and enterprises as an important measure to ensure optimum development and dynamic use of European intellectual capital in order to generate and transfer new skills and innovation. At the same time effective industry-academia links, as well as the development and implementation of research and innovation agendas also through public–private partnerships, are considered to be essential in addressing competitiveness (COM (2011) 809:43–44, 48, 63).

The Horizon 2020 Programme puts an emphasis on the Knowledge and Innovation Community (KIC) in financing European research. KIC is defined as "an autonomous partnership of higher education institutions, research organizations, companies and other stakeholders in the innovation process in the form of a strategic network based on joint mid- to long-term innovation planning to achieve the EIT challenges, regardless of its precise legal form" (Article 2 of the Regulation (EC) No. 294/2008). Therefore, it is important to distinguish between different players in the European research and industry policy.

The exploitation of the results of university research could be a major driving force behind innovation which is the core value-creating process in a knowledge-based economy (for further discussion, see Etzkowitz 2001:18–29, Etzkowitz and Leydesdorff 2000:109–123). However, the role of academia is not always adequately and sufficiently conceptualized by policy-makers, which leads to deficiencies in knowledge management by the university and thereby constitutes an obstacle to academia-industry cooperation (for further discussion, see Formica et al. 2008:289–311, Formica et al. 2008a:21–51, Powell et al. 2007:121–142, Link et al. 2007:641–655).

In this article, the authors with diverse backgrounds in intellectual property law, economics and management explore the new requirements for academia-industry interaction in the context of transformation into a knowledge-based economy. The methodology and conclusions are not only applied to the two countries under research. They can be used for the formation of policy recommendation for other countries facing similar challenges as Estonia did after its radical changes in political and economic system and after joining the European Union.

The article analyzes innovation support systems at Uppsala University, the University of Tartu and the Tallinn University of Technology. Universities of Uppsala and Tartu are traditional classical universities and they both belong to the Coimbra Group of the European multidisciplinary universities of high international standard (see Coimbra Group). These two universities share also a common historical background since they were both founded by Swedish kings (Uppsala in 1477 and Tartu in 1632). The collaboration of Uppsala and the two Estonian universities grew out of the framework of the so-called Uppsala Round-table (for further discussion, see Mets 2010:80–89) connecting innovation specialists from different European universities initiated by the head of Uppsala University Innovation Dr. Lars Jonsson in December 2007. Tallinn University of Technology (1918) represents a modern specialized innovation-oriented university belonging to the European Consortium of Innovative Universities (ECIU). The described cooperation is in line with the aims of the European Union Strategy for the Baltic Sea Region to transfer knowledge and competence from the Nordic countries as innovation top performers to help the Baltic countries to catch up and create together a dynamic environment for further enhanced innovation performance (COM (2009) 248:7).

Estonian universities have experienced radical changes after Estonia regained its independence from the Soviet regime in 1991. The changes in the country's political, economic and legal system had direct impact on universities. Uppsala University illustrates an evolutionary model of development in a stable society. Although the population of Estonia (1.4 million) and Sweden (9.5 million) differs considerably, in a global scale their universities can be regarded as the universities of small countries. At the same time, this article illustrates the case of the so-called post-socialist world as compared to the old Western countries. Similar developments can be followed in the other Baltic states, the states of the former Soviet Union and Central Europe.

The final argument supporting the decision to choose and compare Uppsala, Tartu and Tallinn universities is that the authors have a good insight knowledge and practical experience in these universities.

It is useful to bear in mind that in addition to different historical backgrounds and socio-economic conditions, there are several other aspects which help to explain the differences between these universities. The data on these differences is provided in the appendix.

2. Academia's commitment to entrepreneurship and a shift from technology transfer to innovation support

2.1. Entrepreneurship and academia

Many universities have successful knowledge exploitation projects which are sometimes called academia-industry cooperation success stories (see also ERAC 1205/12). Mention can be made of several examples such as CIGS-based thin film solar cells developed and commercialized at Uppsala University and bacterium Lactobacillus fermentum ME-3 at the University of Tartu.

CIGS-based thin film solar cells are one of the successful stories of Uppsala University in recent years. Solibro, a spin-off company was formed in 2001 and acquired by the German company Q-cells in 2008, which at the time of acquisition was the world's largest producer of solar cells. The acquisition reached a total business value of more than 200m€. The company set a new world-record for thin film solar cell modules by reaching 17.4% efficiency in 2011. In June 2012, Solibro was acquired by the Chinese company Hanergy. The R&D company of Solibro is still placed in Uppsala in close relationship with its mother university (Solibro).

Lactobacillus Fermentum ME-3 Bacteria and the Hellus Product Line are the examples of the success stories of the University of Tartu. It is the first Estonian probiotic lactic acid bacteria which has antimicrobial properties (direct and adverse effects on harmful bacteria) and antioxidant properties (indirect beneficial effects promoting human health). It is licensed to be used in dairy products (Lactobacillus Fermentum ME-3).

Such success stories give rise to a question whether we should always expect similar results from a university. As a matter of fact, this issue has wider implications and concerns about the role of a university in the knowledge-based economy.

The traditional areas of activity of a university have always been teaching and research. Due to the transformation into a knowledge-based economy, entrepreneurship has become an additional function for universities to support the process. Even the concept of an entrepreneurial university has emerged to characterize a university's new role (for further discussion, see Etzkowitz and Leydesdorff 2000, Wright et al. 2004:235–246, Frischmann 2005:155–186).

The discussion about the role of science in society is not new. There are several different views on the role of university in entrepreneurial context and how this role could be fulfilled (see Etzkowitz 2004:64–77, Sörlin 2007:413–440). The topic becomes even more complicated taking into account different models of university (Tadmor 2006:287–298): a research institute, a teaching college and a business unit. The two first models are linked into the (classical) Humboldt type of university (as we understand it today) including education and research domains. The third aspect means that a university is supposed to be in a global competition for students as well as for a research position in the 'marketized higher mass-education', furthermore, universities are encouraged to put their research into industrial practice. All this has pushed the university out of its 'ivory tower' to implement elements of managerialism, including relevant indicators, monitoring, control and evaluation (Barry et al. 2001:88–101). It means that the previous missions of universities – education and research – have been complemented by a third, the mission of economic and social development mentioned also as serving society, innovation (Raivio 2008:xiii) or in a narrower sense – technology transfer activity (Autio 2007). The adoption of the third mission is referred to as the second academic revolution (Etzkowitz 2004:64–77, Sörlin 2007:22) and active universities in that process are called entrepreneurial universities.

These developments lead to the question whether the university has become a new type of an entrepreneurial organization, a business university or an innovative university. The authors support the position that the contemporary university continues to be a traditional university. At the same time the traditional areas of activity of the university should be complemented and innovation support should be included as a new area of activity among the core activities of the university. It is not sufficient when the new role of the university is merely reflected in the relevant regulations and strategy documents. It is even more essential to implement these regulations and strategies consistently and integrate entrepreneurship into the university's everyday activities.

2.2. Innovation enhancement by academia

Entrepreneurship of a university is often associated with technology transfer in the form of a specific type of academia-industry interaction. The underlying idea of technology transfer is rather straightforward. The university's research results are meant to be utilized by the industry. This can be achieved through formal mechanisms such as licensing and spin-off creation.

Although academia-industry cooperation is often conceptualized within the framework of technology transfer, there are no compelling reasons to confine academia-industry collaboration to technical fields. The industry can also make use of the input from social sciences and humanities (e.g. the knowledge how to market a product in different cultural and linguistic contexts, how to develop efficient organization and organizational routines, etc.). For instance, in Estonia a professor of theology gave expert advice on which symbols and texts should be used in a chapel at the Tallinn Airport (Tallinn University). There have been several cases where semiotics and linguists of the University of Tartu have been asked to give expert opinions in questions which are relevant to the society (i.e. questions about commercials, signs used on T-shirts and in public places).

Therefore, universities have started to include humanities and social sciences in their knowledge transfer initiatives. Many studies have also indicated that a vast proportion of the transfer from university to companies or society happens through more or less informal contacts and meetings (Link et al. 2007:641–655, D'Este and Patel 2007:1295–1313). Consequently, the concept of technology transfer has become too narrow and it has evolved into the concept of knowledge transfer.

The widening of the scope of the information transferred from academia to the industry is a positive trend. Enhancement of knowledge transfer, however, has given rise to a question whether it leads to the strengthening of applied research at the expense of basic research. The development and implementation of effective and efficient transfer processes has also transpired to be a real challenge for many universities around the world. Although cooperation is presumably beneficial to academia and industry alike, it does not happen automatically. The university's strategy for cooperation with industry is an important factor. The university's primary focus on profit generation could pose an obstacle to extensive collaboration since profit maximization and facilitation of collaboration and knowledge transfer require different approaches.

It has become evident that even if extensive technology transfer activities seem to be good for the society in general, very few universities can generate any substantial income from them. Only a minority of university-owned patents reaches the market and just a handful of those generates any major income (Åstebro 2003:226–239, Trune and Goslin 1998:197–204, Mullins and Crowe 1999:4–17, Powell et al. 2007:121–142). Therefore, a relevant issue for universities to be decided is whether revenue generation should be the main goal for the university's knowledge transfer activities. There are several aspects which need to be considered. Firstly, it is clear that the majority of universities cannot make any profit since they do not have necessary capabilities, business environment with sufficient absorptive capacity and network access. Secondly, enhancement of broader knowledge exchange processes between academia and industry could be even more beneficial in a long-term perspective because it would not concentrate on a single profitable deal, but instead on sustainable development of economic environment of a country and region (in our common case – the European Union). A wider and more extensive knowledge transfer to industry should take precedence over short-term profit maximization. Therefore, the authors are of the opinion that the university should not solely focus its knowledge transfer activities on making a profit.

In order to become a key actor in the knowledge-based economy, a university also needs to be more proactive. According to Etzkowitz, an entrepreneurial university is constantly involved in entertaining relations with extended stakeholders for such purposes as acquiring external research funds and disseminating their knowledge in the society (Etzkowitz et al. 2004:64–77). Commercialization of research results has to support a specific idea of a researcher, a research group or students. To be more proactive and give innovation support on an organizational level means, for instance, to develop and manage collaborative research arenas within a university which are judged to have superior possibilities to create innovations through direct commercialization or through commercialization within the external organizations which collaborate with the university in the arenas (most probably commercial companies). Innovation support on an organizational level thus means that the professionals of knowledge transfer do not wait for a disclosure to appear but instead they draw the scientists' attention to the issues that are relevant and important for the surrounding industry and other external organizations. For instance, Uppsala University Innovation (UUI) leads a strategic cross-disciplinary research platform – the Ångström Material Academy (ÅMA). It fosters academia-industry collaboration in the field of materials science (for further information, see Ångström Material Academi). The University of Tartu participates in the following competence centers established by academia, industry and the public sector: Estonian Nanotechnology Competence Centre, Competence Centre for Cancer Research, Bio-Competence Centre of Healthy Dairy Products (for further information, see Competence Centre Programme, Competence Centres). The initiatives of ÅMA and the competence centers aim at long-term academia-industry collaboration to enhance innovation and entrepreneurship in the society. Also, short-term measures such as entrepreneurship days regularly organized by the University of Tartu are used in order to facilitate initial academia-industry contacts.

Collaborative platforms can be defined as structured arenas for collaboration with external stakeholders. They can be organized like clubs but with the participating companies and research departments as members on an organizational level. The interaction should be bilateral and used both for disseminating knowledge from the academia to the external stakeholders and to get relevant confirmation and input to the performed research at the university. Different activities can be managed in the area such as PhD projects, student theses, conferences, a company's senior staff used as lecturers at the university, expert panels, conference meetings etc. In order to be really interactive and contribute not only to the companies, but also to the development of the academic research, contract research should be minimized or totally avoided. Instead, collaborative research projects where the companies participate with different resources and knowledge should be encouraged.

AIMday® (Academia Industry Meeting day), which is a unique special meeting format for academia-industry interaction, has been developed in the context of ÅMA at Uppsala University. It is a sophisticated tool controlled by a set of IP tools such as trademark, secret know-how covering the preparatory phase and copyright. According to the AIMday format, the companies which are interested in participating in the conference have to submit their questions in advance. The submitted questions are used for the subsequent discussions among researchers from academia and industry in an open innovation setting. The questions of the companies are formulated (with the help of the KT-professionals) not to solve a simple problem, but to get a better understanding and new ideas for how to approach the problem.

The AIMday has been found to create values both for the companies and the participating researchers. Baraldi, Lindahl and Severinsson (2011) find in their qualitative study that the chosen format combines formal links with informal links and human resources links. The companies use the meeting day to screen the competences and expertise available at the university and capture these through the creation of new networks. Participating spin-off companies often try to find researchers from other areas of expertise than their own 'mother division'. Bigger companies also see a value in screening PhD students for future employment. In the workshops, SME-companies can show to the big companies, which often are their customers, how they can contribute to their business. The AIMday format thus reinforces established networks and creates new ones between the academia, big companies and SMEs. The format has been successfully implemented also in life science and social sciences and is now disseminated to other universities. There are examples of concrete research projects started as a result of an AIMday and also one successful product development but the concept has not been used long enough to show its long-lasting effects on regional business life. The collaborative platforms constitute a solid base for the future cooperation even though their establishment does not necessarily result in any immediate research and licensing agreements or formation of spin-offs. These initiatives are valuable to academia and the industry alike. The industry obtains access to scientific competence and scientists in turn learn about the industry's needs and interests. The experience of Uppsala University Innovation suggests that in order to support innovation, it is essential to develop and support collaborative arenas. The university cannot expect the collaboration with the industry just to happen. It requires systematic and continuous efforts in combination with a new kind of 'non-faculty' professionals, which will be discussed further in section 4 of this article.

A broader concept which encompasses humanities and social sciences in the university's transfer activities and development of collaborative platforms is accepted at Uppsala, Tartu and Tallinn universities. The change of approach serves as an example of the dynamics in the strategies and their practical implementation at these universities – a narrow model of technology transfer has first transformed into knowledge transfer and then into a broader innovation support system.

Uppsala, Tartu and Tallinn universities apply similar strategies to academia-industry collaboration and innovation support. It is vital to be proactive and contribute to the development of different collaboration platforms in a systematic manner. In practice the development of collaboration platforms also results in more effective and efficient knowledge transfer. It is easier to license technology and other knowledge to companies who work very closely with academia and participate in innovation support activities. At the same time, companies who are invited to be engaged in the business verification of a single commercialization idea might also be recruited to be a collaborative partner to the university in research and education. This way the collaborative and the commercialization part of the innovation support unit (ISU) of the University work hand-in-hand. The availability of resources certainly plays a role in this. However, the importance of strategic commitment to prioritizing these activities should not be underestimated.

2.3. Possible criteria for the evaluation of innovation support system at academia

In case we have an innovation support system at academia there is always a need to evaluate how it is functioning. The authors present some preliminary criteria which could be used for evaluation. Since we distinguish between direct and indirect commercialization, which together constitute innovation support system at academia, we propose different criteria for them. The key criteria are visualized in the following Table1.

Table 1. The key criteria for the evaluation of innovation support system at academia

	Direct commercialization or innovation support of an individual idea	Indirect commercialization or innovation support on an organizational level
Start level	1. Recruit engaged people with relevant background and make sure that the recruited team has the trust of the university management. 2. Contact the faculty management and build trust. Identify ongoing research which is commercially interesting together with the researchers. 3. Establish a basic system for innovation support linked to the students.	1. Focus on the strategically strong areas of the university on an ad-hoc structure. 2. Recruit the people with relevant background (preferably people with both a research and a business background within the chosen areas). 3. Engage the top researchers within the chosen areas and invite a small number of suitable companies to participate by using the existing contacts. Focus on the topics proposed by the companies, which the researchers find academically challenging.
Basic level	1. Establish a process to evaluate the new disclosures from both a technical and a business point of view. 2. Establish a business incubator, which focuses upon business development, and start commercialization projects. Establish routine processes for the establishment of new start-ups as well as for out-licensing. 3. Establish basic funds for commercialization projects. 4. Communicate success stories (big and small) on a regular basis internally and externally.	1. Start collaborative pilot projects. 2. Establish activities for the detection of further opportunities to collaboration such as AIMday®. 3. Communicate success stories (big and small) on a regular basis and establish different grants and awards which mark progress. 4. Establish special courses in entrepreneurship and IP for students and PhD students and on a master level for selected disciplines.
Advanced level	1. A patent support process and a business legal advice process are established on a professional level. 2. Courses on commercialization are established for students, PhD students and researchers. 3. Network for the recruitment of the board members of start-ups and suitable business developers for the different commercialization projects is established. 4. University linked funds for investments are established.	1. Different intellectual assets are regularly scanned in the research departments and are used as background knowledge. 2. Possible innovations within the collaborative platform are refined using different processes and funds. Cross-linked projects of complementary research areas are started. 3. Complementary companies such as suppliers and customers are involved in addition to the key companies.
Optimal level	Self-sustaining is guaranteed by profitable exits from start-up and spin-off companies, dividends from profitable portfolio companies and royalty income from patents commercialized in existing companies throughout licensing.	Self-sustaining is guaranteed by the yearly membership fees, sponsorship, conference fees etc., as well as by the research funding of the participating companies, research foundations, government etc. Ideas are commercialized on a regular basis through the partnering companies and/or new start-ups and out-licensing.

3. Enhancement of knowledge management processes at academia

3.1. Knowledge creation and control of knowledge

Successful knowledge management requires extensive scientific, business and legal competence. Neglecting one of these aspects could have an adverse impact on the whole process (for further analysis, see Kelli 2009). As a rule, for commercial exploitation of knowledge it is essential to control knowledge. Control can be established by various means such as secrecy, technological measures, first mover advantage, short innovation cycles and access to marketing channels or resources. Intellectual property (IP), traditionally defined as legal rights resulting from intellectual activity (see Article 2 (viii) of the Convention establishing the World Intellectual Property Organisation), is one of the most efficient knowledge management tools. It allows packaging and thereby controlling knowledge in the forms of patents, copyright, trade secrets and other types of IP. This is why IP is also regarded as an effective competition management tool on a competitive market in the market economy. Professor Reto Hilty (2012:49–50) says that "IP rights are in principle intended to be a positive encouragement of competition by securing the investments that, without protection, could be exploited by third parties in a way that would prevent an appropriate return being made on the investments".

Some universities in the US, but not yet in Europe, have found that controlling the IP created at universities is such an important task that it should not be outsourced to external patent attorneys. Like most big global companies, they have therefore created an in-house patent office taking the strategic decisions about which inventions should be patented. Uppsala University has followed this example and has five experienced patent managers employed in the ISU, which can be used free of charge by the researchers. Even if the authors' impression is that this is very beneficial, comparisons regarding the effect of this are not made in the scope of this article because they need further investigation before any conclusions can be drawn.

The development of appropriate business models and building capacity to use IP tools greatly facilitate knowledge exploitation. The entire process, however, starts with knowledge creation. If there is no valuable knowledge, there is nothing to utilize. Therefore, it is hard to overestimate the importance of the quality of knowledge for the utilization process. From a business' point of view, the exploitable knowledge has to have a unique selling point, which could differ somewhat from the pure scientific excellence. The question is how to develop the knowledge which is of interest to the industry and end consumers. Although no universal recipes exist how to develop excellent and commercially exploitable research results at academia, it is possible to provide some guidelines.

Firstly, every university has its strengths and weaknesses. Therefore, universities could also adopt the concept of smart specialization and prioritize certain fields. The Guide to Research and Innovation Strategies for Smart Specialisation explains the rationale of the concept as follows: "the Smart Specialisation concept is that by concentrating knowledge resources and linking them to a limited number of priority economic activities, countries and regions can become – and remain – competitive in the global economy" (European Commission 2012:11).

Secondly, since competitive products on the market often encompass different technologies, it is essential to create arenas for inter- and transdisciplinary research (for further discussion on inter- and transdisciplinarity, see Jones 2009). Even small measures such as facility sharing could exert a beneficial impact. It is necessary to unite researchers from academia with practitioners from the industry or with people of industry background. The industry can provide valuable insights into the market's needs, which could give a specific direction to the research conducted. The experience of Uppsala University suggests that this type of cooperation is very useful for academia. The management of the collaborative platforms mentioned remains clearly outside the scope of the narrowly defined technology transfer. This is why it is an additional argument to have a more general innovation support system in place at the university. This is the practice followed by the universities in Uppsala and Tartu.

3.2. The starting point of knowledge transfer

A disclosure of an idea to an innovation support unit can be regarded as a starting point for a knowledge transfer process. The initiation of the verification phase is among the first steps taken by innovation support professionals to manage the process. The completion of verification provides valuable insight into the possible exploitation routes.

Verification processes can be divided into two main types: technical and business verification. Technical verification concentrates on the issues such as proof of concept, scalability, robustness, production quality, cost and yield.

Concerning business verification, no universal model exists to prescribe how to develop a functional and efficient verification process. Based on the experience of Uppsala University Innovation there are some general and specific measures which can be utilized. For a general analysis, it is recommendable to use different methods such as SWOT (see the Wikipedia 'SWOT analysis' entry) and NABC and business databases (e.g. Frost & Sullivan, Business Insights). NABC stands for Needs, Approach, Benefits and Competition. It is a business verification method developed by the Stanford Research Institute and the method is the default method used by Swedish universities when they use the governmental agencies funding for initial business verifications of ideas.

For a specific business analysis, professional business consultants should be involved in case there is a lack of in-house competence. This serves also as a practical advice to consider for the universities of similar socio-economic background.

As emphasized in the evaluation of the potential for commercialization of the intellectual property of Estonian research universities and preparation of the expert analysis necessary for developing the system, it is advisable to address the following issues during business verification: the existence of a market and the possibilities to develop it further, market size now and in the future, additional requirements to make the invention commercial, identification of customers and their willingness to pay, possibilities to protect knowledge and the analysis of freedom to operate (not to be done too early) (Jonsson et al. 2010:50).

The analysis of verification processes at Estonian universities reveals that the theoretical level of awareness among researchers and ISU personnel is sufficient. However, there are deficiencies in managing knowledge as a business asset. The evaluation report on Estonian universities supports the assumption that there is too high focus on patenting instead of business considerations. Inventions, however, should not be patented unless they support commercialization of research results (Jonsson et al. 2010: 32-33).

Consequently, Estonian universities need to invest more in the development of adequate business verification processes. It has already been emphasized by Chesbrough (2003:156) that "technology by itself has no inherent value; that value only arises when it is commercialised through a business model". Business considerations have to determine what product it will be, define its technical requirements and choose whether it is more appropriate to license the product or establish a spin-off company.

The results of the verification processes undertaken in a structured and professional manner enable industry partners to better assess the potential risks and advantages related to the investment into the exploitation of a particular piece of knowledge. Verification processes, especially if ISU managers involve the existing companies in the process, serve as additional incentives for the industry to seek cooperation with academia and might be an entrance to further research collaborations based upon the idea or the knowledge created by the inventor(s). We have examples where industry partners have bought a patent mainly because they wanted to establish a relationship with a researcher or a research group who has interesting expertise and knowledge for the company. The inventors are sometimes better paid for consultancy arrangements with the company than for the royalty streams created by the initial IP.

Since knowledge transfer involves researchers (including inventors) and administrators from the universities' innovation support unit (ISU), it could result in a situation in which no one is really in a driving seat of the project. Inventors hope that ISU will take the lead and ISU in turn relies on the inventors' initiative.

It is very important that there is one person responsible for the project's progress. Otherwise there is a chance that it will be down-prioritized on the daily agenda of different activities. If the researcher is not a person with a strong personal drive and some knowledge and experience from commercialization (which is often the case), the most suitable person to be in the driving seat is a project manager in the hybrid organization for commercialization support or a colleague of equal competence. This person should prepare a project plan, which defines deliveries and people responsible for them, follow up this plan at least once a week or every other week, keep track of costs, set up regular meetings to review the progress and decide upon alternative ways when necessary. He or she is most often also the person who contacts companies or other possible stakeholders with an interest in the project and tries to involve them either as reference persons who can give advice or as stakeholders. Perhaps most importantly, this person is responsible for making a critical analysis every six months or so to determine if the effort is worth the cost and when it is necessary to recommend termination. Every hour and euro spent on a project after a certain point means lost resources that would be put into much better use in another project which has not reached this critical point. The establishment of this certain time point needs knowledge and experience.

In our experience a project manager in a hybrid organization can handle 4–7 projects running in parallel since there is usually only one at a time that is really 'hot'. In addition, he or she can keep track of another 10–15 ideas or the so-called slow projects. These are just rough figures which can vary considerably depending on the situation.

Knowledge management involves several hazards, which can be avoided. Based on the practical experience of Swedish and Estonian universities it can be contended that ignoring and separating technical, business or legal aspects of knowledge transfer most certainly results in failure. If there is no business plan or the knowledge is of low commercial quality, it is not reasonable to expect good results. In some cases, business considerations combined with insufficient understanding of IP could outweigh the legal aspects of knowledge protection. Consequently, knowledge is regarded more as an economic asset rather than in terms of legal rights. The great relevance of IP rights is caused by the fact that knowledge is a public good by its nature (for further discussion, see Andersen 2004:417–442). It means that knowledge does not have any attributes that enable its control. In the absence of adequate protection, any investment made in the creation of new knowledge is prone to become lost. As a result, it is difficult to find somebody who is interested in investing in the non-controlled knowledge. Since the economic system does not offer sufficient control mechanisms to protect the valuable knowledge generated, it is up to other mechanisms to fill in the gap. Therefore, it is essential to conclude non-disclosure agreements with the parties involved, adopt organizational measures to prevent industrial espionage, avoid accidental disclosure of information, restrict access to research facilities, address document and electronic security, deal with the education issues of employees, etc. (for further discussion, see Kelli et al. 2010:315–339, Quinto and Singer 2009). The best practice would be to combine technological and organizational means with formal IP instruments.

There are certain factors which should not be ignored when developing a business model based on knowledge exploitation. The cost of knowledge creation does not depend on its extent of utilization on national, regional or global markets. Additionally, the nature of knowledge enables its concurrent exploitation. Therefore, it is advisable to concentrate on regional and global markets. International interest can be further reinforced by the small national markets, which is the case in Sweden and Estonia. The global exploitation of knowledge, however, faces several challenges such as proliferation of national IP systems in Europe and high IP enforcement costs, which require considerable resources or at least a strategic alliance with an industry partner.

A very important issue for the entire knowledge management process at academia is access to international scientific, professional and business networks. On the one hand, networking is usually an expensive and time-consuming process where the results are not achieved within a short time frame. On the other hand, without the network access on an international level it is almost impossible to develop efficient knowledge management and transfer systems at academia. Professional contacts can provide valuable insight into international business trends, quality of the created technology and potential application of technology. This is the utmost aim of the EU research policy to encourage the creation of such networks (see, for instance, COM (2012) 392). There are some positive examples, which have facilitated network development in the Baltic region. For instance, the University of Tartu has participated in the ScanBalt Intellectual Property Knowledge Network (ScanBalt IPKN) project (for further information, see Intellectual Property Strategies in Bioscience 2007). ScanBalt IPKN has contributed significantly to the development of the cooperation of academia and industry stakeholders in the Baltic region in the field of biotechnology.

4. Adoption of an appropriate incentive system

Prior to the adoption of any incentive schemes, it is essential to define the objectives of the university's innovation support system. According to the authors, academia should not be transformed into a research and development (R&D) department for companies. Otherwise universities could run into difficulties in fulfilling their other functions. Traditional European universities provide research-based instruction covering different academic fields. Budgetary restraints, a shortage of highly qualified teachers and researchers and other reasons make it impossible to obtain high-quality research results in all fields. At the same time, the university cannot abandon teaching in less promising fields and disciplines, which could be an option for a private company. This, however, does not mean that innovation should not be fostered. Universities have to facilitate wider academia-industry collaboration by establishing different collaborative arenas and ISU as institutional structures.

The development of adequate incentive schemes at academia is a rather complex endeavor for several reasons. Firstly, these schemes cannot only encourage and facilitate knowledge exchange processes between academia and the industry but could have an adverse impact on them as well. Secondly, there is a need to make a distinction between innovation support professionals and researchers.

The requirements of the qualifications of knowledge transfer support professionals are very high: they need to have a thorough business and academic experience. Consequently, the recruitment of senior and experienced experts with a relevant background is contingent on a competitive pay policy and other benefits. Based on the experience of Uppsala University the salary level for these professionals is at the same level or up to 50% higher than an average salary for a full professor in science and technology fields at the university. Similarly to professors they enjoy benefits such as a high degree of freedom and good vacation possibilities (Jonsson et al. 2010:46).

Another issue is whether the additional monetary incentives for knowledge transfer personnel have a positive or negative impact on transfer. A study on incentive schemes suggests that increasing the share of the proceeds of the employees of the technology transfer unit has a positive effect on the commercialization of the inventions (Markman et al. 2004:353–364). This approach has been criticized as the one that leads to dedication of majority of financial and human resources to patent licensing while not giving sufficient attention to non-patented knowledge (Litan et al. 2007). The authors agree with the opinion that monetary incentives offered to innovation support personnel could indeed lead to concentrating only on more profitable deals for the university. This approach, however, would not enhance other knowledge exchange processes. Instead, it might stimulate a 'cherry-picking' behavior, which limits the number of commercialization processes. In addition to that, profit maximization model could also have an adverse impact on indirect commercialization activities.

There are other reservations to additional benefits such as success fees and options to buy shares of start-ups as well. In literature a concern has been raised that "it is very important for the legitimacy of the system that it should not be possible to throw suspicions on the projects managers for giving advice in individual cases which are favorable for their own pockets. The advice given should always be for the best of the project and nothing else" (Jonsson et al. 2010:47).

To sum up, the authors contend that although the income of ISU professionals has to be competitive, it should not be solely dependent on the number of profitable deals. Currently neither Uppsala nor Tartu innovation support professionals receive direct economic benefits from lucrative agreements.

Before we focus on the incentives for researchers, we shall have to explore briefly a conceptual difference between Sweden and Estonia relating to the ownership of inventions made at academia.

Despite the discussions about the option to change the current system (see Levin et al. 2005), the Swedish researchers still enjoy the professor's privilege, which is also known as teacher's exception. It means that researchers themselves can patent and exploit the knowledge they have created. Due to the institutional ownership regime, the situation is the opposite in Estonia. Academic research inventions belong to the Estonian universities. Researchers, however, receive a share of profit.

There are some misconceptions in respect of the institutional ownership regime, which should be dispelled. The fact that universities are entitled to patent the research results does not lead to the marginalization of the role of the researchers who have created the knowledge. Experts have correctly asserted that "[m]any research faculty members are likely to have better opportunity-recognition skills, both scientific and entrepreneurial, than do TTO (Technology Transfer Office) professionals. Academic researchers have spent years working in their fields, and they have incentives within their disciplines to recognize avenues for scientific advances and breakthroughs. Furthermore, researchers' social capital (their professional relationships with their peers inside and outside the academy) gives them a greater ability to link scientific opportunity recognition to entrepreneurial opportunity recognition" (Litan et al. 2007). As a result, it is crucial to involve inventors in every knowledge transfer process from the first day on.

Another misunderstanding relating to the institutional ownership is that only universities can exploit research results. As a matter of fact the institutional ownership does not exclude the possibility that researchers themselves can lawfully commercialize their inventions. In fact, the University of Tartu quite often waives its rights to patent academic inventions in favor of researchers.

The authors are of the opinion that the ownership regime does not have a considerable impact on knowledge transfer. The professor's privilege and institutional ownership have both their strengths and weaknesses. There is no clear answer, which one is better. The system of professor's privilege has several advantages (for further discussion, see Mets 2010a:550–556). For instance, it gives the researchers more freedom to exploit their knowledge and makes the Swedish universities attractive to foreign researchers. The researchers usually have a very detailed understanding of their inventions compared to (often less experienced) ISU staff. The professor's privilege is also supposed to shortcut bureaucratic deadweight and infrastructure costs. At the same time, it means that universities cannot build up an organizational IP portfolio (OECD 2012:28–29) and that the taxpayers will not get any financial pay-back from a successful commercialization even if tax money has been invested in the research laboratory and equipment etc. Some foreign companies prefer to collaborate with the Swedish universities because of the professor's privilege, which makes it easier for the company to control IP management in the collaboration. At the same time, the system requires knowledge transfer personnel to be more efficient and add real value because otherwise the researchers would not use its services.

One of the main advantages of institutional ownership is that the industry partner can negotiate with one institution instead of many individual researchers. The university operates here as a one-stop-shop. The downsides of institutional ownership are related to high administrative and financial costs of the system. The university is supposed to monitor whether the new inventions are reported and enforce their rights if researchers unlawfully patent the inventions themselves or sell them. Many TTOs are rewarded based on the generated revenue. This practice has created incentives for TTOs to become gatekeepers rather than facilitators. As a result, a home-run mentality has developed in many TTOs and technologies which might have a longer-term potential or might be highly useful to society as a whole, even if they return little or nothing in the way of licensing fees, tend to pile up in the queue or be entirely overlooked (Litan et al. 2007).

Poor knowledge management and deficiencies in the design of transfer processes at the university could easily result in *de facto* professor's privilege. In case of *de facto* professor's privilege, two possible scenarios emerge. In the first scenario, researchers commercialize their inventions on their own even though formally the university is entitled to do it. In the second scenario researchers lack the necessary capabilities to do it and they just publish the knowledge. In both cases, universities are excluded from the process, which reinforces the *de facto* professor's privilege. The *de facto* professor's privilege is also a factor which needs to be considered when analyzing the statistics on university patents.

In order to avoid the emergence of the *de facto* professor's privilege it is crucial to construct a very efficient knowledge transfer system and invest extensively in the competency building of knowledge transfer professionals. University IP holding and management arrangements must be undertaken in an extremely professional way with top specialists and a long-term view (OECD 2012:29).

Having analyzed the differences between the concepts of professor's privilege and the institutional ownership we can return to incentive schemes. The incentives designed for researchers can be roughly divided into the following main categories: moral, monetary and career incentives.

Moral incentives relate to a person's reputation and they should be included in the classification of incentives. This category contains various forms of recognition from the state (nominations for the state science awards and state decorations) or from the general public (reputation as a visionary or a specialist of the field).

Monetary incentive schemes for researchers are based on different principles than those for knowledge transfer professionals. Although it is not recommendable to make ISU personnel's salary contingent upon individual successful and profitable commercialization projects, it is the case with researchers. The professor's privilege inherently places all business risks on researchers. The situation is not very different with institutional ownership because researchers get paid if their inventions are successfully commercialized.

The Estonian universities have adopted the principle according to which the researchers who created patented knowledge are entitled to fair proceeds from the patent exploitation. The share of fair proceeds to inventors amounts to between 1/3 and 2/3 of the profit received from which the costs of legal protection of the invention and other similar costs have been deducted. Researchers who use their professor's privilege to exploit their inventions with the assistance of Uppsala University are treated favorably as well. Uppsala University's standard scheme of the distribution of revenues is dependent on whether the exploitation costs are covered or not. If the exploitation costs are not covered, the researchers are entitled to 50% of the profit received from commercialization. After the exploitation costs are covered, the researcher's share is 65% in normal cases. There are always individual negotiations depending upon the sharing of risks, division of roles and investments into the process by researchers.

By giving a bigger share of profits to inventors, it is possible to motivate them to develop commercially viable knowledge and actively participate in the exploitation processes. However, the actual remuneration that the researchers receive is even more important than a generous policy promising a bigger share of profits. Therefore, the researchers' decision about how to exploit their knowledge – to patent or publish it – is highly dependent on the capabilities of ISU personnel to deliver results.

Researchers' career incentives rely on the acceptance of patents as results of high-level research, equal to high-level publications, which creates additional challenges for the personnel responsible for knowledge transfer. As a rule, researchers are required to publish. For instance, according to the clause 4.1 of the Requirements for Teaching and Research Staff (2010) "[c]andidates for the position of professor are expected to have conducted internationally recognized research in their field of specialization or a closely related field equivalent to at least three doctoral theses". In case the created knowledge is potentially of high commercial value and presumably patentable or protectable by other IP instruments such as design or plant variety registration and trade secret protection, it is crucial to postpone its publication due to the novelty requirement (see Article 54 of the Convention on the Grant of European Patents).

In order to incentivize researchers to cooperate during patenting process and not to publish an article relating to a patentable invention until a patent application is filed or not to publish an article at all (in case the knowledge should be treated as a trade secret) several mechanisms have to be developed. The need for this has been adequately emphasized in literature as well: "It also seems prudent for universities that place a high priority on formal technology transfer to place a higher value on patenting, licensing, and start-up formation in promotion and tenure decisions" (Link et al. 2007:653).

Pursuant to the Estonian regulations concerning the assignment of basic and targeted finances for research and development institutions, a patent application and a granted patent equal to two or three high-level publications (for instance, articles in Thomson Reuters Web of Science database) (Conditions and Procedure for Assignment of Basic Finances for Research and Development Institutions 2010, Conditions and Procedure for Targeted Financing of Research Themes of Research and Development Institutions 2010). All the leading Estonian public universities accept patents as a part of a doctoral thesis (see Statutes of Research Degrees of the University of Tartu, Regulations of the Completion of Studies at the Tallinn University of Technology, Conditions and Procedures for the Awarding of Academic Degrees and for the Defence of Final Thesis of Professional Higher Education in the Estonian University of Life Sciences, Regulations of Doctoral Study and the Defence of Doctoral Thesis at Tallinn University). In addition to patents, the Estonian University of Life Sciences also allows plant variety registrations to form a part of a doctoral thesis (Conditions and Procedures for the Awarding of Academic Degrees and for the Defence of Final Thesis of Professional Higher Education in the Estonian University of Life Sciences). Thus, researchers are motivated to patent their research results. It is also possible to identify several driving forces behind IP portfolio developments at academia. Most importantly, IP instruments are utilized to protect business interests. A valid consideration in choosing a patenting strategy, especially for the universities with institutional ownership system, is the goal in order to create a background IP for joint research projects. Scientific specialization is reflected in patenting patterns as well. For instance, the University of Tartu holds the majority of its patents in the field of bioscience (app. 2/3) and physics (app. 1/3).

According to the practice in Sweden, patents are not formally considered as publications. Patenting is encouraged with the belief that researchers working together with the industry are also better at doing research. When applying for tenure, it is sometimes deemed as a valuable merit. There are always monetary incentives if researchers are successful.

Some factors might exert a negative impact on IP portfolio formation. Although the authors support giving the patents the same importance as publications in the professional career system at academia, we see potential dangers as well. Especially if academic career considerations are combined with high expectations on the university innovation support unit to show clear statistical results, it could result in patenting the inventions which lack commercial application. Patents for mere formalistic purposes cannot create a solid basis for knowledge transfer.

5. Conclusions

The knowledge-based economy sets new challenges for academia. The question is whether research universities should continue as traditional teaching and high-level research institutions or transfer themselves into entrepreneurial universities. Based on the experience of one Swedish and two Estonian leading universities the authors argue that the new economic and social conditions have not transformed these universities into a new kind of entrepreneurial organization. They continue to be traditional universities but with some new additional functions such as supporting entrepreneurship and innovation. Within this general conclusion, each university has aimed to use its traditions, strengths, regional position, human resources and other specific advantages to cope with the new challenges of the 21st century. The authors find that academia's commitment to supporting innovation is twofold: 1) it should not be solely confined to licensing, creation of spin-off companies and other traditional business activities and 2) it is crucial to give more attention and resources to the enhancement of academia-industry interaction. The latter can be facilitated through the establishment of collaborative arenas and development of special formats for cooperation such as AIMday® in Uppsala. As a rule, extensive academia-industry collaboration is a prerequisite for knowledge transfer from academia to the industry. Such transfer should be based on the interests and mutual benefits of both parties.

The university should not aim to get much revenues from IP exploitation. The emphasis of the university innovation support policy should be more on the issue whether knowledge created at universities reaches the industry and society at large. This, however, is contingent upon the university's capabilities, the alignment of academia-industry activities, absorptive capacity and management capabilities of industry actors and many other conditions. Knowledge and competence from social and human sciences still have a low priority in knowledge transfer and the innovation support systems are created mainly from a product and technology point of view. Is this because of the lack of transferable knowledge from the 'soft' part of the universities or is it because our mindset is too narrow? The scope of this article does not cover that aspect of university innovation support system but the fact that an increasing share of the economic values in modern business is related to services on a global market makes the question very interesting. We are convinced that there are big values to be created when adding the skills and knowledge from the researchers in humanity and social sciences into the business developing processes based upon ideas from science and technology. To be able to do this, the innovation support system must be evolved beyond what is described in this paper.

The authors bring their arguments to prove that knowledge transfer from academia to the industry is largely dependent on the following factors: the quality of research results, business models, valuation of research results, legal backing (patent drafting, enforcement of IP rights, contractual arrangements) and participation in relevant academia-industry networks. IP occupies a special role in knowledge transfer since it is managed with the help of IP instruments such as trade secrets, patents and copyright. The choice of specific IP protection models is to a large extent affected by business considerations. The authors show that the management of knowledge transfer at the university requires the consideration of the issues such as the scope of transferrable knowledge, forms and methods of knowledge management (including intellectual property management), technical and business verification of scientific results.

The authors argue that moral, monetary and career incentives are important mechanisms for constructing and facilitating academia-industry collaboration. Incentive schemes are important tools to implement the university's objectives regarding innovation support. Revenue maximization or statistical results about owing patents should not be the ultimate objectives for academia. Academia-industry cooperation should be conceptualized as a long-term investment supporting innovativeness of a country, a particular region (for instance, the Baltic Sea region) and the European Union as a whole.

From the authors' point of view, incentive systems should address two target groups: innovation support professionals in the university and researchers. On the one hand, ISU professionals should not be remunerated extra for profitable deals since it could lead to a situation where general knowledge transfer is not supported and all resources are allocated to procuring the most profitable contracts. On the other hand, a growth in the earnings of researchers encourages them to participate in knowledge transfer more actively.

In contrast to other areas of economy, there is no optimal innovation system, not even in the theory (for further discussion, see Edqvist 2011:1–29). The innovation system must always be conceptualized in a specific cultural and business context. The best way to evolve the system is thus to constantly compare it with other systems in other contexts and by this try to identify bottlenecks and failures in your own innovation system. To some extent this article provides such comparison between three universities in at least two different social and business cultures. We hope that it will inspire other universities to make comparisons with the innovation system and thus enhance an evolutionary development of the knowledge transfer of knowledge from universities into the society, defending the role of the university in the knowledge-based economy.

These conclusions based on the experience of two Member States of the European Union with different backgrounds can be used as a basis for conducting further research in other Eastern and Central-European countries and a comparative research in the countries which are on their way to modernize academia-industry relationships.

Acknowledgements

This publication has been supported by the European Social Foundation through the Research and Innovation Policy Monitoring Programme.

Heiki Pisuke is Head of Unit at the General Secretariat of the Council of the European Union. The views expressed in this article are purely those of the writer and may not in any circumstances be regarded as stating an official position of the Council of the European Union.

Address:
Aleksei Kelli
Faculty of Law
University of Tartu
Kaarli pst. 3
10119 Tallinn, Estonia
E-mail: Aleksei.Kelli@ut.ee

References

Andersen, Birgitte (2004) “If ‘intellectual property rights’ is the answer, what is the question? Revisiting the patent controversies”. *Economics of Innovation and New Technology* 13, 5, 417–442.

Ångström Material Academi. Available online at <http://www.uuinnovation.uu.se/ ViewPage.action?siteNodeId=31081&languageId=1&contentId=-1>. Accessed on 21.04.2013.

Åstebro, Thomas (2003) “The return to independent invention: evidence of unrealistic optimism, risk seeking or skewness loving?”. *The Economic Journal* 113, 484, 226–239.

Autio, Erkko (2007) “Entrepreneurship teaching in the Öresund and Copenhagen regions”. Available at <http://www.entrepreneur.dk/E'ship%20coverage%20report%202007.pdf>. Accessed on 21.04.2013.

Baraldi, Enrico, Marcus Lindahl, and Kristofer Severinsson (2011) “Entrepreneurial universities seeking new ways to commercialize science: the case of Uppsala University’s AIMday”, paper presented at the Nordic Academy of Management. 22–24 August 2011. Stockholm. Available online at <http://www.uuinnovation.uu.se/digitalAssets/80/80886_NFF-Paper2011-BaraldiLindahlSeverinsson.pdf>. Accessed on 21.04.2013.

Barry, Jim, John Chandler, and Heather Clark (2001) “Between the ivory tower and the academic assembly line”. *Journal of Management Studies* 38, 1, 88–101.

Coimbra Group. Available online at < http://www.coimbra-group.eu/>. Accessed on 21.04.2013.

Chesbrough, Henry W. (2003) *Open innovation: the new imperative for creating and profiting from technology*. Boston, Massachusetts: Harvard Business School Press.

Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Region (2012) “A reinforced European research area partnership for excellence and growth”. COM (2012) 392. 17 July 2012. Available online at <http://ec.europa.eu/euraxess/pdf/research_policies/era-communication_en.pdf>. Accessed on 21.04.2013.

Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions (2012) “A reinforced European research area partnership for excellence and growth”. COM (2012) 392. 17 July 2012. Available online at <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2012:0392:FIN:EN:PDF>. Accessed on 21.04.2013.

Communication from the European Commission (2010) “Europe 2020: a strategy for smart, sustainable and inclusive growth”. COM (2010) 2020. 3 March 2010. Available online at <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:2020:FIN:EN:PDF>. Accessed on 21.04.2013.

Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions (2009) “The European Union strategy for the Baltic Sea region”. COM (2009) 248. 10 June 2009. Available online at <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0248:FIN:EN:PDF>. Accessed on 21.04.2013.

Commission of the European Communities. Green Paper (2008) “Copyright in the knowledge economy”. COM (2008) 466. 16 July 2008. Available online at <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0466:FIN:EN:PDF>. Accessed on 21.04.2013.

Competence Centre Programme. Available online at <http://www.eas.ee/index.php/for-the-entrepreneur/innovation/competence-centre-programme>. Accessed on 21.04.2013.

Competence Centres. Available online at <http://www.ut.ee/en/entrepreneurship/competence-centres>. Accessed on 21.04.2013.

Convention on the Grant of European Patents, entered into force on 5 October 1973, 1065 UNTS 199.

Convention establishing the World Intellectual Property Organisation. Stockholm, 14 July1967, entered into force on 26 April 1970. – 828 UNTS 3.

D’Este, Pablo and Pari Patel (2007) “University-industry linkages in the UK: what are the factors underlying the variety of interactions with industry?” *Research Policy* 36, 9, 1295–1313.

Eesti Maaülikooli akadeemiliste kraadide andmise ning rakenduskõrgharidusõppe lõputöö kaitsmise tingimused ja kord. [Conditions and procedures for the awarding of academic degrees and for the defence of final thesis of professional higher education in the Estonian University of Life Sciences.] Adopted by the Regulation No.7 of 30 October 2008 of the Council of the Estonian University of Life Sciences. Available online at <http://www.emu.ee/en/studies/regulations/regulation-for-the-awarding-of-academic-degrees/>. Accessed on 21.04.2013.

Edqvist, Charles (2011) “Design of innovation policy through diagnostic analysis: identification of system problems (or failures)”. *Industrial and Corporate Change* 20, 6, 1-29.

Etzkowitz, Henry (2004) "The evolution of the entrepreneurial university". *International Journal of Technology and Globalisation* 1, 1, 64–77.

Etzkowitz, Henry (2001) "The second academic revolution and the rise of entrepreneurial science". *Technology and Society Magazine* 20, 2, 18–29.

Etzkowitz, Henry and Loet Leydesdorff (2000) "The dynamics of innovation: from national systems and 'mode 2' to a triple helix of university–industry–government relations". *Research Policy* 29, 109–123.

European Commission (2012) "Guide to research and innovation strategies for smart specialisation (RIS 3)", 11 May 2012. Available online at <http://ec.europa.eu/regional_policy/sources/docgener/presenta/smart_specialisation/smart_ris3_2012.pdf>. Accessed on 21.04.2013.

European Commission (2011)"The people work programme 2012", C (2011) 5033, 19 July 2011. Available online at <http://ec.europa.eu/research/participants/portal/page/people;efp7_SESSION_ID=GtLTQP3TVh9xgqxYvRlbWTZy9KTt2ys5SQwJypLRXpZCFn6HhmRd!1553516554?callIdentifier=FP7-PEOPLE-2012-IAPP>. Accessed on 21.04.2013.

European Commission (2011) "Proposal for a regulation of the European Parliament and the Council establishing Horizon 2020 – the framework programme for research and innovation (2014-2020)", COM (2011) 809, 30 November 2011. Available online at <http://ec.europa.eu/research/horizon2020/pdf/proposals/com(2011)_809_final.pdf>. Accessed on 21.04.2013.

European Research Area Committee (2012) "Cross-border cooperation among research-performing organisations: learning from difficult success stories for achieving the European research area", ERAC 1205/12, 27 August 2012. Available online at <http://register.consilium.europa.eu/pdf/en/12/st01/st01205.en12.pdf>. Accessed on 21.04.2013.

Frischmann, Brett M. (2005) "Commercializing university research systems in economic perspective: a view from the demand side". *Advances in the Study of Entrepreneurship, Innovation & Economic Growth* 16, 155–186.

Formica, Piero, Tõnis Mets, and Urmas Varblane (2008) "Knowledge transfer mechanisms in the European transition economies". In Jonathan Potter ed. *Entrepreneurship and Higher Education*. OECD Publishing.

Formica, Piero, Urmas Varblane, and Tõnis Mets (2008a) "Knowledge transfer mechanisms from universities and other HEIs to the SME sector". In Elias Carayannis and Piero Formica, eds. *Knowledge matters: innovation networks and knowledge clusters*. Houndmills, Basingstoke, and Hampshire: Palgrave Macmillan.

Hilty, Reto (2012) "Licensing for competition, innovation and creation". In Ian Hargreaves and Paul Hofheinz, eds. *Intellectual property and innovation: a framework for 21st century growth and jobs*, 49–51. The Lisbon Council.

Intellectual Property Strategies in Bioscience (2007) *Compendium of working papers from ScanBalt IPKN project*. Stuttgart, Berlin: Steinbeis-Edition.

Jones, Ronald (2009) "Fail again. Fail better". Available online at <http://www.red-tape.info/Images/LearningMind_Jones.pdf>. Accessed on 21.04.2013.

Jonsson, Lars, Karin Meyer-Rosberg, Pär Svanström, Mateo Santurio, Torbjörn Fängström, and Gerald Pettersson (2010) "Evaluation of the potential for commercialization of the intellectual property of Estonian research universities and preparation of the expert analysis necessary for developing the system", report from the preliminary analysis performed by the representatives from Uppsala University Innovation.

Kelli, Aleksei, Tõnis Mets, Heiki Pisuke, Elise Vasamäe, and Age Värv (2010) "Trade secrets in entrepreneurs' intellectual property strategies: the Estonian experience". *Review of Central and East European Law* 35, 4, 315–339.

Kelli, Aleksei (2009) *Developments of the Estonian intellectual property system to meet the challenges of the knowledge-based economy*. Doctoral thesis. Tartu: Tartu University Press.

Kelli, Aleksei and Heiki Pisuke (2008) "Intellectual property in an innovation-based economy". *Review of Central and East European Law* 33, 223–238.

Lactobacillus Fermentum ME-3 Bacteria and the Hellus Product Line. Available online at <http://www.ut.ee/en/entrepreneurship/success-stories/lactobacillus-fermentum-me3-bacteria-and-the-hellu>. Accessed on 21.04.2013.

Levin, Marianne, Göran Blomqvist, Anders Hedberg, Bengt Johansson, Max Kesselberg, Monika Selahn, Hans Wigzell, Per Ewaldsson, Per Holmstrand, Eva Jarnvall, Sara Modig, Anneli Skoglund, Peter Adamsson, Katarina Strömholm, and Sanna Wolk (2005) "The right to the results of higher education research". Available online at <http://regeringen.se/content/1/c6/05/34/08/5b44c128.pdf>. Accessed on 21.04.2013.

Link, Albert N., Donald S. Siegel, and Barry Bozeman (2007) "An empirical analysis of the propensity of academics to engage in informal university technology transfer". *Industrial and Corporate Change* 16, 4, 641–655.

Litan, Robert E., Lesa Mitchell, and E. J. Reedy (2007) "The university as innovator: bumps in the road". *Issues in Science & Technology*. Available onine at <http://www.issues.org/23.4/litan.html>. Accessed on 21.04.2013.

Markman, Gideon D., Peter T. Gianiodis, Phillip H. Phan, and David B. Balkin (2004) "Entrepreneurship from the ivory tower: does incentive systems matter?" *Journal of Technology Transfer* 29, 353–364.

Mets, Tõnis (2010) "Entrepreneurial business model for classical research university". *Engineering Economics* 21, 1, 80–89.

Mets, Tõnis (2010a) "Privileged or not privileged academician – view on intellectual property management at university". In Jelena Stankevičienė, Romualdas Ginevičius, Aleksandras Vytautas Rutkauskas and Remigijs Počs, eds. *The 6th International Scientific Conference Business and Management*, 550–556. Vilnius: Vilnius Gediminas Technical University Press.

Mullins, Bob and Jan Crowe (1999) "Technology transfer: a roadmap". *College and University Auditor* 43, 1, 4–17.

Õppejõudude ja teadustöötajate ametinõuded. [Requirements for Teaching and Research Staff.] Adopted by the Regulation No.11 of 24 September 2010 of the Council of the University of Tartu. Available online at <http://www.ut.ee/orb.aw/class=file/action=preview/id=888324/%F5judude+ja+tt%F6%F6tajate+an%F5uded_eng.pdf>. Accessed on 21.04.2013.

Organisation for Economic Co-operation and Development (2012) "OECD reviews of innovation policy: Sweden. Preliminary version". Available online at <http://www.oecd.org/sti/innovationinsciencetechnologyandindustry/innovation-review-sweden-preliminary>.pdf. Accessed on 21.04.2013.

Organisation for Economic Co-operation and Development, "The Knowledge-based Economy", OCDE/GD (96) 102, 1996. Available at <http://www.oecd.org/dataoecd/51/8/1913021.pdf>. Accessed on 21.04.2013.

Petrusson, Ulf (2011) "Patents and open access in the knowledge economy". In Annette Kur and Vytautas Mizaras, eds. *The structure of intellectual property law. Can one size fit all?,* 56–96. Cheltenham: Edward Elgar.

Powell, Walter W., Jason Owen-Smith, and Jeannette A. Colyvas (2007) "Innovation and emulation: lessons from american universities in selling private rights to public knowledge". *Minerva* 45, 121–142.

Quinto, David W. and Stuart H. Singer (2009) *Trade secrets: law and practice*. Oxford: Oxford University Press.

Raivio, Kari (2008) "Foreword: university reform – a prerequisite for success of knowledge-based economy?". In Carmelo Mazza, Paolo Quattrone, and Angelo Riccaboni, eds *European universities in transition: issues, models and cases*. Cheltenham: Edward Elgar.

Regulation (EC) No.294/2008 of the European Parliament and of the Council of 11 March 2008 establishing the European Institute of Innovation and Technology (9 April 2008), OJ L97, 1–12.

Solibro. Available online at < http://www.solibro.com/>. Accessed on 21.04.2013.

Sörlin, Sverker (2007) "Funding diversity: performance-based funding regimes as drivers of differentiation in higher education systems". *Higher Education Policy* 20, 4, 413–440.

Tadmor, Zehev (2006) "The triad research university or a post 20th century research university model". *Higher Education Policy* 19, 3, 287–298.

Tallinn University, "Usundiloo professori ekspertarvamus universaalse palvetoa loomiseks Tallinna Lennujaama". [Professor of the history of religions expert opinion on the establishing of the confession free pray room at the Tallinn Airport.] Available online at <http://www.tlu.ee/?LangID=1&CatID=2637&ArtID=3852&action=article>. Accessed on 21.04.2013.

Tallinna Ülikooli doktoriõpingute ja doktoritööde kaitsmise eeskiri. [Regulations of doctoral study and the defence of doctoral thesis at Tallinn University.] Adopted by the Regulation No.13 of 26 April 2010 of the Senate of Tallinn University. Amended by the Regulation No.24 of 14 June 2010 of the Senate of Tallinn (in Estonian). Available online at <http://www.tlu.ee/files/arts/1666/Dokto9bdf9fab8769ad67913b7de661815b60.pdf>. Accessed on 21.04.2013.

Tallinna Tehnikaülikooli lõpetamise eeskiri. [Regulations of the completion of studies at Tallinn University of Technology]. Adopted by the Regulation No.5 of 18 November 2008 of the Tallinn University of Technology Council. Amended by the Regulation No.5 of 16 June 2009 of the Tallinn University of Technology Council. Amended by the Regulation No.10 of 16 November 2010 of the Tallinn University of Technology Council (in Estonian). Available online at <http://www.ttu.ee/ope/oppeinfo/juhendid/oppetegevuse-juhendid/>. Accessed on 21.04.2013.

Teadus- ja arendusasutuste baasfinantseerimise määramise tingimused ja kord. [Conditions and procedure for assignment of basic finances for research and development institutions.] Entered into force on 27 March 2005. – RTL 2005, 34, 483; RT I, 16 December 2010, 27 (in Estonian). Available online at <https://www.riigiteataja.ee>. Accessed on 21.04.2013.

Teadus- ja arendusasutuste teadusteemade sihtfinantseerimise tingimused ja kord .[Conditions and Procedure for Targeted Financing of Research Themes of Research and Development Institutions.] Entered into force on 20 April 2002. – RTL 2002, 50, 710; RT I 2010, 61, 431 (in Estonian). Available online at <https://www.riigiteataja.ee>. Accessed on 21.04.2013.

Teaduskraadide põhimäärus. [Statutes of research degrees.] Adopted by the Regulation No.36 of 30 November 2007 of the Council of the University of Tartu. Amended by the Regulation No.12 of 20 June 2008 of the Council of the University of Tartu. Amended by the Regulation No.1 of 29 January 2010 of the Council of the University of Tartu. Available online at <http://www.ut.ee/livelink_files/8104455.pdf>. Accessed on 21.04.2013.

Trune, Dennis R. and Lewis N. Goslin (1998) "University technology transfer programs: a profit/loss analysis". *Technological Forecasting and Social Change* 57, 3, 169–284.

Wikipedia 'SWOT analysis' entry, available online at <http://en.wikipedia.org/wiki/SWOT_analysis>. Accessed on 21.04.2013.

Wright, Mike, Sue Birley, and Simon Mosey (2004) "Entrepreneurship and university technology transfer". *Journal of Technology Transfer* 29, 235–246.

APPENDIX

General data and indicators of R&D commercialization[1] are presented in the following table:

	Uppsala University	**University of Tartu**	**Tallinn University of Technology**
Founded	1477	1632	1918
Number of 1) Students (full time) 2) Employees 2.1) Academic employees 2.2) Full professors	 40000 (26000) 5924 4000 600	 18047 3596 1748 186	 14000 2000 1148 133
Legal status	Governmental agency	Legal person in public law	Legal person in public law
R&D funding, M€ (2011)	428	43.864	31.464
ISI publications, 2011 – per academic person – expenses per publication, M€	2859 0.84 0.150	952 0.54 0.046	390 0.44 0.081
Structure of the innovation support system	The innovation support system consists of two components: 1) Uppsala University Innovation (a structural unit of UU) and 2) UUAB Holding	Innovation support unit	Innovation and Business Center
The period of time during which the current innovation support system has been in place	12 years	10 years	10 years
IP ownership regime	Professor's privilege	Institutional ownership	Institutional ownership
Revenue distribution (IP is exploited through the university's innovation support system)	Inventor is allocated 50% of the revenues (before exploitation costs are covered). After the exploitation costs are covered, the inventor's share is 65%.	Inventor is allocated 2/3 of the income received from an invention (protection and other similar costs deducted).	Inventor is allocated 1/3 of the income received from an invention (protection and other similar costs deducted).
In order to encourage patenting, patents are considered as high level publications	No, but may be considered in favor for an applicant to a full professor position or a chair.	Yes	Yes

[1] The information in the Table is collected from the web pages of Uppsala University, the University of Tartu, the Tallinn University of Technology, Web of Science (2011) and it is also based on the authors' knowledge. Additional information regarding Tallinn University of Technology was given by Kersti Peekma (e-mail communications, 11 November 2011 and 3 December 2012).

	Uppsala University	**University of Tartu**	**Tallinn University of Technology**
Extent of innovation support			
1) Transfer activities	No	No	No
1.1) Limited to technology (technology transfer)	Yes	Yes	Yes
1.2) Wider than technology (knowledge transfer)			
2) Enhancement of industry-academia strategic collaboration			
2.1) Structured	Structured		
2.2) On an *ad hoc* basis		On an *ad hoc* basis	On an *ad hoc* basis
3) Business incubator as a structural unit of the university's innovation support system	Yes	No	No
4) Investment (policy) into spin-offs	Yes	No	No
Models of knowledge transfer include licensing, spin-off and assignment	Yes	Yes	Yes
Idea disclosures (2006–2011)	467	77	95
Accepted disclosures (investments in projects, not necessarily patenting) (2006–2011)	71	61	81
New companies (2006–2011)	23	0	4
License agreements (2006–2011)	10 (>50 if transfer of patent rights from inventors to a founded start-up company with UUAB Holding as a part-owner is considered)	22	4
Patents sold (2006–2011)	2	4	2