

THE POLICY SUGGESTIONS CONCERNING MOTIVATIONS AND BARRIERS OF UNIVERSITY-INDUSTRY COOPERATION¹

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Abstract

The universities as scientific and educational bodies transform into entrepreneurial organizations focusing on cooperation with industry. The motivations for increased cooperation with industry include additional funding of research, application of research results in practice, sharing experiences with practitioners, discovering novel research problems, and securing jobs for alumni. Industries seek cooperation with universities in order to build competitive advantage, increase productivity, gain access to new technologies and to potential qualified labour, influence curricula development, use labs and equipment, and to improve image. The barriers to cooperation include differences in goals and culture, miscomprehensions, biased attitudes, remuneration systems, different focuses, lacking communication, and difficulties in commercialization. The purpose of this study is to suggest policies to enhance motivations and/or reduce barriers of university-industry cooperation.

Keywords: university-industry cooperation, motivations, barriers, policy making

JEL Classification: O31, O32, O38

Introduction

At present, several EU member states face difficulties with sustaining their global and regional competitiveness. The new knowledge-based competitive advantages require success in R&D and innovation. This in turn is unlikely to commence without the extensive and elaborate cooperation between universities and industries. The universities as academic organizations take lead in terms of fundamental research, but applied research and commercialisation of results via innovations requires active involvement of industry and entrepreneurial initiatives. Thus, university-industry cooperation is paramount channel for transferring the leading edge research results into companies and for transferring them into marketable business solutions. Although this might seem straightforward, the establishment of these cooperative ties is a complex and challenging process.

Despite the fact that in general both parties are motivated for cooperation with each other, these intentions are often not sufficient for long-lasting fruitful transfers of monetary, knowledge, and human resources. Barriers to university-industry

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cooperation originate from several sources. In several countries universities tend to be public organizations whose mission and development goals differ considerably from private companies. These differences are reflected and amplified by potential differences in values and organizational culture. The differences in operational logic and environment complicate the understanding of each other, while evaluation and remuneration systems of academic researchers fail to set focus on commercial application aspect of research. The impulses and ideas for research are created within academic circles based on previous discourse and not in cooperation with practitioners. As a result, academic universities and industries establish separated communities without common focus, understanding, and interests. Thus, research becomes detached from development and innovation.

In case universities and industries are unable or unwilling to acknowledge these dangers, government policies could have very important catalytic role in bringing the parties closer together. Even if universities have started transformation towards becoming more entrepreneurial as the knowledge provider for industries, public policies can still enhance the situation by supporting the process with legislation and other measures. It is equally important to motivate and reward industries in their search of new knowledge and assistance from universities. Some of these facilitating policies might reflect EU-wide policy initiatives, while others address more local aspects.

The purpose of this study is to suggest policies to enhance motivations and/or reduce barriers of university-industry cooperation. The analytical discussion elaborates on the motivations of universities as well as the motivations of industries for cooperation and joint projects. These motivations and university-industry cooperation in general is influenced by various barriers. Some of these barriers could be removed or at least reduced by appropriate policies. Policy measures could create additional motivations for cooperation or influence both aspects simultaneously.

The study is structured as follows. The discussion starts with short explanation of the changes in the role of universities and their connections to industry and society along with some examples about the forms of cooperation. The following section outlines the motivations for university-industry cooperation on the basis of literature and evidence from other countries. Then we discuss the barriers to cooperation. The next section provides short overview about the situation and main problems with university-industry cooperation in Estonia. On the basis of this theoretical and contextual evidence, the fifth section provides a set of policy suggestions aimed at enhancing motivations for cooperation and/or at reducing the barriers. Conclusions outline the main results, limitations, and suggest paths for future research.

The research-oriented university versus modern entrepreneurial university

In order to understand the nature, benefits, and obstacles of university-industry cooperation, one should first observe the changes in the operating environment of companies and universities as well as in their role in society.

At the beginning, in the Middle Ages, when universities were established, they were seen as the preservers and carriers of culture. (Etzkowitz 2001) In that era, the universities, professors and students lived rather separately from society. However, over time universities have become much more integrated with surrounding environment, including the needs and activities of companies. If in case of companies we observe the increase in competition, then the environment of universities has evolved towards higher competition as well. The global number of various universities has increased considerably, which means in turn that the competition for students and funding intensifies in time.

Wissemma (2009) outlines three generations in the development of universities: the middle age or first-generation university, Humboldt or second-generation university, and third-generation university. At present, we live in the age of transition from second to the third generation and thus, third-generation universities will be more prevalent in the future. Table 1 shows the differences between various generations of universities.

Table 1. The nature and differences between three generations of universities

	First-generation universities	Second-generation universities	Third-generation universities
Goal	Education	Education and research	Education, research, and application of know-how
Role in society	Protection of rights	Discovery of nature	Creation of value
Thought and formed	Professions	Professions and researchers	Professions, researchers, and entrepreneurs
Orientation	General	National	Global
Language	Latin	National language	English
Management	Chancellor	Academic (part-time)	Professional manager

Source: Wissemma 2009

The changes in the role of universities have been explained alternatively via describing academic revolutions. During first academic revolution, the universities took on as primary tasks as preservers and distributors of knowledge along with research function (Gibbons 2000). Second academic revolution has entailed increase in the connections of universities with enterprises and the trend that universities themselves have become more entrepreneurial in nature.

The notion of entrepreneurial university coincides with a notion of third-generation universities that was discussed earlier. After first academic revolution, universities started to look for opportunities how to turn research results into marketable goods. Entrepreneurial university has innovative organization structure, technologies, and financing schemes. It values and develops among the employees as well as students the entrepreneurial attitudes, behaviour, and individual abilities, which have impact on person's career and brings long-term benefits to society and economy. (Bratianu, Stanciu 2010)

In order to be entrepreneurial, university has to become largely independent from industry or government sector. At the same time, the mutual interaction of these parties is very important. If university system is based on principle that ministry decides how many students are to be admitted on particular curricula, then there is not enough autonomy, which would enable university to be entrepreneurial. University has to have certain authority over its strategic decisions. Another important precondition for entrepreneurship in university is the close cooperation with other relevant parties. (Etzkowitz 2003)

In case of entrepreneurship in universities, there are different levels or categories from which in turn depends the format and nature of university-industry cooperation. The formation of entrepreneurial university could be seen in three levels and accordingly university categories, these are (Etzkowitz 2003):

- transitional entrepreneurial university,
- full-fledged entrepreneurial university,
- entrepreneurial university as an extension of the science park.

Transitional entrepreneurial university is still engaged with formulation of research problems and setting research goals from within the organization and in the framework of academic disciplines. The difference from traditional research university relates to the fact that economically or socially beneficial research results are accounted for and if possible applied. These universities establish specialized positions or units that help to transfer such applicable knowledge. In general, however, on this transitional level the boundaries between university and society remain strong. (Etzkowitz 2003) On this level, the universities engage mainly in the consultation of companies (Gibbons 2000).

The most important characteristic of full-fledged entrepreneurial university is the fact that research problems are defined also on the basis of external sources and not just on the basis of intra-university academic disciplines. These universities adapt themselves and their research according to the needs and requests of industry and make the research results more accessible (Ibid). One possibility to organize such cooperation is to establish joint research centres, where academic and corporate researchers define research problems and conduct research together (Etzkowitz 2003).

The third level entrepreneurial university as an extension of the science park invests its resources into establishment of new companies and participates actively in joint businesses with companies, in order to increase income (Gibbons 2000). Thus, in the model of entrepreneurial university as an extension of the science park academic research is often preceded by knowledge-based business, which is thereafter strongly related with research (Etzkowitz 2003).

The role of university in modern and future society is symbiosis of teaching, research, and services to society (Santoro 2000). In the development and transition economies, the third mission is often interpreted as serving societal needs in terms of

policy development or the development and provision of social services. In developed economies, however, the transfer of knowledge and technologies is seen as the third mission of university. That, which role should university assume in addition to teaching and research depends largely from the history of country or region as well as from previous models of operation (Göransson et al. 2009).

In order to characterize and facilitate the university-industry cooperation, several cooperation models have been discussed. Earlier models were linear or sequential in nature. In these, either a university took initiative by sharing knowledge via publications and other means, or alternatively an industry initiated research process by reflecting the market needs to universities. Contemporary views favour circular, spiral, and interactive models. (Mora-Valentín, Ortiz-de-Urbina-Criado 2009) In these models, information and knowledge is exchanged and developed between parties through numerous iterations on qualitatively higher and higher level. Thus, there are several feedback loops, which refine the understanding of the problem and capabilities.

In conclusion, the modern universities are becoming increasingly entrepreneurial by doing not only the teaching and research, but providing also services for industry or establishing new companies, which bring research results into market. The cooperation with industry is not simple linear process, but it involves several mutual exchanges, which increase the likelihood of reaching desired outcome.

The motivations of both parties for university-industry cooperation

There is growing consensus that technological innovation is derived from the collaboration of enterprises and universities or research centres (Mora-Valentín, Ortiz-de-Urbina-Criado 2009). To achieve economic growth it is important to create and apply new knowledge. While universities are important sources of new knowledge (Agrawal 2001), the linkages between enterprises and universities are very important for supporting the economic growth.

Current competitive environment is characterized by intense global competition, rapid technological change, and shorter product life cycles (Elmuti et al. 2005). For firms there is a pressure to advance their knowledge and technology in order to ensure survival and long-term prosperity. Due to the rapid changes, limited expertise, and resources, the firms are looking for knowledge and technology increasingly from different external sources. These sources include suppliers, customers, competing firms, research organizations, government laboratories, industry research associations, and universities. (Santoro, Chakrabarti 2002)

Organizations are limited in the amount of skills and knowledge they can develop and maintain internally since firms have a finite group of people and resources. Technologies are becoming increasingly complicated and need resources or knowledge the firm does not have or, due to the limited time for the commercialization of new product, does not have time to acquire (Santoro 2000).

Universities can provide firms with skills, knowledge, and access to facilities needed to effectively evolve the firm's capabilities. Universities are unique in the way that a firm can not only obtain knowledge and technology, but it can also recruit graduates and faculty members to serve as employees and consultants. (Santoro, Chakrabarti 2002) For that reason, the universities have become useful and important cooperation partners for the enterprises.

The relationships between universities and industry encompass very different activities, structures and concepts. In general the cooperation of universities and industry is the exchange of ideas or resources between a unit of university (or researcher) and business organisation or part of it (Anderson 2001).

The interest in the cooperation processes of universities and industry has been there already since the 1980s (Geisler, Rubenstein 1989). Over the years, both the cooperation and the desired result of it have become increasingly focused.

There are several reasons for universities and industry to cooperate (see figure 1). Universities interact with industry for additional funds both from public and private sector (Barnes et al. 2002), expose students and faculty to practical problems, create employment opportunities for their graduates, and gain access to applied knowledge in technological areas (Santoro, Chakrabarti 2002). Knowledge transfer works not only from university to industry, but also in other direction. Research has shown that interacting with industry enables university scientists conduct better basic research, provide improved understanding of research applications in industry, and may give them a different perspective on a problem, which can lead to new ideas. (Siegel et al. 2003; Geuna, Muscio 2009)

In the study of European university-industry cooperation, the research results revealed that universities and academics regard the benefits of cooperation for students as the highest. The personal benefits to researchers were rated the lowest, especially those regarding the incentives provided by the universities. (The State of European University-Business Cooperation ... 2011)

In general, the enterprise will cooperate with university in case it cannot achieve its goal alone, or it is quicker or cheaper to do it in collaboration with university. For example, R&D collaboration with universities makes it possible to develop through new products, services or processes competitive advantage of the firm and thus raise its competitiveness in the market. Through cooperation, it is possible for the industry to gain access to new technologies universities have. Cooperation gives to the firm access to the valuable and limited resources mentioned before – knowledge, technology, equipment, and laboratories. Although the university-industry collaboration is in some cases funded by governments, the additional financial resources may be also a motivation for this kind of cooperation. Doing R&D collaboration with university may lower R&D expenditure of the firm in some cases (Barnes et al. 2002, Elmuti et al. 2005).

Through cooperation with universities, industry can influence also the development of human resources according to the needs of industry. By taking part in curriculum development and delivery, the industry can shape future employees. In cooperating with university, the firms gain access also to students and notice qualified and suitable people early on, whom they can hire. Access to highly trained students is one of the most acknowledged benefits from the industry side. Research results indicate that firms value also an enhanced image, which they get from collaborating with a prominent academic institution (Santoro, Chakrabarti 2002).

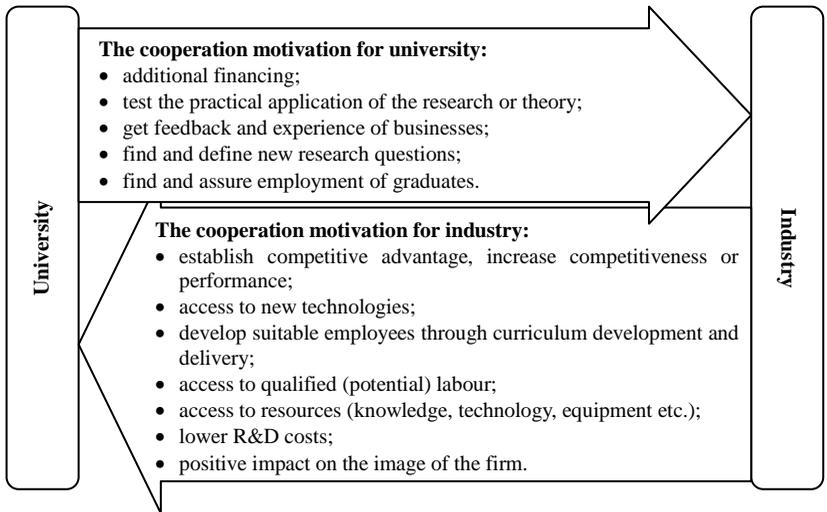


Figure 1. The cooperation motivations of universities and industry (composed by authors based on Santoro 2000, Elmuti et al. 2005, Guan et al. 2005, Pertuzé et al. 2010, Geisler, Rubenstein 1989).

It is important to stress that the cooperation *per se* is not important, but the outcome of this cooperation or even more precisely the positive impact to the partners. This is especially true from the viewpoint of industry (Pertuzé et al. 2010). For enterprises the cooperation partners can be also customers, suppliers or even competitors, whose role and impact on the firm's R&D is somewhat different. The advantage of universities as partners is that they are institutions outside of the industry and hence may possess unique and different knowledge, resources or skills than the firm or possible partners in the industry. The research has confirmed that university collaboration have positive influence on firm's product innovation. (Kang, Kang 2010)

Cooperation motivation with universities is influenced also by the type of industry. The research has shown that knowledge from universities is more important for the science-based firms (in the sector of electronics, chemicals, pharmacy) (Pavitt

1984). Thereat enterprises from different industry sectors use and value different technological and market knowledge (Bekkers, Bodas Feritas 2008).

In the situation of increasing global competition and rapid development of technology, the governments try to conduce to the cooperation of universities and industry. University-industry cooperation should lead to innovation that is more effective and this in turn should lead to economic growth and value creation. (Barnes et al. 2002) The experience of USA shows that governmental support of qualitative academic research brings along positive effect for the whole economy. Through support of academic research, there is created knowledge and skills, which in turn attract to the region other high-tech companies. (Pavitt 2000)

There are several benefits for the parties in university-industry cooperation. The motivations include financial benefits for both universities and enterprises. Universities consider also the benefits to students important, but the personal benefits for academics are considered moderate. The cooperation motivation for firms is the access to external and valuable resources, which include knowledge, technology, equipment, and qualified labour.

The barriers to university-industry cooperation

Although there are many benefits from the university-industry collaboration, there are also barriers, which do not allow the aforementioned benefits to realize in practice or hinder the collaboration altogether. It seems that most of the problems arise from the big differences between academic and business communities.

The main barriers to cooperation of universities and industry are following (Elmuti et al. 2005, Iqbal et al. 2011, Widiawan 2008, Santoro 2000, Guan et al. 2005, Bruneel et al. 2010):

- different objectives;
- different organizational cultures (values, time, language);
- different focus of the research;
- conflicts over intellectual property;
- lack of financial resources and funding;
- unawareness of the partner's operational environment;
- unsupportive incentive, compensation, and career systems in university;
- low absorptive capability of the firm;
- low technological capability of university;
- problems with commercialisation of university research results;
- long geographic distance between the firm and university.

Universities and companies have different goals, orientation, time approaches, languages, principles and basic assumptions. Several researches have shown that for universities it is important to integrate the results of both basic and applied research into teaching of students, and this way develop future specialists and scientists (Santoro 2000; Iqbal et al. 2011). Companies' interest is to use the research results

for solving present problems and thereby increase the return and profit (Santoro 2000). Universities main principle is create and disseminate new knowledge. At the same time, companies are operating in very competitive environment and would like to make knowledge confidential and develop from that their competitive advantage.

Companies act more on short term goals and time frame, while in academia the time horizon is longer and the goals might be not so defined. Different organizational cultures, languages and values can bring along many communication problems (Elmuti et al. 2005), and prejudice toward the other party. Because of the cultural differences, it is important that partners define common goals and mutual perception before the agreement (Iqbal et al. 2011).

The firms have usually very tight time constraints and need solutions to their problems right away. In universities the research and publishing of research results takes time. One time consuming aspect is the academic “principle” that research should be conducted with attention to details and in-depth investigation, so that the results would be well-founded and reliable. Companies take quick results as more important and for that they are accepting also a bit more robust research. As companies are not always ready to wait, they use a possibility to import the solution, instead of collaborating with universities. (Iqbal et al. 2011)

Industry is interested in the applied research, which results allow develop new marketable product or service, process or solution to a problem. Academic researchers are interested rather in contributing to creation and development of knowledge, thus a new concept, model, empirical finding or measurement technique would be a desired result.

Besides the orientation-related barriers, there can be also transaction-related barriers, which relate mostly to conflicts over intellectual property. The problem with the ownership of intellectual property is one of the most mentioned conflicts between universities and industry. (Bruneel et al. 2010) Both partners are interested in getting the rights as this is the possibility for providing and securing the income or return on investment. Institutional and group agreements, strong commitment (Iqbal et al. 2011), and high level of trust enable to diminish this barrier.

The lack of financial resources and funding is an important constraint in the cooperation of universities and industry, especially for universities. The financial support and benefits are for universities important and make possible to establish and maintain the relationships with industry. (The State of European University-Business Cooperation ... 2011) Funds, scholarships, grants, endowments are assisting researchers, but are also good success criteria of university-industry collaboration (Iqbal et al. 2011). As the study of European universities revealed, for greater cooperation between academia and industry, it is not enough just to increase the funding of universities, the relationship drivers or perceived benefits (motivators) have to be increased as well (The State of European University-Business Cooperation ... 2011).

Usually the enterprises do not understand the distribution of work in university or for example, how the budget of university is formed. At the same time, universities do not perceive the market forces, time limits and inside processes of the firm. This kind of unawareness brings along communication problems. (Elmuti et al. 2005)

The academic institutions include strong competitive mechanisms and researchers are competing with their peers over financing and status. The success is achieved mainly through publications and due to strong internal dynamics; the science system is quite separated from market transactions. (Bruneel et al. 2010) The compensation and career system in universities take into account the achievements in the field of scientific research, but applied research and interaction with industry is usually not important in academia.

Successful cooperation depends definitely on the capabilities of the firm. The research has shown that there are certain characteristics of the firm that influence its ability to utilize externally generated scientific knowledge, and thus the knowledge transferred from universities (Agrawal 2001). Cohen and Levinthal (1990) have introduced the concept of absorptive capacity, and define it as ‘the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends’, and which depends on prior related knowledge and experience (Cohen, Levinthal 1990: 128). Several studies have revealed that for example enterprises with higher R&D intensity have also more collaboration with universities (Giuliani, Arza 2009).

The technological competency of the firm is important. If it is low, the university has to spend more time and energy on providing technical assistance with the technology. Sometimes universities solve this problem by licensing their technologies to foreign countries and this way feeling less obligated to provide assistance. For getting over the problem of low technological competency, an adequate communication is important. Frequent communication between university and company allows partners to share problems, information, and to provide assistance. (Iqbal et al. 2011)

For successful cooperation is important that the technological capabilities of university are higher than industry's capabilities. Otherwise, there is no need for industry to collaborate with university. The higher technological capabilities of university, the more successful are the partnerships with industry. (Widiawan 2008) Some studies have stated that the quality of the staff and research of the university is even more important than strength of industry demand. If the university is characterized by low-quality research, it has little to offer to industry. (Giuliani, Arza 2009)

In some cases the firms complain that there are problems with commercialisation of university research results as the research results are immature, have high marketability uncertainty, or there is lack of efficient communication channels for transfer of the research results. These problems are more related to the purchase of

university research results, and can be diminished by collaborating in R&D and by developing research results together. (Guan et al 2005)

Several studies have shown that the results of academic research are put in practice more through personal contacts and mobility of people. But the geographic distance and language limit those personal contacts and direct interaction. This means that the benefits from the academic research are more likely to stay inside the country or region (Pavitt 2000). Previous research has shown that geographic proximity plays an important role in the intensity of university-industry relationships and greater level of tangible outcomes (Santoro 2000).

One reason why the potential benefits of cooperation do not realize is the absence of an effective cooperation management (Barnes et al. 2002). Qualified and competent project managers are the crucial factors for successful cooperation and satisfying outcomes (Pertuzé et al. 2010). The studies reveal that experience of collaboration, breadth of interaction channels, and inter-organizational trust are mitigating the barriers to collaboration (Bruneel et al. 2010).

In conclusion, it can be said that the barriers to university-industry cooperation are in general orientation-related, transaction-related, financial, and institution specific. For successful university-industry collaboration, it is important to find the possibilities to reduce the barriers, and in the same time increase the motivation of parties for cooperation.

The university-industry cooperation in the small EU member state Estonia

One aim of Estonian Higher Education Strategy 2006-2015 is to guarantee that the higher education serves Estonia's developmental interests and innovation. This means that universities have to account for the needs to develop economy and society in their layout of teaching and research. The goal is to involve all relevant social partners, including industry, into planning and execution of activities in higher education. This education sector should take an important role as the leader of economic and social innovation or modernisation as well as in integrating the society into political, economic, and social networks. (Estonian Higher ... 2006)

Although, this aim and its layout might seem declarative, there is a need to establish new development connection between universities and society. The six public universities along with their colleges and some private universities (see table 2) form a strong core of Estonian higher education. Despite the differences in research and teaching profile, all these universities have potential to establish cooperative arrangements with industry. For example, Estonian Academy of Arts has potential capabilities to contribute to industrial design and architecture.

Table 2 indicates that the number of students in most public universities has steadily grown, while number of students in private universities has decreased. These figures reflect the general development trend in Estonian higher education. According to this trend, several private universities have been or are seeking to be acquired by

public universities. University of Audentes merged in 2008 with the Tallinn University of Technology and Academia Nord later with University of Tartu. This concentration of higher education is positive, because very small domestic market does not offer sustainable development opportunities for duplicating offers of similar education. The private background of acquired small universities might also facilitate some cooperative ties with industry by inducing more practice-oriented culture. Even without direct shift in culture, the mergers help to gain new insights and competences, because private universities tend to provide more applied education.

Table 2. The number of students in Estonian public and private universities

	Founded	No. of students 2005	No. of students 2008	No. of students 2010
PUBLIC UNIVERSITIES:				
University of Tartu	1632	18 536	17 130	18 196
Tallinn University of Technology	1918	10 700	13 122	13 883
Estonian University of Life Science	1873/1951	4 752	4 735	4 838
Tallinn University	1919/2005	7 350	8 451	9 630
Estonian Academy of Arts	1914	962	1 170	1 220
Estonian Academy of Music and Theatre	1919	567	681	762
<i>Total of students in public universities</i>		<i>42 867</i>	<i>45 289</i>	<i>48 529</i>
PRIVATE UNIVERSITIES:				
Estonian Business School	1987	1 981	1 607	1 544
Euroacademia	-	850	1 281	1 009
Other private universities		3636	993	123
<i>Total of students in public universities</i>		<i>6 467</i>	<i>3 881</i>	<i>2 676</i>
Total of students in all universities		49 334	49 170	51 205

Sources: Estonian Education System Database (EHIS)

The comparison of data from three Community Innovation Surveys (CIS) reveals that the importance of universities as knowledge sources for innovation has over the years slightly grown (see table 3). The other public R&D institutions are considered less important than universities and in general less relevant than universities. Despite certain progress in university- industry contacts close to 74 % or $\frac{3}{4}$ of respondents do not use universities as knowledge partners at all. Private consultants and labs are more popular as innovation sources.

In 2006-2008 CIS survey, 5.3 % of respondents considered them to be with high importance and 15.5 % with average importance. However, 4.1 % responded that universities are their most important innovation partners, which represents considerable growth in comparison with earlier studies. Thus, according to CIS results the universities are gaining in importance as cooperation partners for industry. Somewhat naturally, intra-corporate ties within concern, suppliers, and consumers are much more important innovation knowledge sources than universities. (Reid et al. 2011)

Table 3. The importance of innovation knowledge sources (% of respondents)

	1998-2000		2004-2006		2006-2008	
	Univer -sities	Public R&D Institutions*	Univer -sities	Public R&D institutions	Univer -sities	Public R&D institutions
High	1.3	0.9	2.8	0.8	3.0	0.7
Average	8.1	3.4	6.6	3.8	8.9	5.1
Low	10.6	7.4	9.7	6.9	14.2	9.3
Does not use	80.0	88.3	80.9	88.5	73.9	84.5

* includes also private R&D institutions

Sources: Reid et al. 2011

The comparative results of CIS show that large and foreign-owned companies use universities and public R&D institutions as additional knowledge sources for innovation more than SMEs or domestic companies. Somewhat surprisingly, service sector companies use universities marginally more than producers do. This might be related to ICT services, but difference between producers and service providers is indeed marginal. Producers rely more on suppliers and fairs as innovation sources, while other sources are comparatively more used in service companies. In general, the innovation cooperation has considerably grown during three survey periods in small companies and medium companies. In large companies, there is no clear growth trend. (Ibid)

In international comparison, Estonian companies are actively engaged in innovation cooperation. 48.6 % of respondents in 2006-2008 CIS had some cooperative ties, which gives fourth place after Denmark, Cyprus, and Belgium. Majority of these relations are created with European partners. Therefore, similarly to Slovenia, the cooperation tends to be more regional than global. Such openness to cooperation and its growth trend among SMEs reveals good potential for building joint projects among partners, including universities. (Ibid)

Other more specific studies that, in addition to questionnaires, incorporate numerous interviews with industry representatives allow us to discuss reasons why several foreign-owned companies or companies from certain do not cooperate with universities. These studies include the Study of Foreign-Owned Companies in Estonia made by The University of Tartu FEBA in 2009 and more recent Study of Estonian Machinery Industry from 2011.

The data gathered from foreign-owned companies in Estonia indicates as well that universities, their colleges, and institutes are not very important cooperation partners (average score only 2.38 from 5) (see Table 4). The cooperation with branch unions and state organisations is evaluated also as rather unimportant, while state-owned or non-profit R&D labs are almost not important as cooperation partners at all.

Table 4. The average importance scores of cooperation with various parties (1=not important at all...5=very important)

Cooperation partners:	Score
Customers	4.41
Other companies and subsidiaries of your foreign owner	4.14
Suppliers of equipment, materials, intermediate products and/or software	4.05
Competitors and other companies from the same field	2.67
Branch unions and state organisations	2.61
Universities, their units and institutes	2.38
Consultation companies	2.33
Companies offering R & D services	2.12
State or private non profit R & D institutions	1.92

Source: Varblane et al. 2010

Interviews with the managers of foreign-owned companies revealed that academic education in universities is seen as too theoretical and mismatching with the development needs in business practice (for example in the sector of waste management). The thought curricula are not very well in accordance with labour requirements of industries. Introduction of new professions to be educated by universities or professional schools is too time-consuming process for which it is difficult to motivate all related parties. (Varblane et al. 2010)

Yet, the managers brought some very positive examples about cooperation with the Tallinn University of Technology or University of Tartu as sources for management knowledge. In essence, managers of Foreign-owned companies do see potential for exchange of experiences and knowledge with universities (for example in the form of guest lecturers from companies and by researchers contributing into the development of industries). However, at present a lot depends from the initiatives taken by certain persons or from the lack of such initiatives. The managers with engineering background see more cooperation perspectives with the Tallinn University of Technology and their experiences with research and teaching offered by the University of Tartu suggests that the research activities there tend to be more distant from entrepreneurial practices. This hinders the mapping of common ground and progress forward with cooperation. Therefore, such managers have difficulties in perceiving traditional research-oriented university as beneficial partner for companies. Thus, even the awareness about research profiles of the university is often not sufficient precondition for successful cooperation. (Varblane et al. 2010)

It can be generalized that foreign-owned companies expect from universities and professional schools more flexibility in curricula development according to the changing needs for labour and better connection between the theoretical aspects of subjects and the developments of applications in business practice. In some cases, the problem relates to the fact that the current motivation schemes used in universities and in scientific institutions does not establish clearly defined incentives for the facilitation of cooperation and integration with companies and industries. (Varblane et al. 2010)

The Study of Estonian Machinery Industry showed that respondents see universities as import cooperation partners (14 % said they are very important and 47 % that universities are rather important). The cooperation with professional schools was seen as even more important (21 % said very important and 50 % rather important), while private or public R&D institutions were less important. Somewhat surprisingly, consultation companies were evaluated as rather unimportant partners. (Varblane et al. 2011)

Despite the fact that machinery producers value universities as important partners, there is actually not much long term cooperation with universities. Some respondents revealed in interviews that they have used universities for testing purposes, but without longer engagement into cooperation. Customers and suppliers clearly dominate as most important cooperation partners for machinery producers. However, 33 % of respondents noted that in a period 2005-2010 they had some kind of cooperative experience with scientific institutions. Most of these cooperative ties related to product development, technology improvements, engineering, materials suitability testing, and design. Metalworking cooperates least with scientific institutions, perhaps because this sub-sector focuses on subcontracting. (Ibid)

For machinery producers the most important cooperation partner is the Tallinn University of Technology, which was mentioned 19 times, followed by Estonian University of Life Science (5 times) and University of Tartu (4 times). Due to considerable role of engineering in the sector, this is logical set of preferences. 85 % of respondents who had cooperative experience were satisfied with the results. (Ibid) However, smaller companies noted that universities are often not interested in small scale projects and that their services tend to be too expensive, while project times are too long. Machinery producers establish relations with universities either through personal contacts or by directly seeking assistance. The various testing services and experiments related to new product or technology seem to be in the focus of university-industry cooperation in Estonian machinery industry. (Ibid)

International comparison about the importance of various innovation partners reveals that machinery producers in Finland, Sweden, and even in Czech Republic and Lithuania cooperate much more with universities as innovation partners (according to Eurostat in Estonia 6 % of machinery producers consider universities to be most important innovation partners, while in these countries well above 20 % or in case of Finland up to 43 %). (Varblane et al. 2011)

When asked about obstacles to cooperation with R&D institutions, 40 % of machinery producers said that they just do not perceive the need for cooperation, 27 % had opinion that the results produced in these institutions are not applicable in companies, 26 % pointed out the lack of information as obstacle, 17 % said that its too difficult to find contacts with R&D institutions, and 10 % said that R&D institutions themselves lack interest for cooperation. (Varblane et al. 2011)

Recent Feasibility study for an Estonian Materials Technology Programme done by Finnish experts concludes as well, that although universities in Estonia are well

connected internationally, they need to communicate their expertise to industry. In addition to that, universities could function as important partners in interpreting and transmitting the new technologies to companies that have been invented elsewhere in the world. This conclusion reveals additional role for universities as knowledge interpreters and not just knowledge creator. (Kauhanen et al. 2011)

Even though studies indicate that universities are not seen as very important cooperation partners, the data collected by University of Tartu indicate that the funds received via industry contracts and from other entrepreneurship-oriented funding projects have nearly doubled within three years (in comparison of years 2008 and 2010) and constitute above 12 million Euros, while University of Tartu constitutes for 47.1 % of all research projects in Estonia that are not financed from public budget. (Haller 2012) These figures are perhaps to general to outline the financial merit of university-industry cooperation, because it includes financing from various other non-budgetary sources. Still, they reveal positive trends in diversification of university funding, which relates to such motive of cooperation.

The University of Tartu organizes annual entrepreneurship days to familiarize interested company representatives with offers for cooperation. In this recent meeting the managers asked how to solve the problem related to unsuitably long project times in case of company contracts. The director of University of Tartu, Institute of Technology, which is leading sub-unit for industry contacts, shared following experiences (Puura 2012):

1. involving university researchers as partners into intra-company processes;
2. split identity of researcher as academic faculty member and entrepreneur;
3. researchers who priorities in their value system servicing the needs of companies 24/7 as potential consultants and build trust beyond contracts.

These experiences indicate that university-industry cooperation could be most effectively facilitated by people who take personal interest in academic research as well as in entrepreneurial applications of the results of such research. They tend to act as gatekeepers between two communities.

The evidence from statistics indicates that private universities are merging with larger public universities, while number of students has predominantly increased. These processes could great some cultural shifts towards cooperation with industries. The various studies of industries reveal, however, low importance of universities among cooperation partners, and various barriers on the way of such cooperation. Still, the amount of non-budgetary funding received by universities, which includes industry contracts, has considerably grown, while entrepreneurial attitude of academic researchers is seen as perhaps most important determinant in overcoming the cooperation problems related to long project times and lack of interest.

The policy measures concerning university-industry cooperation

It takes a long time to mitigate the barriers to university-industry cooperation, as the problems and difficulties are complex and involve many parties. This means that the incentive system for cooperation stimulation has to be definitely a long-run strategy. Additionally to financial support to cooperation of universities and industry, it is also important to raise the awareness of the potential benefits of this kind of collaboration in the whole society. This relates also directly to the role and missions of universities, which have to be considered in development of policy measures.

The experiences of other countries show that more successful have been policy measures which support bottom-up defined researches, SME's collaboration with universities, mobility of researchers, commercialisation of research results through start-ups, and development of institutional regulation, which supports the knowledge transfer activities between universities and enterprises (Polt et al. 2001).

The discussion above and general R&D and innovation context in Estonia allows providing following suggestions for policy development:

- In order to facilitate university-industry cooperation in Estonia more attention should be devoted to applied research. This could include specialized research grants for industry-initiated research topics, or using applicability of research results in practice as an important evaluation criterion by research grant applications. For successful cooperation, there has to be a reason why the collaboration is required, and the applied research is something a firm can use and is interested to do so. This should increase also the cooperation motivation for industry.
- Involvement of industry partner in the provision of certain research results could be made compulsory in some research areas. However, such partner's actual contribution to the project has to be explicitly reported and measured.
- In terms of education policy, the industry leaders should be involved more closely into the university curricula development. Although formally such initiative 'Cooperation between Institutions of Higher Education and Enterprises' already exist (Archimedes Foundation 2012), there is little actual involvement of companies in the development discussion. It shows that the cooperative procedures are inadequately stimulated, established or monitored.
- The usage of company managers as guest lecturers by the universities could be supported by specialized funding schemes, to reward managers tutoring efforts.
- The university-industry cooperation could be facilitated by well-focused internship program for students and researchers that would compensate companies for their contributions into intern tutoring.
- Long-term policy about university-industry cooperation might include privatization or partial privatization of certain research labs in order to increase their incentive to be involved in commercial testing tasks.
- Perhaps it would be possible to create best practice guidelines for distributing intellectual property rights related to research cooperation between university and industry.

- University career and remuneration systems should reward contributions to applied research in equal merit with the contributions to academic research. Such guidelines could be championed by the Ministry of Education and Research.
- The facilitation of technological capabilities of the universities and absorptive capacities of the companies should be targeted by even more specialized R&D development programs targeting specifically these issues.
- The establishment of publicly funded information exchange system that would combine R&D and innovation related information inputs from the universities as well as from various industries.

These policy measures might not render quick results. Yet, over time, they would help to shift research focus more towards the needs of industries. Enterprise Estonia already offers start-up program, innovation voucher grants and some other initiatives that should create links between companies and universities (Enterprise Estonia 2012). However, these policy measures and the initiatives started by Archimedes Foundation seem insufficient for generating widespread and substantive cooperation between parties.

Conclusions and implications

The university-industry cooperation is a complex process that requires long term effort. Increased need for this cooperation relates to the changing role of universities in the modern society. Contemporary entrepreneurial universities teach and do research, but in addition, they seek opportunities to commercialize research results in order to obtain additional funds. University-industry cooperation is one important source for such funding. Additionally, it helps to test practical applications, get feedback and new experiences, find new research topics, and employment to graduates. Industries seek such cooperation in order to gain competitive advantages, new technologies, qualified labour, and other resources. They are also interested in reduced costs and improvements to image.

However, university-industry cooperation is influenced by various barriers, such as differences in objectives, organizational culture, and in research focus. Other important obstacles relate to insufficient funds, incentives, and capabilities, while problems tend to increase with geographic distance.

In Estonia, universities have low importance among cooperation partners of companies. The cooperation barriers include lack of interest as well as lack of information, and the perceived insufficiency of capabilities. Yet, the amount of non-budgetary funding received by universities, which includes industry contracts, has grown. The results suggest that policies needed to overcome these barriers should focus on applied research, industry involvement, refocused usage of research labs, distribution of intellectual property, adjusted career systems and capabilities, and enhanced information exchange.

The limitations of this study relate to the fact that this is preliminary view on the issue based on literature and secondary research evidence. However, as such it serves as a starting point for more detailed investigation of the subject.

The theoretical implications from this study relate to the possibilities of combining university development and transformation literature with R&D and innovation facilitation literature. This combination of the outward look from the viewpoint of universities and the inward look from the viewpoint of society and industries helps to gain more holistic understanding.

The implications to management reveal business opportunities that relate to increased cooperation with universities in terms of improved resources and competences. The ability of managers to benefit from described policy measures depends at least partially from their absorptive capacities.

The future research should focus on establishment of more refined understanding of the motivations of universities and companies for the cooperation and knowledge exchange. For that, survey data should be used along with more in depth qualitative evidence from well-focused interviews and group discussions.

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