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Lappeenranta University of Technology
School of Industrial Engineering and Management
Department of Industrial Management

Master's Thesis

OPEN INNOVATION: UNIVERSITY-INDUSTRY COLLABORATION IN RUSSIA

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ABSTRACT

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Innovation nowadays is one of the key elements of counties' competitiveness. In the face of continuous world economic changes, open innovation business model implementation allows many companies to improve and accelerate their innovation processes through collaboration. Universities as traditional sources of knowledge might be involved in such kind of collaboration. In developing countries, which are in transition towards innovation-based economy, as Russia, open innovation business model can serve as a tool to speed up this transition.

The Master's Thesis explores the implementation of open innovation model in collaboration between companies and universities in global scale and particularly in Russia. The study is qualitative and it is based on integrative analysis of literature, secondary data and results of the survey, conducted among Russian universities.

In the thesis a model for implementation of open innovation into Triple Helix model is elaborated. The study also explores not very common practice of reverse-directional interaction - from industry to university. The findings of this research show a necessity of solving the identified problems in parallel with implementation of open innovation concept in university-industry collaboration.

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Lappeenranta, November 2013

Ekaterina Albats

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LIST OF ABBREVIATIONS

HERD - Higher Education Research and Development

R&D – research and development

U-I – university-industry

OI – open innovation

IP – intellectual property

IPRs - intellectual property rights

IS – information systems

IT – Information Technologies

ERI – education, research and innovation

FASIE – Russian Foundation for Assistance to Small Innovative Enterprises in Science and Technology

RAS – Russian Academy of Science

TT - technology transfer

TTO - technology transfer office

1. Introduction

The part one includes theoretical background, identification of the research gap and research questions. Theoretical framework and clarification of central concepts are given in this chapter as well. The rest of this chapter is devoted to thesis' structure. Delimitations of the research are presented in the last subchapter.

1.1. Background

University-Industry (U-I) collaboration as a phenomenon and as a concept in academic literature has a rather long history: starting with preparing qualified employees by universities for industry, and finishing with framework agreements between higher-education institutes and companies (Kenney, 1987). For instance, MIT's Research Laboratory of Applied Chemistry in 1927 had a paid contract on research, value of which was $172 000 (Kenney, 1987), that has approximately the same buying power as $2 309 000 for 2013 (according to Inflation Rate Calculator by Tim McMahon (McMahon, 2013). By years the relationships were developing by own actors' efforts, by policy improvements and general economic evolution processes.

Nowadays U-I relationships play a very significant role in generating innovations (Perkmann & Walsh, 2007). There are a lot of complementary assets from one side to another: educated graduates, scientific discoveries, independent view on technical issues (Chesbrough, 2006) - from university side: additional findings, equipment, industrial experience, field-testing opportunities (Perkmann, et al., 2013) – from industry side. However in the recent time, a lot of researchers tend to consider these relationships not just as a mutual collaboration, but more from perspective of growing importance of external sources (Perkmann & Walsh, 2007; Chesbrough, 2006) and exploitation (Bozeman & Dietz, 1999), in the context of networking (Howells, et al., 2012; Van der Steen & Enders, 2008) and commercialization of internal R&D (Perkmann, et al., 2013; D'Este & Patel, 2007; Markman, et al., 2008). All of these contexts are covered by concept of open innovation (OI) (Chesbrough, 2003). Some authors are already discussing these relationships using the term *open innovation* (Perkmann & Walsh, 2007;

Howells, et al., 2012; Lucia, et al., 2012) and some are focusing more on relationships in particular, without discussion of OI concept (Lin & Boziman, 2006; Siegel, et al., 2004; Ramos- Vielba, et al., 2009).

The concept of open innovation offered by Henry Chesbrough in 2003 has obtained a wide circulation in both: academic literature and real strategies of companies as well as in consulting firms’ recommendations (Lichtenthaler, 2011). Nowadays there is a big discussion about what “open innovation” actually is and how to identify it. In other words there is a problem of open innovation indicators or formalization (Chesbrough & Brunswicker, 2013). Originally, Chesbrough explained the nature of open innovations like this:

“*Open innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology. Open innovation combines internal and external ideas into architectures and systems whose requirements are defined by a business model*” (Chesbrough, 2003, 24).

Later Chesbrough added one aspect to definition of open innovation:

“This approach places external ideas and external paths to market on the same level of importance as that reserved for internal ideas and paths to market in the earlier era” (Chesbrough, 2006, 2).

In that study the original definition is used. To make the phenomena clearer Chesbrough also explains the difference between Closed innovation Model (the traditional one) and the new one – Open. In the closed innovation model, which worked successfully for the most of 20th century, borders of the firm are closed to the environment and new ideas are coming exclusively from the firm’s own research base. The best ideas are selected and developed and the less fit ideas or projects are shelved. Thus there is a single way of the ideas to enter the funnel of projects’ selection and one way to go out – to the market as new products and services (Appendix 1, Figure 1, left). Chesbrough illustrates the success of Closed Innovation by such examples as breakthroughs made by Thomas Edison in the closed laboratory of General Electric and transistor, created by Bell Laboratories (Chesbrough, 2006).

As any kind of changes, switching from closed to open model at the end of 20th century had several reasons. Chesbrough (2003) calls them *erosion factors* and name these causes:

- Mobility of highly skilled personnel: knowledge acquired at college, training or at work started to spill out from different fields at research labs;

- Increasing availability of venture capital: private capital, which was growing new businesses started to create competitors for large firms;

- Shortening product lifecycles and then time to market: forcing companies to mobilize other kinds of resources besides internal ones;

- The increased supply of highly capable external suppliers: that challenged firm's ability to benefit from the own knowledge silos;

- Diminished US hegemony: the expansion of competitiveness from non-US companies;

- Improved knowledge markets: new sources of information (Internet) allowed increasing of customer's education (Chesbrough, 2003; Hemphill, 2005).

In contrast to closed model, in open innovation model, ideas can come from both internal and external sources and moreover, inventions, ideas or products can enter the market at any stage of their development – by patenting, licensing, technology spin-offs, or by traditional launching to the market (Appendix 1, Figure 1, right). Henry Chesbrough (2006) illustrates the use of this model by practices of such companies as IBM, Intel, Procter & Gamble (P&G) (Chesbrough, 2006). The role of Procter & Gamble in open innovation practices are discussed by many authors (Huston and Sakkab, 2006; Dodgson et al., 2006; Gassmann, 2006; Lichtenthaler, 2011; Lazzarotti et al., 2009 and many others).

Researches define three types of OI: *outside-in (inbound OI), inside-out (outbound OI) and coupled OI*. So-called *outside-in process* is in bringing outside ideas into the company (Chesbrough, 2006). Another type of open innovation process – *inside-out* implies the overcoming of barriers to let the usefulness ideas go out of the company (Chesbrough, 2006). Gassmann & Enkel (2004) also highlight so-called *coupled process* – combination of outside-in and inside-out open innovation processes by working in alliances with complimentary companies. Researchers characterize this type of partnering with other companies, universities, competitors, research companies as strategic networks. However, Huston et al. (2006), describing those networks, only highlights the aspect of turning to external resources in order to complement the lack of inside technical knowledge. The particular example of coupled process is given by Gassmann & Enkel (2004): "Fento-Second Ultra-Fast Quantum Device" was created in Hitachi's Cambridge Laboratory (HCL), which is used for developing ultra-fast switching devices in high-end telecommunication and ultra-fast computing. The discovery is based on the "wave" nature of the electron (Gassmann & Enkel, 2004).

Concerning the university-industry collaboration under the types of OI processes it could relate to any of them: depends on the interest of each party, their motivation and the side from which the collaborative initiative is coming. In other words, it depends on particular type and direction of interaction (chapter 3.2.), motivation (chapter 3.1.) and particular objectives of the project.

Chesbrough in his book, while discussing collaboration with universities, highlights the importance of such resource as graduate students, because of the comparatively law cost of their labor in combination with high level of enthusiasm. Moreover, professor claims that researchers from academia are valuable not just by sharing useful ideas and breakthrough technologies, but even more by serving on a technical advisory board. Scientists are able to provide independent perspective on technical issues (Chesbrough, 2006).

Even though the theory of open innovation gained a widespread in academic literature, it got criticism as well. Trott & Hartmann (2009) in their paper examine carefully the explanation given by Chesbrough (2003) and argue that open innovation is "Old wine in a new bottle". Criticism based on the idea of the 'false dichotomy', which implies that companies were already practicing OI, the theory is just a *representation of concepts and findings presented over the past 40 years*. The researchers also claim that OI model is linear, because the trajectory of knowledge flows is linearly forward. Moreover, Trott & Hartmann (2009) highlight that in the theory of OI – the inside borders between the company's departments are closed (Trott & Hartmann, 2009).

In spite of criticism the theory of open innovation is widely discussed in the literature in the last decade – see Appendix 1, Figure 2 (Vrande, et al., 2010; Dahlander & Gann, 2010). The necessity of using outside technology and scientific advice, even in cases of a strong in-house scientific base is a wide known fact since SAPPHO project in the 1970s (Radosevic & Yoruk, 2012). The theory of OI brings together the ideas on different sources of external knowledge, but also includes the organizational changes for successful innovations.

1.2. Research gap, objectives, research questions and delimitations

The field *university-industry collaboration* in the context of *open innovations* is very wide. Nowadays exists the problem of identifying *open innovation* and therefore, obviously, the same problem exists for this particular type of collaboration. That's why the most general and key research question of this study is:

How is university-industry collaboration executed as a part of open innovation framework?

To answer this question literature review and analysis of the survey results is used. However, in the questionnaire the term '*open innovation'* and even simply *open* are not used, in order not to confuse the respondents and to focus on the practical problems. The analysis of the *openness* is made by indirect questions about dynamics of collaboration with industry.

In the particular area of open innovations two research gaps are identified by Howells et al. (2012). The first one is that open innovation practices are considered in the literature as activities mostly only undertaken by firms and there is less discussion about other kind of actors as universities, for instance. The second research gap is that companies, which are practicing open innovations, are mostly considered in isolation, without taking into account other actors of their environment (Howells, et al., 2012). Simply taking the two actors into account at least in the literature review solves the first issue. The second one is solved by evaluating the collaborative processes from both perspectives academia and industry. The literature review together with the survey results analysis are done to solve these problems in Russia.

One of the themes, which are not widely discussed in the literature, is the reverse-directional interaction: the process of collaboration with universities, which is initiated by the industry (firms). The search in databases (SCOPUS, Web of knowledge, EBSCO) shows that combination “from industry” & “to university” are quite rarely discussed, and in the most of the cases authors discuss funds provided by industry, no other kinds of collaboration. Therefore, one of the objectives of this research is to explore this reverse directional interaction, its’ nature and manifestations in general and in particular context of Russia. Thus, the first research sub question, which was elaborated, is:

1) Does the reverse direction (industry-university) of knowledge transfer exist and, if yes, how is it implemented?

Another objective of this study is to identify the key problems in university-industry collaboration, their nature and find possible solutions to these problems based on the previous works related to this topic, analysis of the survey and integrative analysis of both sources. Therefore, the next research sub questions are:

2) What is the motivation of each side to initiate collaboration?
3) What are the key problems of university-industry collaboration in general and in the particular context of Russia?
4) Which solutions could better address these problems?

All the research questions, goals of these questions, methods and data used for getting the answers to these questions are presented in the table 1.

Table 1. Research questions, goals, methods and data used

Research questions	Research goal	Method and data
The main research question: ***How is university-industry collaboration executed as a part of open innovation framework?***	To identify the forms of open innovations in the university-industry collaboration in general and in the context of Russia	Desk research; academic literature and secondary data
Research sub question 1: *Does the reverse direction (industry-university) of knowledge transfer exist and, if yes, how is it implemented?*	To test the existence of interaction with university initiated by industry (in theory and practice)	Desk research, case study, survey; academic literature, survey and interview results
Research sub question 2: ***What is the motivation of each side to initiate collaboration?***	To identify the motives of both actors to interact	Desk research, survey; academic literature, survey results
Research sub question 3: *What are the key problems of university-industry collaboration in general and in the particular context of Russia?*	To find the problems in U-I collaboration in general and in Russia	Desk research, survey, interview; academic literature, survey and interview results
Research sub question 4: *Which solutions could better address these problems?*	To find solutions for general problems and for particular Russian problems	Desk research, survey, interview; academic literature, survey and interview results

1.3. Theoretical framework and central concepts

The theoretical framework of the study is defined by the topic and its central concepts. These concepts are *University* and *Industry*. However, the relationships between these two phenomena are representing the next concept – *Collaboration.*

One of the goals of this research is to consider these relationships in the context of the *open innovations* theory; therefore it is another key concept. *Innovation* represents the outcome of collaboration between universities and industry, wherein collaboration between the actors is *open* and reflects the character of the collaboration presented by Henry Chesbrough’s theory (2003). The theoretical framework is given below on the figure 1.

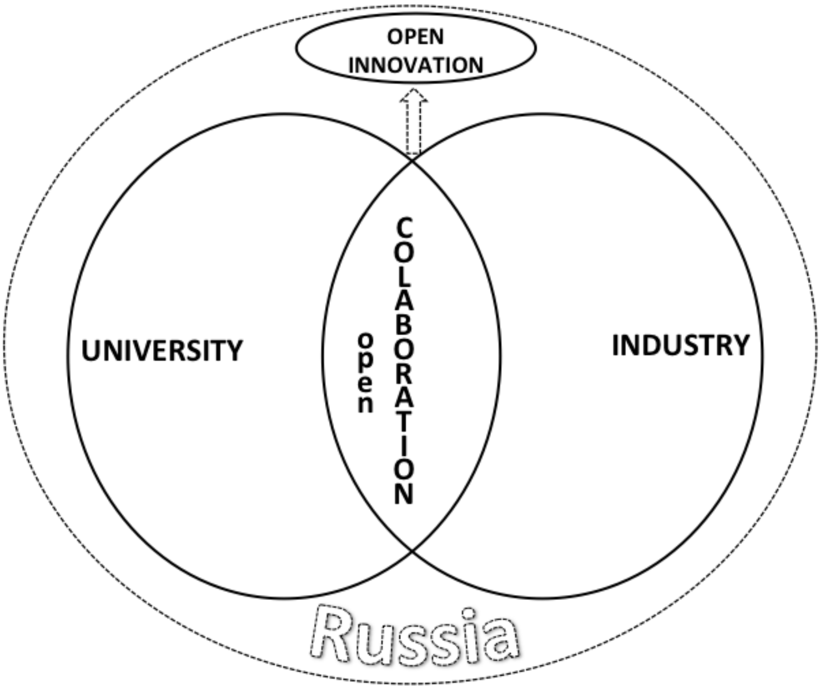


Figure 1. Theoretical framework

To make the discussion of these concepts clearer, it is necessary to identify the working definition of each phenomena and various topics and subtopics, related to them, taken from the current view in the literature and the context of the study. The concepts are summarized in the table 2.

The first concept, which is important to be clarified is *University*. In the context of this research *University* - is a higher education institution or a technical/engineering school. The respondents of the survey, conducted for this research are Russian Higher education institutions. The problems related to this concept in the context of university-industry collaboration could be divided into internal and external, even though these two groups are interrelated. Among internal problems there are different organizational issues, management of IP (Kleyn et al., 2007; Slowinski & Zerby, 2008), university patenting (Dalmarco et al, 2011; Leydesdorff, et al., 2010; Leydesdorff, 2012; Mowery, et al., 2005), bureaucracy (Siegel, et al., 2003; Siegel, 2004), educational issues and role of university-industry collaboration in that (Lucia et al., 2012). Other important aspects related to this concept are the start-up and spin-off companies based on university research (Shane, 2004). Among external problems there are such as governmental policy (van Hemert, 2013), lack of funding (Bruneel, et al., 2010; Kleyn et al., 2007), dependency on economic changes as a global recession in

Euro area, social problems and 'brain drain' (i.e. the outflow of highly talented and/or educated individuals to other regions).

Table 2. Working definitions of central concepts, related problems and literature

Concept/ topic	**Working definition**	**Related problems/ subtopics concerned in this thesis**	**Related literature by key authors in the context of U-I collaboration**
University	Higher education institution or technical/engineering school	Internal problems: organizational problems; management of IPR; patenting; bureaucracy; educational issues, start-ups, spin-offs; External problems: governmental policy, lack of funding, influence of economic changes, social problems, brain drain.	Kleyn et al. (2007); Slowinski & Zerby (2008); Dalmarco et al. (2011); Leydesdorff & Meyer (2010); Leydesdorff, (2012); Mowery, et al., (2005); Siegel, et al., (2003); Lucia et al., (2012); others
Industry	2 dimensions: the global understanding as manufacturing (profit-making) activity as a whole, and less global meaning-profit-making enterprises/companies	Lack of human resources, qualification of staff; "Not Invented Here" (NIH) syndrome; lack of opennies to others' ideas	Kathoefer & Leker (2010); Siegel, et al., (2003)
Collaboration	The interaction of two or more actors, which provides equal or various extent of benefit (both tangible and intangible) to each side and can be initiated by one actor or by several ones as well	Research collaboration Motivation to collaborate	Bozeman, et al. (2013); Perkmann, et al. (2013), Abramo, et al., (2011)
Open innovation	Paradigm, which suggests that *valuable ideas can come from inside or outside* and these ideas have *the same level of importance*	Problem of OI indicators; Problem of defining the "Open collaboration"	Chesbrough (2003), (2006); Howells, et al., (2012); Laursen & Salter (2006)

The next concept to be described is *Industry*. In the context of the topic this term has two dimensions: the global understanding as a manufacturing (profit-making) activity as a whole, and a less global meaning, which is represented by profit-making enterprises. In this research industry is considered from the point of view of collaboration with universities, therefore, the problems, which are discussed, are mostly related to the research collaboration. Among the issues are the following: shortage of highly-qualified personnel, lack of funding and new technologies, growing competitiveness (Meyer-Krahmer & Schmoch, 1998).

The term *collaboration* may also be defined in different ways. In the context of this research the meaning of this phenomenon is close to the definition, given by Bozeman et al. (2013): "*social processes whereby human beings pool their human capital for the objective of producing knowledge"* (Bozeman, et al., 2013, p.3). However, the authors highlight that even if the aim of *producing knowledge* is not reached, the attempt to do so will still be defined as collaboration. Researchers note that publishing articles is not necessarily the purpose or effect of cooperation, although often an article on the studied topic appears in the end. The common meaning particularly for university-industry interaction, in other words *academic engagement* is defined by Perkmann et al. (2013) as "*knowledge-related collaboration by academic researchers with non-academic organizations"* (Perkmann, et al., 2013, p. 424). Nevertheless, in the definition given by Perkmann et al. there is a term *collaboration* within itself and the direction of the impulse of this *collaboration* is clear: from academia to industry.

It is obvious, that the kind of interaction considered in this study, is knowledge-based, because the university is primarily a source of knowledge or human scientific and technology capital. Abramo et al. (2011) highlight that single research collaboration may take place between not just two actors. According to the research findings, cooperation between two parties only is the most common, but the participation of several companies and several universities in pursuit of common objectives also takes place (Abramo, et al., 2011). Therefore, following the purposes of this research the term *collaboration* could be defined as *the knowledge-related interaction of two or more actors, which provides benefit (both tangible and intangible) to each side and can be initiated by one actor and by several ones as well*.

Abramo et al. (2011) defines two levels of exploring the phenomenon of university-industry collaboration: the organizational level (university-company) and single disciplinary sector (Abramo, et al., 2011). This research is devoted to the first, more global level of studying university-industry collaboration with general perspective.

The next key concept *open innovation*, which suggests that *valuable ideas can come from inside or outside* and these ideas have *the same level of importance*, was discussed in the part 1.1.

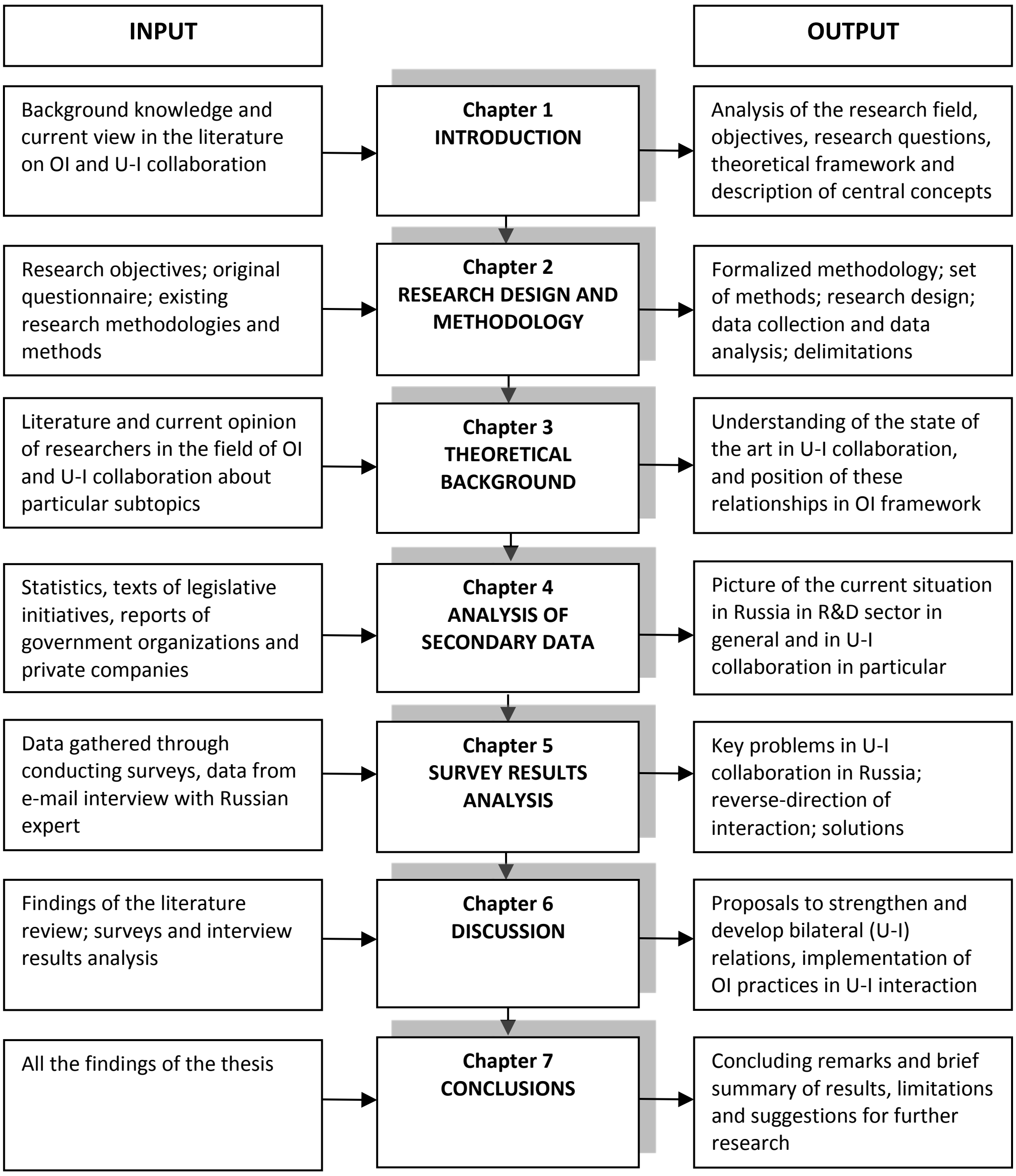
1.4. Structure of the thesis

The rest of the thesis is structured as follows. Chapter two is a detailed description of the research design and methodology. In the third chapter most of the aspects widely discussed in the literature are considered in details in the attempts to find theoretical implications for answering the research questions. The list of these important subtopics includes:

- the nature of collaboration and motivation of each side to work together;
- *links* of interaction;
- the reverse-directional interaction;
- personal profile: description of a typical person, who is most likely to work on establishing and maintaining cooperation;
- Triple Helix model: general and Russian;
- University-industry collaboration in the context of open innovation;
- Good practices of university-industry collaboration;
- Problems of university-industry collaboration.

The fourth chapter is devoted to the analysis of secondary data, including statistics, legislative initiatives, reports of government organizations and private companies, international companies’ reports. This analysis is given to sum up the situation and to balance the view of both sides (universities and industrial companies). The whole chapter 5 is an analysis of Russian survey results, and it also includes a review of the expert’s opinion. Chapter 6 is a discussion and summary of findings from the literature review and surveys results analysis.

Finally, in chapter 7 the general research conclusions and suggestions for further research are given. The thesis structure is visualized in figure 2.



INPUT		OUTPUT
Background knowledge and current view in the literature on OI and U-I collaboration	**Chapter 1** **INTRODUCTION**	Analysis of the research field, objectives, research questions, theoretical framework and description of central concepts
Research objectives; original questionnaire; existing research methodologies and methods	**Chapter 2** **RESEARCH DESIGN AND METHODOLOGY**	Formalized methodology; set of methods; research design; data collection and data analysis; delimitations
Literature and current opinion of researchers in the field of OI and U-I collaboration about particular subtopics	**Chapter 3** **THEORETICAL BACKGROUND**	Understanding of the state of the art in U-I collaboration, and position of these relationships in OI framework
Statistics, texts of legislative initiatives, reports of government organizations and private companies	**Chapter 4** **ANALYSIS OF SECONDARY DATA**	Picture of the current situation in Russia in R&D sector in general and in U-I collaboration in particular
Data gathered through conducting surveys, data from e-mail interview with Russian expert	**Chapter 5** **SURVEY RESULTS ANALYSIS**	Key problems in U-I collaboration in Russia; reverse-direction of interaction; solutions
Findings of the literature review; surveys and interview results analysis	**Chapter 6** **DISCUSSION**	Proposals to strengthen and develop bilateral (U-I) relations, implementation of OI practices in U-I interaction
All the findings of the thesis	**Chapter 7** **CONCLUSIONS**	Concluding remarks and brief summary of results, limitations and suggestions for further research

Figure 2. Structure of the thesis

2. Research design and methodology

This study is qualitative by the nature of research questions. However, following the classification of research methods given by Saunders et al. (2009), this research should be identified as quantitative, because it is partly based on analysis of numbers (gathered from the survey results) and this analysis is conducted by using diagrams and statistics (Saunders et al, 2009). Nevertheless, this master thesis uses mixed methods in order to fulfill the research objectives. First, the literature related to university-industry collaboration and open innovation is overviewed. Then, secondary data related to the case of Russia is analyzed. Subsequently, on the basis of the project OPEN-UNIC[1] a questionnaire had been developed and data was collected in Russia. Finally, the structured e-mail interview with an expert in university-industry collaboration in Russia was conducted. For this study mixed methods are beneficial because:

1) it is necessary to explore two completely different perspectives (university's and business' points of view), and taking into account limited organizational capabilities, the analysis of the companies' view could be done just through the analysis of secondary data and literature, when the university's opinion is studied through analysis of survey results;
2) analysis of qualitative data should be complemented by quantitative data analysis in order to fill the gaps in each of the two data types;
3) using independent data sources (literature, secondary data, survey results) allows to build a more generic view on the situation and to corroborate research findings – achieving of triangulation effect (Bryman, 2006).

Increasing the reliability and validity of research results the text of the questionary was pre-tested on the group of three respondents with comments and suggestions.

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[1] Open-UNIC research project focuses on the role of universities as utilizers of unused intangible assets of firms – patents and ideas – in organized and managed research and student projects. Research partners are: VTT Technical research center of Finland; Lappeenranta University of Technology, Kouvola unit; University of Tampere, TaSTI; University of Helsinki, department of social research. The project is funded by Tekes (the Finnish Funding Agency for Technology and Innovation).

2.1. Research design

The research design is presented in Figure 3. The input is literature, secondary data, survey and interview results. Literature review as a basis for research questions and questionnaire in combination with analysis of survey results allows answering research questions and filling in the research gap.

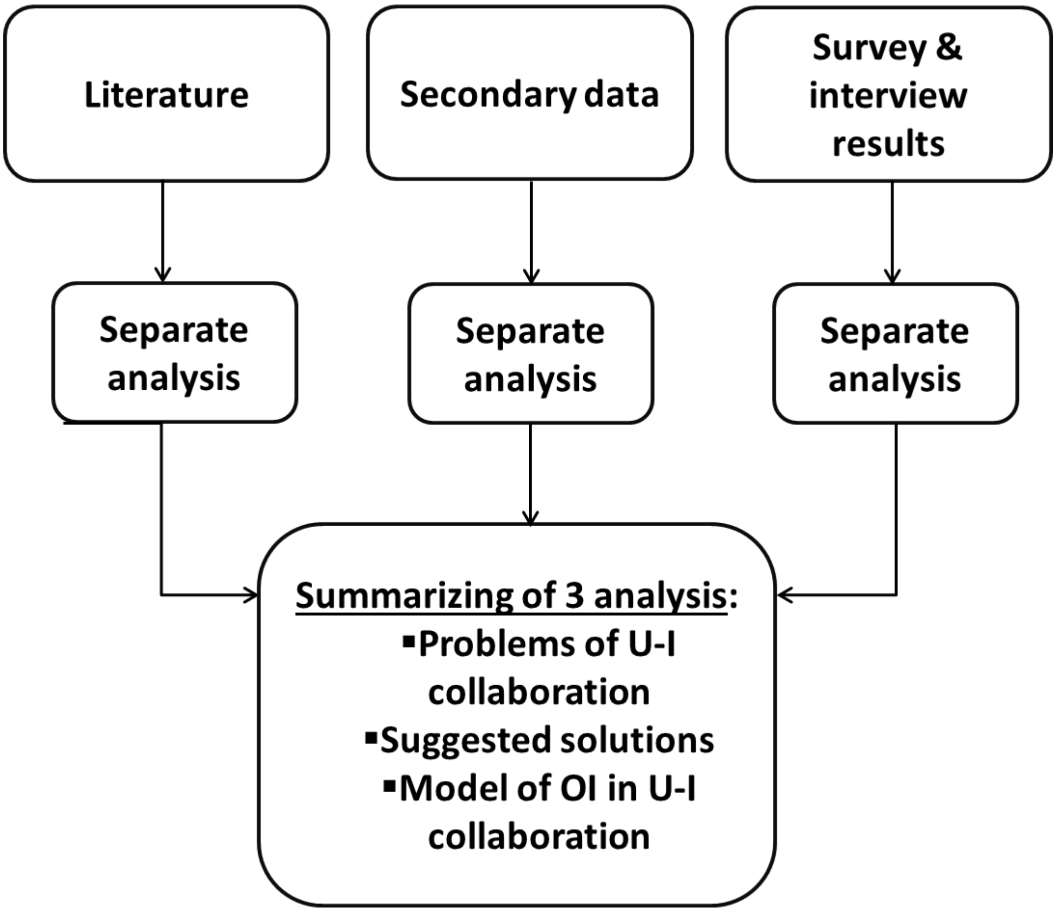


Figure 3. Research design

2.2. Secondary data analysis

There are several reasons for using secondary data in this research. The first one is that due to limited organizational capabilities, the exploration of the company's view could be done just through analysis of easily available secondary data. This analysis is needed to balance the view of both sides (universities and industrial companies). Moreover, in order to identify which particular solutions already exist in Russian reality, what initiatives are undertaken by Russian government to improve university-industry collaboration, it is necessary to analyze in detail the laws, acts, state programs, reports and also expert literature, which includes critical evaluation of these initiatives. Finally, to explain certain actions and events, and the nature or reasons for the decisions, that take place in Russia in the field of U-I cooperation, to justify, or critically analyze certain steps by decision makers, it is necessary to refer to the statistics, which represents formal objective data.

The analyzed secondary data includes mostly written materials, such as:
- Reports (country reports, reports by Russian governmental organizations, reports by European Commission and others);
- State Statistics Services (Russian Federal State Statistics Service -Goscomstat, Eurostat);
- Articles in newspapers and magazines (including the ones in Russian);
- Interviews, published on the Internet;
- Public and private organizations' websites.

2.3. Primary data analysis

Data collection process

The questionnaire for the survey was originally created in Finnish by the team of research project OPEN-UNIC. It consists of 48 closed and 3 open questions about University interaction with industry. Russian version is an adopted translation of the Finnish questionnaire with an added block (plus 3 closed questions) about special Russian governmental program (supporting the development of cooperation of Russian higher education institutions and high-tech organizations). For this thesis and project's reports the English version was created (including translation of 3 additional questions from Russian Survey). The questionnaires in Russian and English are included into Appendix 2.

The survey was conducted through sending questionnaires by e-mail and through phone-calls. Phone calls were made, if the response was not received within 2 weeks after sending the questionnaire by e-mail, or in cases when the respondents preferred to answer the questionnaire by telephone;

During the data collection process there was identified a respondent, who is presenting not just a particular university, but who is also an expert from the Ministry of Education and Science of the Russian Federation in the implementation of projects aimed at the creation of high-tech manufacturing (Government Decree of 09.04.2010). To gather the expert's opinion a separate list of four qualitative questions was elaborated and sent by e-mail. The responses were received.

Sample description

The sample includes in total 53 Universities in the following regions of Russia: in Moscow (16), Saint-Petersburg (15), Kazan (3), Tomsk (3), and by 1 University from 16 other Russian regions. The response rate is 41,5 % with responses from 23 Universities. However, from one university responses were only gathered to open questions, in the chapter 5 responses from 22 universities are analyzed.

Most of the universities taking part in the survey are partners of Lappeenranta University of Technology in co-operational education (18/23) and winners of the Federal State funding program (Decree №218) (19/23). The first group of the respondents was targeted because communication with partnering universities is easier, and the second group was chosen in order to examine the universities' assessment of the governmental program efficiency. The sample description is presented below in the table 3. Among studied universities there are 2 with the 'Federal' status, 9 with the status of 'National Research University' and one of 2 existing 'National Universities' – Saint-Petersburg State University. These statuses provide additional funding and responsibilities to universities.

For more detailed description of Russian Universities statuses, see chapter 4 (analysis of secondary data).

Table 3. Description of the Universities taking part in the survey

Number	University	City	LUT partner	Winner of the federal funding program	Status of Federal University	Status of National Research University	Dynamic of the number of partners in the last 3 years
1.	Southwest State University (Kursk State Technical University)	Kursk	YES	YES			increased significantly
2.	Bauman Moscow State Technical University (National Research University)	Moscow	YES	YES		YES	increased
3.	Mendeleev University of Chemical Technology of Russia	Moscow	YES	YES			increased
4.	Moscow State Forest University	Moscow	YES	NO			increased significantly
5.	State University of Management	Moscow	YES	NO			increased
6.	National Research University Higher School of Economics	Moscow	YES	YES		YES	increased
7.	The Moscow Aviation Institute (National Research University)	Moscow	NO	YES		YES	increased significantly
8.	Moscow State University of Instrument Engineering and Computer Science (MSUIECS)	Moscow	NO	YES			remained stable
9.	Gubkin Russian state university of oil and gas	Moscow	NO	YES		YES	remained stable
10.	Perm State University	Perm	NO	YES		YES	increased
11.	Petrozavodsk State University	Petrozavodsk	YES	YES			increased
12.	Ogarev Mordovia State University (National Research University)	Saransk	YES	YES		YES	increased
13.	Bonch-Bruevich St Petersburg State University of Telecommunications	St. Petersburg	YES	NO			increased significantly

Number	University	City	LUT partner	Winner of the federal funding program	Status of Federal University	Status of National Research University	Dynamic of the number of partners in the last 3 years
14.	St Petersburg Mining Institute (National Research University)	St. Petersburg	YES	YES		YES	increased
15.	St Petersburg University of Fine Mechanics and Optics (National Research University)	St. Petersburg	YES	YES		YES	increased
16.	St Petersburg State Electrotechnical University	St. Petersburg	YES	YES			increased significantly
17.	St Petersburg State Forest Technical University	St. Petersburg	YES	NO			increased
18.	St Petersburg State Technological University of Plant Polymers	St. Petersburg	YES	YES			decreased
19.	St Petersburg State University	St. Petersburg	YES	YES		National University	increased
20.	Saint-Petersburg State University of Engineering and Economics	St. Petersburg	YES	YES			-
21.	Tomsk Polytechnic University (National Research University)	Tomsk	YES	YES		YES	increased
22.	Far Eastern Federal University	Vladivostok	NO	YES	YES		increased
23.	Ural Federal University	Yekaterinburg	YES	YES	YES		increased
	Total		18	19	2	9	increased

Most of the respondents are managers of R&D or innovations (7 persons), 6 of them are directors of Universities' department, only 4 are directors of Research and Development activities. Among other titles are such as: Vice-Rectors for work with business, deputy vice rector in Innovations, director of IP and technology transfer department and director of International Centre for Forestry and Forest Industry. Only one respondent said that his work is not connected with U-I collaboration (see Figure 4).

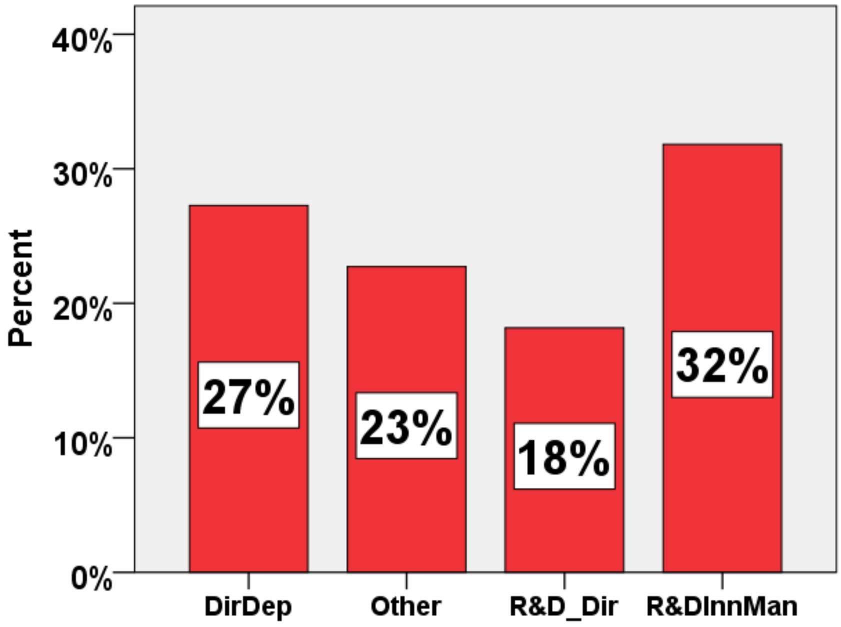


Figure 4. Respondents' profile: job title

Measurement

Most of the questions are built in a way to learn about the condition, progress and changes of university-industry collaboration in particular Russian university in the recent three years. In the closed questions of originally-based questionnaire the 1-5 Likert-style rating scale was used. There 1 means that particular aggregate has decreased significantly, 2 –decreased, 3 - remained stable, 4 – increased, 5 – increased significantly. For additional question about governmental program 1-7 scale of program effectiveness was used to have a wider distribution of the answers to make respondents able to choose the degree of efficiency that matches their opinion (1 - is not effective; 2 - very little effective; 3 - weakly effective; 4 - moderately effective; 5 - quite effective; 6 - very effective; 7 - effective and critically important for universities).

Methodology of analysis

When data was gathered, first of all it was tabulated into Excel file, and the values were codded according to the scales used. After that the data set was checked and uploaded to SPSS and analyzed there. For data exploration and presentation tables and graphs are used. Bar charts are used to show frequency of values, so the highest is clear to identify the common trend. Pie charts are used to identify and show proportions of values for each variable among different cases (universities). Among descriptive statistics mean is used to calculate the average value.

Delimitations

The one of the research delimitations are the geographical focus on Russia. The other one is a sample size for Russian case (just 53 with 22 responses, when there is a plenty of universities in Russia). This limit is determined by the organizational research capabilities. The limitation by LUT partners and regions (mostly Moscow and Saint-Petersburg) are also determined by organizational capabilities and the fact that cooperating universities are more active in the dialog with a partner university than with others.

Another delimitation is in translation. The nature of the problem is not even in transmission of meaning of the questions (which was successful), but even more in deficiencies of policy in Finland and in Russia. For example, one respondent in the phone talk noted that “*there cannot be donations of equipment from company to university in Russian realities*". However, the case of the city-forming enterprises hire graduates of specific high schools and these companies are interested in their target training - companies of such a type invite graduates or students to practice and provide equipment for their training. Because it is spread mainly in the regions of Russia, the respondent from Moscow could lose sight of that. The common difference is in the question concerning bankruptcy of university start-ups. In Russian realities, the company, based in university cannot be a bankrupt, they “*may not engage in any activity*”. Nevertheless, some respondents were active not only in answering questions, but also in giving comments to questions, which explain more the situation with university-industry collaboration in Russia.

3. Theory: university-industry collaboration and open innovation

The whole part 3 is a review of the literature related to the topic *university-industry collaboration in open innovation*. The particular case of Russia is discussed more in chapter 4 (analysis of secondary data), since the number of studies about Russia, related to this topic is not big, and even less works are written in English.

3.1. Motivation to collaborate

The question of motivation is one of the central issues of any collaboration. Two actors of the considered relationships have a completely different nature, thus they have different goals of research and collaboration in general. To identify the motives of each party a detailed analysis is needed. The view on the motivation problem presented in the topical literature is majorly limited, as is only discusses the universities' perspective.

Table 4 illustrates the difference between industrial and academic research as separate concepts. The table represents universities as very closed actors and industrial companies as open ones. Therefore, industry-university collaboration is not very natural for the actors (Parker, 1992).

In cases of some Russian universities the process of collaboration with industrial companies is so unnatural, that the mere idea of talking about it, or about commercialization of the R&D results annoy their representatives, as these topics apparently are not allowed for discussion with any outside parties, possibly the reason is that Russian universities operate under the Russian Ministry of Education and Science. Especially in cases of state universities, which get their funding exclusively from Russian government the process of collaboration with industry is under strict control. That is an illustration of the fact that motivation and conditions of U-I collaboration vary not only from one field to another (Meyer-Krahmer & Schmoch, 1998), but also from one regional environment to another.

The reverse-directional interaction (from firm to university) could be described through motivation of universities to collaborate with firms. The motivation for academia includes such advantages as: access to resources and equipment; support for students; getting additional funds from the industry; access to learning opportunities (testing of findings and getting new ideas) (Perkmann, et al., 2013).

Table 4. The differences between academic and non-academic research

Typical Aspects	University	Industry
Focus of the R&D	Basic Research; curiosity-oriented	Applied research; experimental development
Basic rationale	Advance knowledge	Increase efficiency
Aim	New ideas	Profits
Characteristics	Idea-centered	Practical; product centered
Framework	Open	Closed, confidential
Evaluation	By peers	By the boss
Schedule	Open-ended	Tight, predetermined
Recognition	Scientific honors	Salary increases

Source: Parker, 1992, Blais, 1990

Responding the universities' need *to find new ideas* described in the table above, *knowledge exchange* is ranked as the second most important factor for universities to collaborate. However, the financial factor plays no less important role for universities for developing these ideas, therefore, getting additional investments and flexibility of industrial funds are in the top three of motivations – table 5 (Meyer-Krahmer & Schmoch, 1998).

Table 5. Ranking of advantages of U-I interaction from the perspective of academic researchers

Rank	Advantage	Relevance Index
1	Additional funds	87
2	Knowledge exchange	84
3	Flexibility of industrial funds	75
4	Additional facilities	61
5	References for public projects	52

Source: Meyer-Krahmer & Schmoch, 1998 cites Schmoch 1997

The academia sees the observation of scientific development as the most widespread motivation for industry to engage in collaboration with university. However, the relevance indexes of such factors as *solution of technical problems with university help* and *recruitment of personnel from universities* are relatively close to the first rank (see table 6 below).

Table 6. Ranking of industrial interests in interaction with universities from the perspective of academic researchers

Rank	Interest of industry	Relevance index
1	Observation of scientific development	82
2	Solution of technical problems	70
3	Recruitment of personnel	69

Source: Meyer-Krahmer & Schmoch, 1998 cites Schmoch 1997

D’Este & Perkmann (2011) identified four most important kinds of motivation for universirties to collaborate with industry (table 7). Noteworthy, that three of them are reserch-related and just one reflects the entrepreneurial nature. The study results show that the most of academics collaborate with industry to further their research and 74,5% of the respondents rated *applicability of research* as very important, at the same time only 11.1% rated *seeking IP rights* the same way. Moreover, commercialisation as the factor in general was ranked lowest by academics (D’Este & Perkmann, 2011). The limitation of the study by D’Este& Perkmann (2011) is that the survey was conducted among academics from physical and engineering fields only.

Table 7. Four motivational factors to collaborate for universities

Motivational items	Motivation
Source of personal income	Commercialization
Seeking IPRs	
Information on industry problems	Learning
Feedback from industry	
Information on industry research	
Applicability of research	
Becoming part of a network	
Access to materials	Access to in-kind resources
Access to research expertise	
Access to equipment	
Research income from industry	Access to funding
Research income from government	

Source: D’Este & Perkmann, 2011

The study also examines the dependence of links of interaction on the particular motivation. The results show that academics motivated by learning usually take part in joint research, contract research and consulting activities, at the same time researchers motivated by commercialization frequently engage in patenting, spin-offs and consulting. However, the figures show that these *commercialization* activities are quite rare in comparison with collaborative research for instance (just 17% of the survey respondents, operating with industry, participate in spin-off companies, 30% applied for patents).

The one of the most important motivations for firms is in getting access to a human capital from faculty and students. This fact illustrates the industrial need of highly qualified personnel highlighted by Meyer-Krahmer & Schmoch (1998). University could be the right place for searching these people, because they have that *scientific and technical human capital*, which represents the “sum of researchers’ professional network ties and their technical skills and resources” (Bozeman, et al., 2013, p. 10).

The wider picture of motivation for U-I collaboration is given by Siegel, et al. (2003, 2004). The researchers describe U-I technology transfer and consider the role of the intermediary – technology transfer office (TTO). Authors highlight that for the most of university scientists the primary motivation for interaction with the industry is recognition of the scientific community: publications in prestigious journals, getting grants. The monetary motives as getting financial support are secondary. Moreover, all US universities have a *royalty distribution formula,* which determines the distribution of the profit from royalty between faculty members (typically the net income to the inventor is from 25 to 50%) (Siegel, et al., 2004).

For TTOs the primary motivation is to protect the university IP, but to launch it to the market at the same time. Among secondary motives authors call search of additional funds and supporting of the technology diffusion (Siegel, et al., 2004).

The primary motive of companies is to get profit. At the same time, to be competitive they need to have a control over the new technology and to reduce *the time to market* (Siegel, et al., 2004).

The summary of the actors’ motives, actions and general perspectives is presented in the table 8. The table shows the polarity of the general perspectives of university and industry: scientific vs. entrepreneurial, which differs from one field to another and from one country to another. However, in general it exists, but it does not mean that collaboration is impossible - just the reverse is true: the complementarity of different perspectives will give the results. According to

D’Este & Perkmann (2011, p. 332): “for universities, the benefits of university-industry collaboration are best attained by cross-fertilization rather than encouraging academics to become economic entrepreneurs. Collaboration is fruitful when it facilitates or contributes to both industry applications and academic research”.

Table 8. Key stakeholders in technology transfer and their motivation to collaborate

Stakeholder	Actions	Primary motive(s)	Secondary motive(s)	Perspective
University scientist	discovery of new knowledge	recognition within the scientific community – publications, grants (especially if untenured)	financial gain and a desire to secure additional research funding (mainly for graduate students and lab equipment)	scientific
Technology transfer office	works with faculty members and firms/entrepreneurs to structure deals	protect and market the universities’ intellectual property	facilitate technological diffusion and secure additional research funding	bureaucratic
Firm/ entrepreneur	commercializes new technology	financial gain	maintain control of property technologies	organic/entrepreneurial

Source: Siegel, et al., 2003

3.2. ‘Links’ of interaction between university and industry

To characterize the university-industry collaboration it is necessary to identify the existing ways of communication between two actors. Researchers use different terminology to describe these interactions. Considering the influence of public research on industry Cohen et al. used category *channels* and *sources* (Cohen, et al., 2002). However, they are mostly focused on one direction: influence of academia on industry. In other studies researchers highlight, that they are focusing, not just on one-directional driven relationships as technology transfer, but more on bi-directional *interactions* or *linkages* (Roessner 1993; Schartinger et al. 2002; D’Este & Patel 2005). *Linking mechanisms,* described by Meyer-Krahmer & Schmoch (1998) are mostly oriented on academic perspective and importance of industry for university. Perkmann & Walsh (2007) highlight that words *channels* or *mechanisms* are not suitable enough to the case of description of U-I collaboration, because the first one reflects just the *media* for interaction, and the second one defines *social processes*. Thus, both categories were claimed as too socially-oriented and imperfect in term of generalization. Researchers suggest using the more general term *links* to describe the university-industry mutual cooperation (Perkmann & Walsh, 2007). In the context of this study the term *links* was defined as general enough for the moment of research.

Different scientists defined various kinds of interactions, some of them are repeated from one analysis to another, and some are used by just one particular author or in particular context only. In table 9 there are different classifications reviewed in these work.

The mostly discussed in the literature types of interaction are compiled in the table 10. The compilation is based on literature reviews by Perkmann & Walsh, (2007), Perkmann et al. (2013) and Boronowsky et al. (2012). Since the most of academic publications consider the university-industry collaboration from the university perspective the categorization of ‘links’ is mostly subordinated to the academia’ goals.

Academic entrepreneurship

The first type of link, *academic entrepreneurship*, aims at commercial utilization of inventions, made by academy and further development of them inside of the company, established and owned (partly) by academics-inventors.

Table 9. Types of interactions between university and industry

Roessner (1993), *interactions*	Meyer-Krahmer&Schmoch (1998), *linking mechanisms*	Cohen et al. (2002), *sources/channels*	Schartinger et al. (2002), *types of knowledge interaction*	Perkmann&Walsh (2007), *links*	D'Este & Patel (2007), *types of interactions*	Ramos-Vielba et al. (2009), *types of interactions*
1.Contract research (by industry); 2.Sponsored research (by lab); 3.Cooperative research; 4.Workshops, seminars and briefings (by lab); 5.Llicensing; 6.technical consultation (by lab); 7.Employee exchange; 8.Use of laboratory facilities (by industry); 9.Lab visits (by industry); 10.Information dissemination (by lab)	1.collaborative research 2.informal contacts 3.education of personnel 4.doctoral theses 5.contract research 6.conferences 7.consultancy 8.seminars for industry 9.scientist exchange 10.publications 11.committees	1.Patents, 2.Informal information exchange, 3.Publications and reports, 4.Public meetings and conferences, 5.Recently hired graduates, 6.Licenses, 7.Joint or cooperative ventures, 8.Contract research, 9.Consulting; 10.Temporary personnel exchanges	1.Employment of graduates by firms; 2.Conferences or other events with firm and university participation; 3.New firm formation by university members; 4.Joint publications; 5.Informal meetings, talks, communications; 6.Joint supervision of Ph.D. and Masters theses; 7.Training of firm members; 8.Mobility of researchers between universities and firms; 9.Sabbatical periods for university members; 10.Collaborative research, joint research programs; 11.Lectures at universities, held by firm members; 12.Contract research and consulting; 13.Use of university facilities by firms; 14.Licensing of university patents by firms; 15.Purchase of prototypes, developed at universities; 16.Reading of publications, patent	1.Research partnership; 2.Research services; 3.academic entrepreneurship; 4.Human resource transfer; 5.Informal interaction, 6.Commercialization of property rights; 7.Scientific publications	1.Creation of physical facilities; 2.Setting up spin-off companies 3.Joint research agreements 4.Contract research agreements 5.Consultancy work 6.Training of company employees 7.Postgraduate training in the company (joint supervision of PhDs) 8.Secondments to industry 9.Attendance at conferences with industry and university participation 10.Attendance at industry sponsored meetings 11.Creation of electronic networks	1.Consultancy work from a university or public research center 2.Commissioned R&D projects (financed exclusively by the firm) 3.Joint R&D projects (shared financing or with public support) 4.Training of postgraduates and internships at the firm 5.Temporary exchange of personnel 6.Specific training of the firm workers provided by the university 7.Use or renting of facilities or equipment 8.Exploitation of a patent or utility model/joint patents 9.Creation of a new firm (spin-offs and start-ups) 10.Participation in a joint venture of hybrid research centers 11.Informal relationships 12.Other types of collaborative activities 13.Non-academic knowledge diffusion activities

Table 10. University-industry links

Type of link	Description	Subtypes
Commercialization		
Academic entrepreneurship	Development and commercial utilization of technologies invented by representatives of academy, and support of these technologies through a company they (partly) own	Spin-off companies: inventor-led spin-off, investor-lead and external entrepreneur-lead spin-off (Shane, 2004)
Commercialization of Property rights	Transfer of university-generated IP (such as patents) to firms and reverse-directional interaction (from firm to university)	Selling of patenting; licensing; selling of prototypes, developed in Universities; joint patenting
Academic Engagement		
Research partnership	Inter-organizational activities for joint R&D	Joint research agreements, joint research programs, joint creation (using) of physical infrastructure (laboratories, incubators, and research centers); research joint ventures
Research services	Activities planning and hosting by industrial clients	Contract Research, Consultancy (Industry Sponsored meetings)
Human Resource Transfer	Multi-context learning mechanisms	Training of industry employees; postgraduate training in industry; employment of graduates by firms; graduate trainees; internship of faculties; temporary personal exchanges
Informal Interaction	Establishing of relationships on non-formal meetings	Informal meetings; talks; communications; conferences
Scientific Publications	Utilization of scientific knowledge within industry	Joint publishing; testing theories, hypothesis; Joint supervision of Ph.D. and Master theses; reading of publications, patents; joint preparing of conference proceedings
Knowledge sharing (e.g. through staff movement)	Knowledge distribution (mostly intangible) through mobility of researchers between universities and firms	Lectures at universities, held by firm members; sabbatical periods for university members (work in the firm, giving lectures, knowledge and experience sharing); non-academic knowledge diffusion activities (meetings, conferences, fairs) (Ramos-Vielba, Fernández-Esquinas, & Espinosa-de-los-Monteros, 2009)

Source: adopted from Boronowsky, et al., (2012), Perkmann & Walsh, (2007) and Perkmann, et al., (2012)

Shane, S. A. (2004) describes different types of academic spin-offs according to leader in the company:

- Inventor-lead spin-offs: companies, which are established and lead by inventors of technology ("New firm formation" represented by Schartinger et al. (2002));

- External entrepreneurial-lead spin-off: licensing of university inventions through technology-licencing offices;

- Investor-lead spin-off: bringing money and further development of the technology (Shane 2004).

Universities' IP commercialization

Patenting and licensing represent the direct *universities' IP commercialization*. The continuous growth of university patenting caused by institutional changes (such as the Bayh-Dole Act, 1980 and other acts by OECD countries, which are described in more detail in chapter 3.7) gave a way to decline as a common trend (see Appendix 3, Figure 2). Scholars explain this declining by "structural" reasons (Leydesdorff and Meyer 2010) and say that patenting has become a possible option for universities, but not a core one (Leydesdorff, 2012). Other scientists highlight the decreasing importance of patenting, licensing and commercialization in general, compared to other links of interactions such as contract and cooperative research (Levin et al. 1987; Cohen et al. 2002; Roessner 1993).

Collaborative research

The next university industry link is *collaborative research*, which includes all the kinds of activities for conducting joint research. This kind of collaboration returns us to the notion of resource complementarity, i.e. the actors begin collaboration to get an access to resources. Both actors could have a monetary or knowledge expansion gain: companies get human capital, additional funding; universities get financial support, entrepreneurial base (Bozeman et al. 2013). D'Este & Patel found joint research agreements among other interactions as a formal type of linkage representing a collaborative research. It implies involving research undertaken by both parties (D'Este and Patel 2007).

Schartinger et al. define sixteen types of knowledge interactions and together with a collaborative research scholars mention another more or less formal type of linkage as joint research programs (Schartinger et al. 2002).

According to factor analysis, conducted by D'Este & Patel, joint research is a very independent category, and therefore, the creation of physical facilities is a separate type of activity (D'Este & Patel, 2007). Nevertheless, the channels and degree of depth of the university-industry interaction are different from one industry to another (Grossman, 2001). From the practical side, joint research may help to reduce costs and development time, as it was achieved in the US joint research venture in project in electronics (Perkmann & Walsh, 2007).

Research services

Research services represent activities conducted by the universities, but financed by the industry. These activities include contract research and consulting. Contract research is mentioned by most of authors in their categorization as a separate type of interaction (Cohen et al. (2002), Schartinger et al. (2002), D'Este & Patel (2007)). In addition, this type of interaction is described as commonly used (by evaluated share compare to other activities) (Schartinger, et al., 2002). According to scientific observations, contract research and consulting are widespread mainly in fields of science with low level of interaction, which almost do not use other links. This type of interaction could be used in such sectors of science most likely due to relatively low entry costs, requiring comparably low absorption and transfer capacities (Schartinger, et al., 2002).

Human resource transfer

Human resource transfer implies direct movement of researchers from academia to industry (postgraduate training in industry; employment of graduates by firms; graduate trainees; internship of faculties) or vice versa (training of industry employees) or interactive process of temporary personal exchanges (Perkmann & Walsh, 2007). Both sides have motivations for those human resources flows. Firms establish relationships (network ties) with universities to get an access to human capital, because the long-term private industry network provides benefits for current and future research (Bozeman, et al., 2013). Moreover, in context of collaboration with industry researchers use the category *Scientific and technical human capital* (S&T human capital), that implies a sum of individual human capital, researchers' tacit knowledge, craft knowledge, know-how and social capital (networks for further knowledge creation) (Bozeman & Dietz, 1999). Thus, companies are willing to get a long-term base of S&T human capital. The academia, as it was mentioned above, gets a support for students and opportunity to test their findings. However, scholars note the negative influence of industrial experience on the number of scientific publications. According to the research by Lin et al. (2006) and Bozeman et al. (2013) after the first ten years following their Ph. D., the productivity of scientists with industrial experience starts to decline compared to not-industry-affiliated ones (three publications less annually as average). However, industrial experience may, at the same time, increase the contribution to the cross-disciplinary collaborations (Bozeman, et al., 2013). Results of the survey, analyzing by Howells et al. (2012), shows that training and continuing professional development are rated by companies as the most useful and important types of collaboration with universities.

Informal interaction

Informal interaction as separated type of activities is mentioned by Perkmann & Walsh (2007), Cohen et al. (2002), Schartinger et al., (2002). This type of collaboration includes informal meetings, talks, communications, informal exchanges at forums, conferences and workshops (Schartinger, et al., 2002). Meyer-Krahmer & Schmoch (1998) in a survey evaluate importance of different collaboration types from perspective of German professors of research centers. According to their findings collaborative research and informal contacts are the most important types of interactions (Meyer-Krahmer & Schmoch, 1998). Cohen et al. got the common results by survey among managers of US R&D units conducting R&D in manufacturing industries. Publications/reports, informal interaction and meetings and conferences (as a separated type of interaction) are the most important channels of communication between industry and academia (Cohen, et al., 2002). Howells et al. (2012) got similar results among UK firms as well: informal collaborations are rated very high compare to the patenting and the licensing activities (Howells, et al., 2012).

Publications

Publications as another important link of collaboration is noted by Perkmann &Walsh (2007), Cohen et al. (2002), Schartinger et al. (2002), Meyer-Krahmer & Schmoch (1998). Remarkable, that research conducted by Cohen et al. (2002) defines publications (and reports) as the most important channel, at the same time in Meyer-Krahmer & Schmoch (1998) research this type is almost the lowest ranked. However, probably, the most important reason for it is in that surveys were made from different perspectives (the first one was conducted among US R&D units in industry and another among German universities). Joint publications are defined as type of collaboration, when at least one representative of each party (academia and industry) cooperate (Schartinger, et al., 2002). However, Bozeman et al. (2013) highlight that in some cases collaborators never meet or even interact with each other. Nevertheless, in joint supervisions of Ph. D. and Master's theses the interaction is provided through third party (students) (Schartinger, et al., 2002). For the industry such non-interactive way as screening scientific publications is a source of ideas and indicator of university's competencies, which may help to choose the right partner (Fontana, et al., 2006). According to findings of Fontana et al. (2006) the acquiring knowledge by companies through the screening of publications may increase a chance of signing the agreement with Public Research Organizations (PROs), but not effect on the collaboration, at the same time patenting may become a signal for PROs about the company's competencies.

Knowledge sharing

The last type of interaction, identified in this analysis, *knowledge sharing*, is used above the Perkmann et al. categorization. It was placed to compile all the separate interaction activities, relating to knowledge exchange and mobility of research staff. This type includes such activities as lectures at universities held by firms, which implies transfer of tacit knowledge (Schartinger, et al., 2002). Sabbatical periods for university members are also mentioned by Schartinger, et al. (2002) and reflect the more or less informal knowledge sharing from academia. In addition Ramos-Vielba, et al., (2009) highlight the *non-academic knowledge diffusion activities* considering for research teams only. This subtype includes meetings, conferences, fairs, and is defined as one of the most common in the group of researchers together with consultancy, joint research projects, commissioned R&D projects from firms and informal interactions.

The interesting view on this subtopic is given by Uyarra E. (2010). The researcher in the study considers university' role in the economic development and innovative potential of regions. The author identifies five different roles of universities in that development (see Appendix 4, Figure 1). Uyarra gives some kind of classification of the university relationships by its' direction. For instance, universities – *knowledge factories* represent the unidirectional interaction by providing new knowledge, know-how, innovations to firms. *Relational universities* interacting with mostly large firms take part in bi-directional interaction, where both actors are sharing their knowledge. It is interesting, that Uyarra marks the relationships with such a kind of university as *implicit bi-directional* (the author does not give explanation to this emphasis, but it can be assumed that the initiative is more transferred to the side of university, which in some extend work on a large manufacturing company: whether by contract research or by creating high-qualified human resources). The *entrepreneurial universities*, which play an active commercializing role, are in *explicit bi-directional relationships* with large manufacturing firms and Spin-off companies. The next group, *System universities* are already in tripartite relationships with industry and government for developing regional innovation systems through networks. This kind of relationships reflects Triple-Helix model (see chapter 3.5). The last model of university identified by Uyarra is so-called *engaged university*, which plays the role of integrator: promoting involvement and mobility, creating the base of skills developing and basic research (Uyarra, 2010).

Summarising the analysis on the types of interactions it is important to define the actual direction of every action. Figure 5 shows classification of 'links' into three groups: university-industry activities (on the figure they are shifted more toward the block *University*); bi-directional interactions (they are green and placed in the center); industry-university directed activities (on the figure they are shifted more toward the block *Industry*).

According to Bozeman et al. (2013), provider of resources couldn't be defined as a collaborator; it is rather a patron (Bozeman et al., 2013). Therefore, such types of activities as Spin-off companies, commercialization of IP, research services (sponsored by industry) actually has one-direction, the one thing, that university gets back is funding from business.

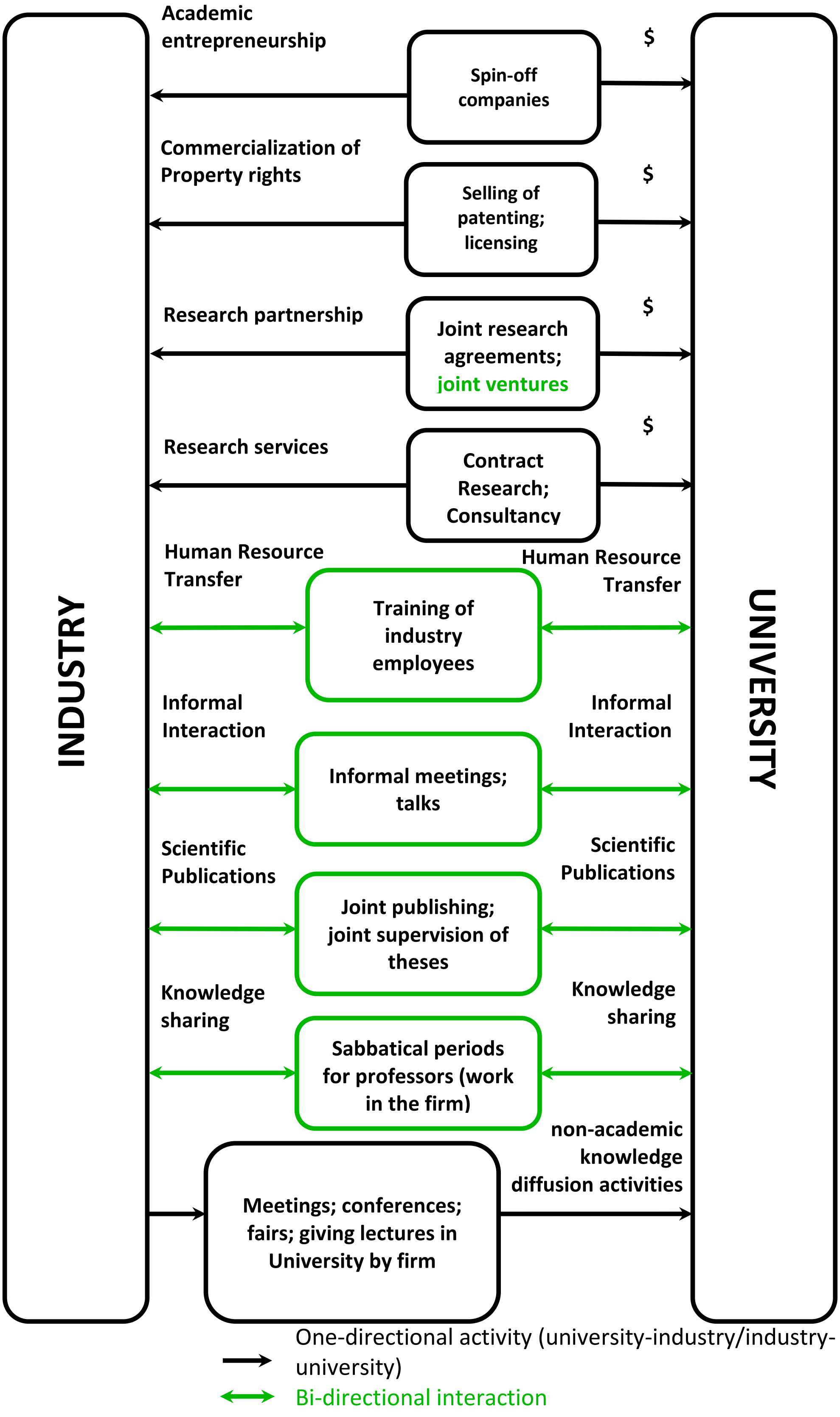


Figure 5. Summary of types of 'links' by direction of interaction between university and industry

The situation is less univocal with research partnership, because in much of descriptions by authors the word *joint* is used. Obviously, that industry is more like an investor here and University is a source of human S&T capital.

However, in case of operating on a common platform (labs, incubators, and research centers) entails the bi-directional knowledge exchange. That's why some activities in this category are marked with green.

Obviously, that in some cases this generalization is too categorical. For instance, in a research partnership and in case of provision research services, universities get more than just funding, they get experience, collaborator for further research, source of industrial experience.

At the same time, of cause, the every kind of bidirectional link (human resource transfer, informal interaction, scientific publications, knowledge sharing) may cause financial benefit for any of the parties (as any kind of promising collaboration).

The reverse-directional interaction is mentioned by Ramos-Vielba, et al., (2009) like *non-academic knowledge diffusion activities* (Ramos-Vielba, et al., 2009), and during the guest lectures at universities the knowledge transfer from business experience to academia is conducting.

Considering the motivation of academic side for collaboration it could be a financial advantage, as fee for instance, or non-financial benefits, as an access to data from practical side or rare or expensive materials, which could be provided by industry.

However, according to Perkmann et al. (2013), percentage of scientists involved in the commercialization (academic entrepreneurship, patenting and licensing) is significantly lower compared to the academic engagement (collaborative research, consulting and other non-commercialization links).

Perkmann et al. (2013) give an overview of external engagement of academics. The results are various from one science field to another, but there is a general trend, that academic engagement is more common among scientists than commercialization. For instance, the share of academic entrepreneurship in the given data is no higher 10%, at the same time share of consultancy in most cases is above 30% (Appendix 4, figure 2) (Perkmann, et al., 2013). Collaboration is not just more commonly used, but moreover, this type of interaction unlike IP transfer has a larger value (D’Este and Perkmann 2011).

3.3. Industry-university collaboration: reverse directional interaction

As it was mentioned above, the reverse-directional interaction from industry to university is not disclosed enough as an academic topic. There are discussions on indirect factors as industry-to-academia human resource transfer, providing facilities and equipment to university, giving guest lectures by representatives of business in universities.

The search in two databases (Scopus and Web of Knowledge) with query "from industry" AND "to university" proves the lack of academic research on this topic. For instance, in Web of Knowledge database 24 articles were founded, but actually all of ones discussing the UI collaboration talk about University-to-Industry direction. Analysis by abstracts shows that founded items are about technology/knowledge transfer *from university to industry*. The combination *from industry* in founded articles always relates to providing funds from companies.

The search in Scopus database was more productive with initial result in 14 articles, and after abstracts analysis 5 articles were selected as sources discussing the reverse-directional interaction in some extend. The most of these articles are analyzed below.

The basic search at the EBSCO data base with query *from industry to university* gave result in 1106 sources. Fortunately, to find the directly relevant articles it is possible to limit the search results by particular sub-topic: “academic-industry collaboration”. Most likely the target sources are in that category, because others apparently discuss these relationships indirectly, if they actually do. The final result with this limitation is 9 sources, from which one is a small column in periodical. Thus, finally EBSCO data base claim 8 academic articles relevant to the sub-topic. The detailed analysis of each article allows identification of one really relevant source – article by Lucia et al. (2012).

In that article authors discuss the long-term collaboration established between the University of Zaragoza and the Bosh and Siemens Home Appliances Group. Lucia et al. consider the advantages and disadvantages of collaborative program from both perspectives: university and industry. That means that researchers are considering the reverse-directional outcome as well. Authors research the benefits for students and for faculty. They name the follows useful activities for students, initiated by industrial partners: lecture activities; hands-on training; research activities (covering mainly BSc and MSc theses and Ph. D. dissertations with supervision from both – university and industry); participating promotion events (including technical visits to the factory and Technology Competence Center); participating conferences; participating the BSH–UZ innovation award (the annual prize that identifies the best invention related to the household appliances sector. The competition has two nominations: student groups and research groups) (Lucia, et al., 2012).

Among learning outcomes the authors listed: knowledge of technology, specific techniques and understanding of particular phenomena; usage of lab equipment, specific tools, advanced simulation tools; knowledge of specific industrial issues from experienced people; skills of communication, work in research groups; industrial experience (Lucia, et al., 2012).

Scientists argue that even though getting funding for research is the most beneficial for faculty, they also organize technical conferences; apply for a stay as visiting scholar in the Technology Competence Center in order to collaborate with research projects; annual group meeting with representatives of the industry (Lucia, et al., 2012).

According to findings made by Dietz & Bozeman (2005) in the research devoted to career patterns of US engineers and scientists, the majority of job transformations among academics and engineers happen in academic-to-academic direction, it takes about 62.5 percent of all job transformations. However, it is interesting that the number of industry-to-academia transitions is bigger, than academic-to-industry job transformations (8.1 percent of all job transformations compared to 4.8 percent respectively) (Dietz & Bozeman, 2005).

Lubango & Pouris (2007) researching the influence of industry work experience on inventive capacity in five local universities of South Africa, argue that human transfer from industry to university would increase the inventive capacity. The study results show that this professional flow would improve the scientific and technical human capital as well (Lubango & Pouris, 2007).

Despite of the lack of development of industry - to university topic in the academic literature, in practice, this direction of interaction exists, and it works – in Russia as well. For instance, special centralized association “Finnish-Russian University Cooperation in Telecommunication (FRUCT)” was created in 2007 and its aims are:

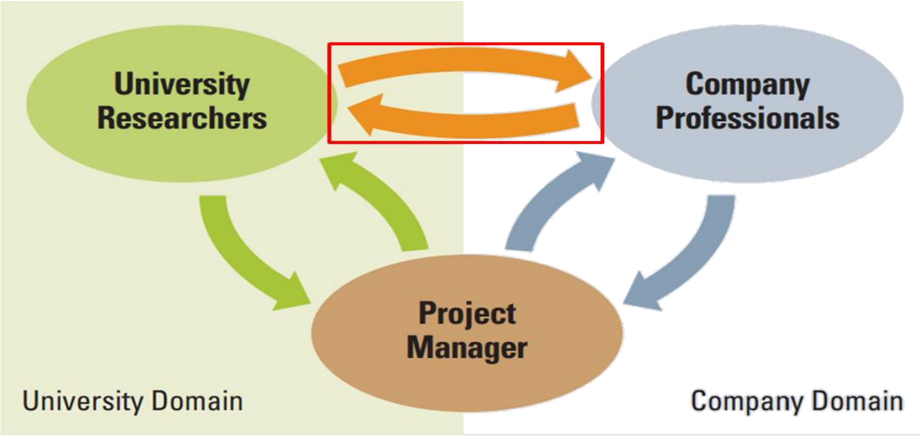
- to help regional universities to build world-class IT and ICT competences demanded by the industry;
- creation of innovative startups;
- improvement of the innovation ecosystem of Russia and Finland;
- improvement of competitiveness of the graduate students;
- development of cooperation between universities and industrial research groups (FRUCT, 2008).

The realization of the idea of cooperation between university and industrial teams gives a lot *to academia from business*:

- the business environment in that team helps students and university researchers to get the experience;
- solving particular problems and cases help to concrete the task and to increase the applicability of academia ideas by getting from industry a valuable knowledge: industry needs or feedback;
- strong brand from close partnering company may work as a “customer reference” for universities to keep the best students in the departments and to increase the prestige of scientific research (Balandin, 2012)

Obviously, companies have to be motivated enough to provide all these benefits. In that particular case companies get long-term and high-risk research done by the universities, they have an access to the latest research results and therefore have an opportunity to come the first to the market (Balandin, 2012).

Discussing the best practices of industry-university collaboration Salas et al. (2010) looks at the problem from the business perspective. Their research is based on a survey of more than 100 projects at 25 multinational companies collaborating with universities. The authors highlight the importance of two-way knowledge transfer not just between actors and project managers, but directly between university research teams and company professionals (Figure 6). According to authors, the purpose of the reverse directional knowledge flow should be in informing university teams about the ideas from the company considering potential linkages with other company activities in addition to the plain company's feedback and sharing the corporate vision of the collaboration output (Salas & Alberto, 2010).



Source: Salas & Alberto, (2010)

Figure 6. Knowledge exchange paths in industry-university collaboration

Hottenrott & Thorwarth (2011) look at particular aspect of industry' influence on academia: scientific productivity. According to the research results (based on a survey among professors in science and engineering in Germany) a big share of financial support from industry reduces publication output of academics both in terms of quantity and quality. The authors fear that it proves the "skewing problem" hypothesis for science and engineering in Germany and restrict the knowledge distribution between researchers: that could have a negative effect for science development. However, the positive affect for academia was identified as well. It is in improving the volume and quality of applied research, which is reflected in successfully patented relevant technologies (Hottenrott & Thorwarth, 2011). However, in that study just the financial support from industry was considered as an aspect of reverse-directional interaction.

Another kind of reverse-directional influence of industry is taking part in educational programs. Barr (2008) considers the problem of the gap between graduate students in engineering and industry of civil engineering in UK. Professor gives the quotation from “Guidelines for Developing Degree and Further Learning Programmes”, created by Joint Board of Moderators in 2005:

“There should be strong, viable and visible links between departments and the profession. It is strongly recommended that local practicing engineers should become involved with the education of students. Industrial liaison groups should be established and should meet regularly to identify how local and national needs for graduate employment might influence programmes” (Barr, 2008, p.22).

In other words experts highly recommend the involvement of professionals from industry into educational process to nurture professionals with an understanding of the current needs and concerns of industry.

To summarize the discussion of this chapter it is important to note, that separate structured study considering the industry-university interaction is needed, especially realizing that the phenomena exists in reality (FRUCT). The analysis showed that more often authors talk about funding from industry. However, some researchers pay attention to the knowledge and experience transfer (Salas et al., 2010, Lucia et al., 2012), highlight that importance and suggest it as an obligatory requirement for successful collaboration (Barr, 2008). The one of the most important findings is that authors mention the necessity to involve industrial companies into educational process and even into its planning (Barr, 2008). Even though, the collaboration with industry may decrease the time, which scientists spend on their academic knowledge sharing, that defiantly should increase the applicability of their research (Hottenrott, et al., 2011) and bridge the gap between two actors. The last important aspect of industry-university collaboration is social. For instance, Manoj V. (2009) in the article talks about industry' responsibility not just for unemployment, but for *unemployability*. The researcher suggests that industry and university have to *join their hands* to find solutions for existing unemployment and for preventing the future ones (Manoj, 2009).

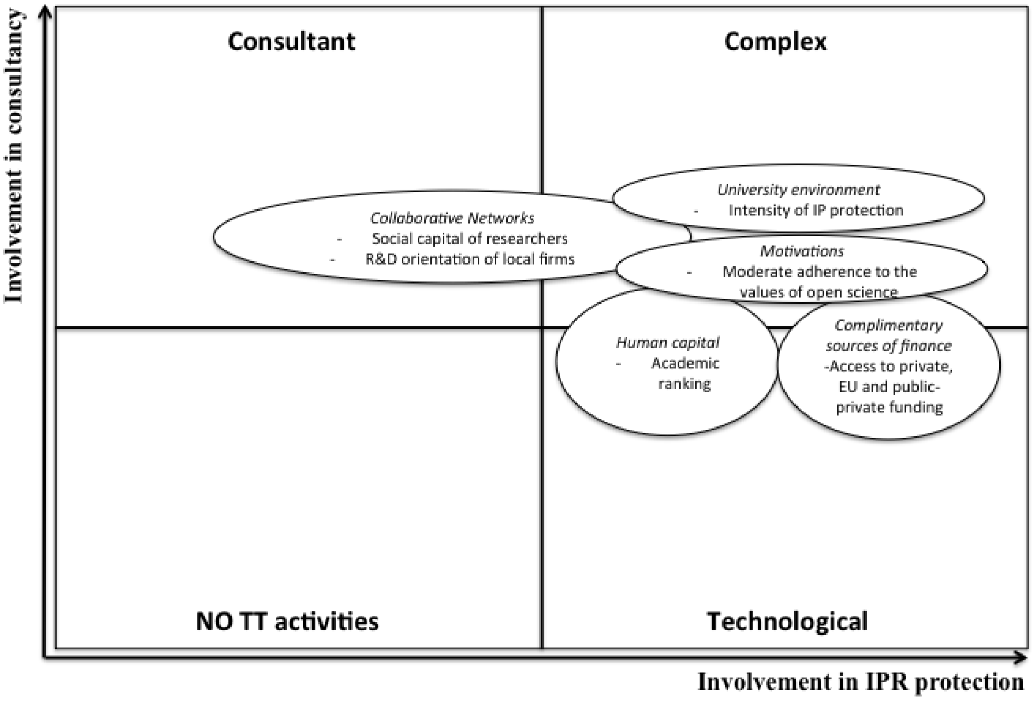
3.4. Personal profile: academia and business, which collaborate

Profile of academician, which is engaged with industry, including age, stage of carrier and other personal characteristics, is discussed in this chapter. Male scientists are much more active and successful in collaborating with industry, than female (Perkmann, et al., 2013). Age is a bit controversial indicator: some researchers emphasize that more experienced and correspondingly older scientists have more opportunities in collaboration (Boardmana & Ponomariov, 2009; Haeussler & Colyvas, 2011), at the same time some authors claim that younger academics have more mobility for knowledge transfer (Bekkers & Bodas Freitas, 2008; D'Este & Patel, 2007; Giuliani et al., 2010) find that there is a U-correlation between U-I collaboration and age of academics: the younger and older are more actively taking part in collaborating with industry, than professors in the middle of their carrier (Giuliani, et al., 2010). Several researchers do not find any relation between age and cooperation intensity or its' commercial output (Gulbrandsen & Smeby, 2005; Renault, 2006). Perkmann et al. (2013) highlight that the negative affect of the age could be explained by the practices, which existed in the past: if the older generation of scientist is not used to collaborate with industry, then most likely they will not engage with companies (Perkmann, et al., 2013).

Psychological factors also play an important role in research collaboration. One of them is suggested by Bozeman (2013), it is a job satisfaction: the more satisfied a scientist is with his (her) position - the more this person collaborates (Bozeman, et al., 2013).

Considering the technology transfer (TT) between university and companies, Lauto et al. (2013) highlight four different groups of researchers based on their involvement in two mechanisms of university–industry collaboration: IPR protection and consultancy. Scientists identify 4 different types of person by these dimensions, which are presented on the figure 7 (Lauto, et al., 2013).

The results of the research confirm hypothesis of the authors: the one is about positive correlation of researcher' involvement in TT in case of funding granted by non-academic organizations and another one is in the positive influence of breadth of the researcher's social capital.



Source: Lauto, et al., (2013)

Figure 7. Variables having a positive association with the profiles of technology transfer

Azagra-Caro (2007) identifies the profile of scientists, which interact with industry very clearly: male, having senior status and administrative position. Moreover, the author gives the portrait of a firm, which is willing to collaborate with university: larger size, in science-based sector (Azagra-Caro, 2007).

Lam (2010) highlights four different types of scientists:

1) *traditional* – which emphasizes the distance and difference between University and industry and claims that basic research should be done at the university, and applied and commercial activities – at the firm;

2) *traditional hybrid* – agrees with the first type on the importance of the differentiation University and Industry, but tends to engage with industry in order to get new knowledge with aware of commercial activities;

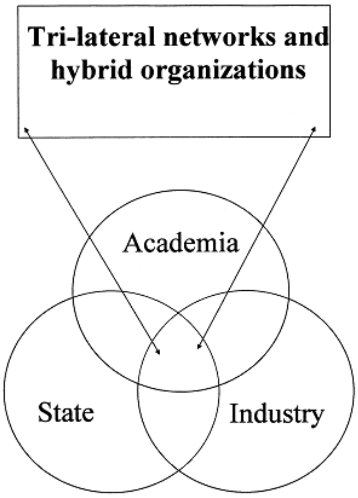
3) *entrepreneurial hybrid* - combines entrepreneurial orientation with an old school commitment to the core norms of the academic science. They see the boundaries between University and Industry as *open space* and do not suppose, that commercial activities can harm research or educational processes;

4) *entrepreneurial scientist* – sees science as a commercial activity, which is compatible with academic career.

According to Lam, the *hybrid* types are most likely take part in cooperation (Lam, 2010).

3.5. Triple Helix university-industry-government relationships model

Not just important but very often-decisive actor in the university-industry collaboration is the government. Thus, the influence of governmental institutions on university-industry relationships should be considered. The Triple Helix model of university-industry-government (UIG) relationships represents the interaction of all of three actors and it was described by H. Etzkowitz & L. Leydesdorff in 2000. The idea of the concept is in understanding the nature of each actor and building mutual cooperation through tri-lateral initiative (Etzkowitz & Leydesdorff, 2000) Research has defined three models of interaction between state, academia and business, which could be named as an evolution of the Triple Helix model of the relationships. The first model was called as *statist* and it describes the dominance of the governmental institutions, which control university and industry separately and their interactions well. The opposite *laissez-faire* model is based on a view that all of three actors exist separately from each other and there are strong borders between actors and interaction is modest. The examples of interaction according to this model are Soviet Union Institutions, triode in France and Latin American countries. In this type of relationships academia is distant from industry (Etzkowitz, 2008). The changes in the environment, appearing of such manifestations of knowledge based economy as university spin-off firms, the common UIG projects, strategic alliances, governmental and commercial laboratories - all these moves set in motion a new model of relationships, see figure 8. In this model all three institutions spheres are overlapping, actors interact according to the mutual interests and aims, in contrast to the second type of the model, but at the same time there is no total control from the governmental side (Etzkowitz & Leydesdorff, 2000).

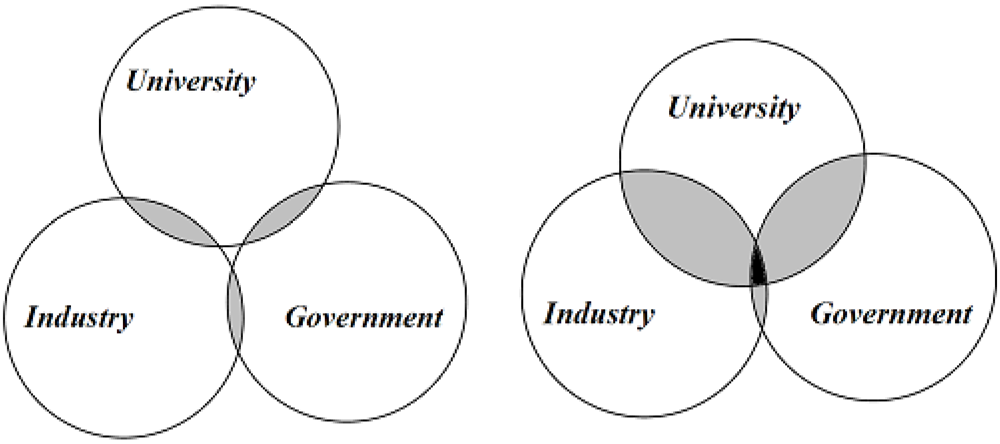


Source: Etzkowitz & Leydesdorff, (2000)

Figure 8. The Triple Helix Model

Later on, Leydesdorff (2012) described different configurations of Triple Helix (TH) model, and he named the combination of bilateral relationships (separate University-Industry, Industry-Government, Government-Industry) as a negative overlap, because of the differences in their own missions (Figure 9). He suggested establishing of compromise between integration and differentiation in the trilateral relationships and overlay of the political, scientific and economical exchange (Leydesdorff, 2012).

However, there is some criticism of the Triple Helix Model. For instance, Rodrigues & Melo (2012) state, that TH model has too global level. Researchers highlight the regional role of universities and the importance of their contribution to the global economy through local economy (Rodrigues & Melo, 2012). Thus, they suggest looking at the TH model with more local, regional approach. At the same time, Kaukonen & Nieminen (1999) argue that TH is narrow from the perspective of the global development, that it should have “the glocal dimension”. Researchers note that the model structure could be different on different levels, but it should include global system of S&T (science and technology), macro-regional, national and local systems, where the TH model is operating across (Kaukonen & Nieminen, 1999).



Source: Leydesdorff, 2012

Figure 9. A Triple Helix configuration with negative and positive overlap among the three subsystems

Triple Helix model in Russia

Discussing Russia in the context of the Triple Helix Model, the most of researchers note *special features* of the Russian economy and the innovation system. Some of them inclined to consider that it did not even exist until recently, and universities played the role of teaching institutions with low level of academic research (Uvarov & Perevodchikov, 2012). The dominant role of the state in the Russian triangle relationships seems indisputable, mostly because of the inheritance of the Soviet system. In the end of 20th century the main task of government was to stop the termination of national research institutions and the “brain drain”, that was a prerequisite for the existence of the Triple Helix model in Russia. It was achieved in some extent through implementing policies of restructuration of universities. Uvarov & Perevodchikov (2012) distinguish the following stages of the development of the Russian innovation system:

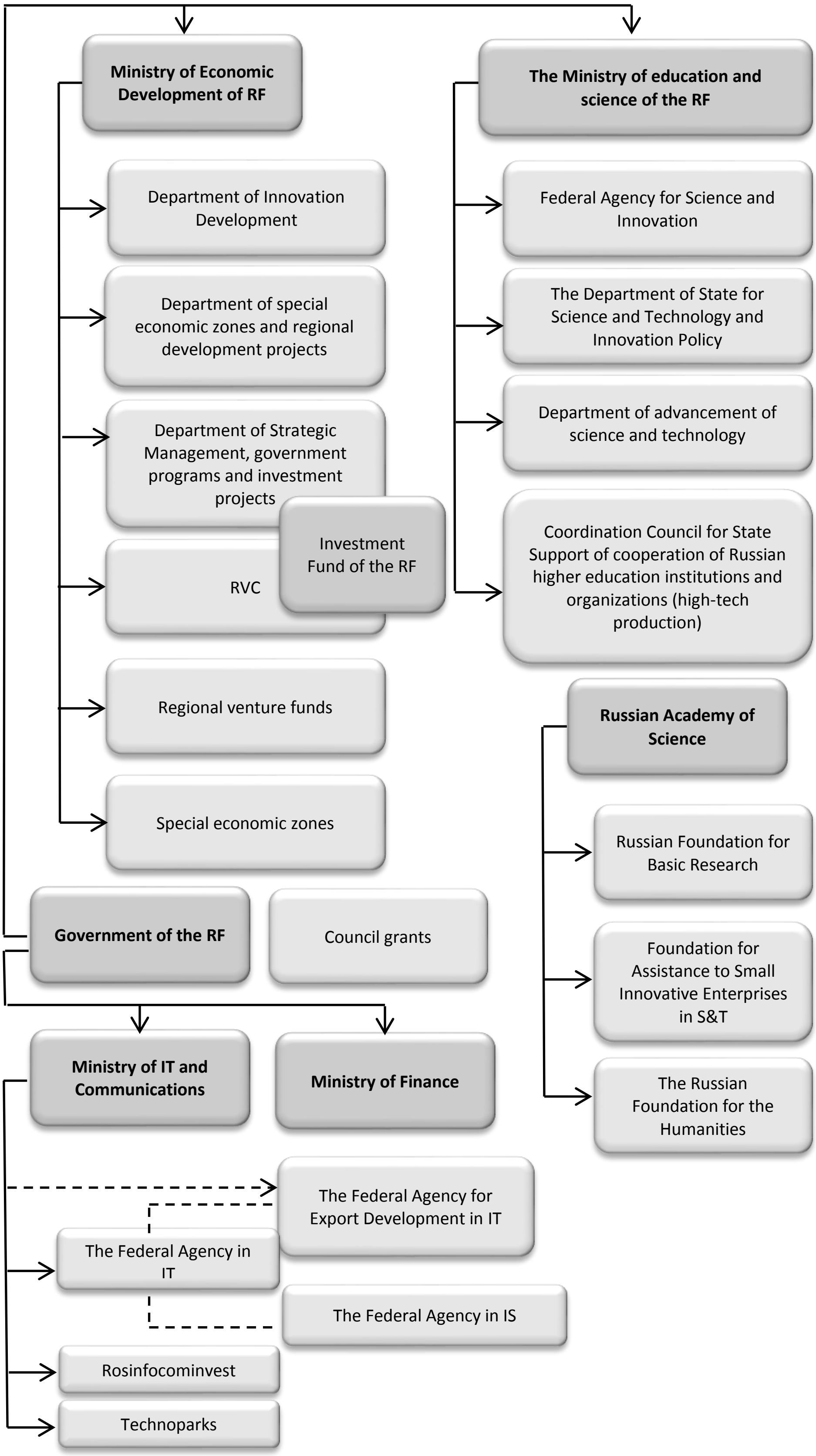
– the first one was represented by Russian science and was in *open letters to government*, the reaction from the government was rather slow;

– in 2005-2008 science and technology parks were founded by government across Russia. According to data from Russian Ministry of communication and Mass Media nowadays in Russia are developing 12 technology parks in high-tech industry only, 7 of which were created under the program approved by the Federal Government on 10 March 2006 (minsvyaz.ru, 2013);

– in 2009-2011 the legislature was accepted to facilitate the innovation development;

– 2011-2012, the government provided federal grants to create entrepreneurial universities and regional innovation clusters (Uvarov & Perevodchikov, 2012).

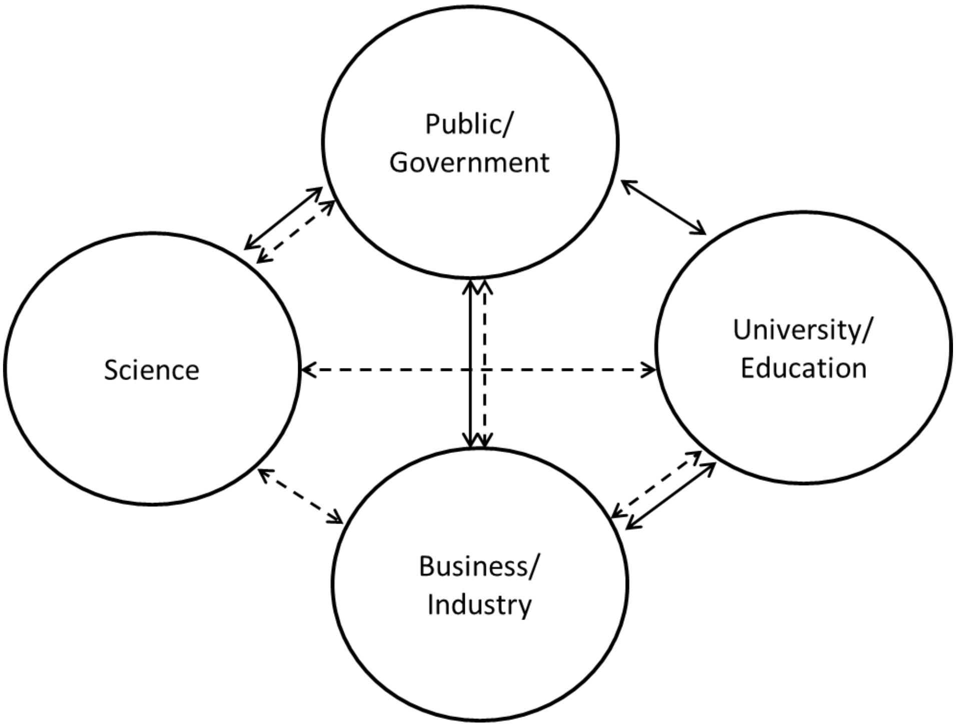
In Russia the sector of science is represented by Russian Academy of Science (RAS), not by universities, contrasting to the most Western countries. The basic research is practically handled by Russian Academy of Science institutes (not in higher educational institutes), thus there is a need to move to entrepreneurial university and to make them independent or interdependent and collaborative with RAS (Pospelova, 2012). If we look at the structure of Russian R&D sector – Russian Academy of Science is a separate element, which is operating more or less autonomously (see figure 10). According to statistics of 2007, only 0,8% of RAS' institutions collaborate with business and 8% with universities (Dezhina & Kisileva 2007), while close cooperation of science with higher-educational institutions looks logical and necessary for normal mutual development of both sides. It is interesting to note, that both – Russian and European experts show the Russian R&D sector by hierarchical structure, where R&D organizations are under the control of the State and do not have any links with business structures (see Appendix 5).



Source: adopted from Aterekova & Jukov, (2006)

Figure 10. Organizational structure of science and innovation in Russia

That is why Savitskaya (2009) proposes a “Quadruple-Helix” model for Russia, where science (RAS) is a separate component (see figure 11 below). In the figure the dashed line implies weakness of interaction and full line reflects strong relationships. Even though, Savitskaya marked U-I relationships by both types of the line, she highlights that such strong relationships exist in reality just in a limited number of cases and could not be generalized. At the same time government has a strong link (influence) with all of other three actors.



Source: Savitskaya (2009), based on Dezhina & Kisileva (2007)

Figure 11. Adaptation of Triple-Helix to Russia - "Quadruple-Helix"

Another specialty of UIG relationships in Russia is that business sector is not very interested in collaboration with universities and creation of new technology; most of the companies prefer to adopt technology from foreign companies (Pospelova, 2012). This illustrates a lack and sometimes even absence of connection between university and industry in Russia. Most likely, the state now is the main moderator of university-industry relationships in Russia. However, Dezhina & Zashev (2007) note, that generally, universities do not show the strong willingness to collaborate with business as well and remain the position of consumer of governmental decisions and support.

3.6. University-industry collaboration in the context of open innovation

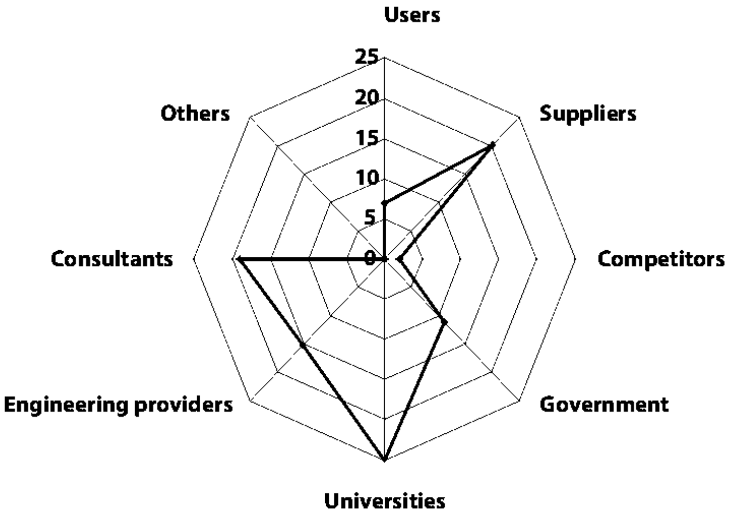
Due to the fact, that open innovation as a phenomenon is quite new, there are a lot of research gaps within that are intensively explored. Two of these gaps are identified by Howells et al. (2012). The first one is that open innovation practices are mostly discussed in the context of firms, and less in the context of other actors, such as universities. The second research gap is that firms or even business units are discussed in isolation, just dyadic relationships are under consideration, when in reality they are interacting with others, forming networks, and operate in the conditions of particular industry (Howells, et al., 2012).

Researchers highlight that after the open innovation concept had emerged, universities' role began to change. From traditional transferring of knowledge to the firms, universities have started to perform a wide range of functions, such as conducting multidisciplinary research, social and commercial responsibilities (Van der Steen & Enders, 2008).

However, it is too early to say that the university' role in companies' productivity has changed dramatically and became extremely significant. For instance, Howells et al. (2012), in the study based on the survey, conducted in the UK in 2008-2009 among 3600 firms, claim that universities are poor sources of innovation information (just 3% of responding companies rank universities as a valuable source of information, in compare – 67% marked *clients or customers* as such a kind of source). Moreover, researchers call universities as low-priority, low-order partners for collaborations. Nevertheless, in term of innovation output, universities are ranked as second after public R&D institutes in term of products, services and organizational methods and their impact on process innovation outputs is the highest among all considering actors (Howells et al., 2012).

In addition, according to analysis by Allied Consultants Europe (ACE, 2012), a strategic partnership of 11 leading European management consulting firms, which is based on the survey of 42 European organizations (two thirds of which are already using OI practices), universities, suppliers and consultants are the preferred partners for OI processes. Figure 12 shows that those universities are leading in the list of preference (ACE, 2012). However, universities as partners are not an exception – firms need to spend resources (time, human resources, financial resources) on establishing and even more on maintaining relationships with universities (Howells et al., 2012).

Considering the indicators of collaborative actors, Howells et al. highlight that larger firms are 1,42 times most likely name universities as valuable source of information and potentially good partners. The researchers claim that another indicator is industrial sector: manufacturing firms will more likely establish a partnership with university, because this type of organizations is closer to general science, than service companies (Howells et al., 2012).



Source: ACE, 2012

Figure 12. The main partners in open innovation in %

Establishing any types of relationships with universities is significantly influenced by openness of firms to the external environment (Laursen & Salter, 2006; Fontana et al., 2006; Uyarra, 2010) suggest that openness of firms to the external environment influences very significantly on results of the survey made by Bercovitz & Feldman (2007) show that companies with exploratory in-house R&D strategy are likely to invest in university' exploratory projects to speed up their own research (Bercovitz & Feldman, 2007).

The one of the most important limitations of considering open innovation theory is that it was created in conditions of the set of laws, rules and restrictions existing in USA. Therefore, the theory and practices under this theory should be evaluated and identified clearly and carefully for the each particular context of National Innovation Systems (West, et al., 2006).

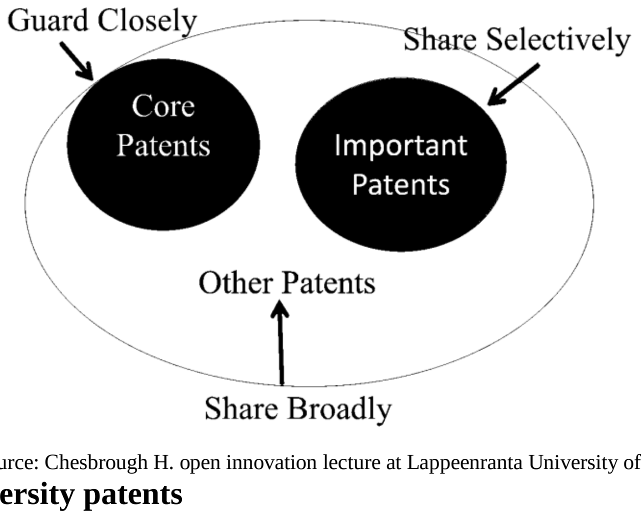
Henry Chesbrough, the creator of the open innovation Theory, presenting a workshop in Lappeenranta University of Technology, held on 31st of May 2013, gave comments to this work and discussed the topic "University-industry collaboration in the context of open innovation". First of all he named this topic as a very important and noted that the most of the problems related to this have to be solved through policy changes. Chesbrough listed some of links, which should work successfully in terms of these particular relationships, such as:

- Leave of absence: he was talking about sabbatical periods for university members, which give them an opportunity to work in industrial companies, to share and to get the experience. He gave an example of Stanford University, where faculty members may spend 20% of their work time on any other activities. Chesbrough described this practice as a very successful and useful for collaboration with industrial companies.
- Companies invite advisors from universities: that provides new knowledge for industry. Professor gave an example of Spanish company Telefonica, where the special program 'Thinks Big' was created in 2012. The idea of the program is "to invest in future generations by addressing three critical issues facing young Europeans today: 1) A lack of opportunities for young people in Europe; 2) Europe lagging behind in entrepreneurship and innovation 3) Skills Shortage in Europe" (Lloyd, 2012). The company highlights the importance of the experience in academia and invites university members to "drive Telefónica's strategy to kick start positive societal and economic change in Europe" (Lloyd, 2012).
- Science parks: Henry Chesbrough mentioned this type of link as an infrastructural place for meeting representatives from industry with academia and sharing ideas in the work atmosphere. Professor called it "knowledge innovation communication".

Chesbrough also highlighted that the project management system should be flexible, “should be different for each particular project”.

Considering the topic of reverse-directional interaction, professor shared the idea, that the reason for limitation of this process “could be the fact that industrial companies are not satisfied by the results of the universities’ work”.

Chesbrough also talked about diversification of royalty as the instrument of implementing open innovation strategy for universities. At the lecture, which was held from 30th May 2013 he presented a picture, which is given on figure 13. The figure shows, that universities usually have just a few core patents, which play the main role in the university IP portfolio and which are the key assets. These patents should be stored inside, and should be guard closely according to Chesbrough. The next group, important patents, should be evaluated and for each particular patent the decision should be made: to keep it inside or to let it go outside. The other patents should be evaluated as well, and the decision about their commercialization or using inside should be made as well. Obviously, among the important group of patents much less patents will be commercialized than assets from “other” group, which according to Chesbrough should be shared broadly.



Source: Chesbrough H. open innovation lecture at Lappeenranta University of Technology, 30.5.2013

Figure 13. University patents

3.7. Good practices in university-industry collaboration

The author of this thesis uses term *good practices* instead of more common *best practices*, because best ones implies just a single scenario for success, while companies and their environment are complex and there could not be an ideal practice for each company (Slowinski & Sagal, 2010).

Governmental regulations are rather effective and required stimulator for the developing of open innovation cooperation between industry and universities, in particular, they support increasing technology commercialization and technology diffusion from universities to business (Markman, et al., 2008). In US the higher education system as the whole had been practicing a lot of collaboration activities between academy and industry (including not just patenting and licensing) much longer before the Bayh-Dole Act, 1980 (Mowery & Sampat, 2005). This development has been gradual. Already in 1912 the Research Corporation for managing university patents was founded by Frederick Cottrell, researcher from University of California. The 1980s had become a period of active patenting by universities (especially in bio-medical field), which weakened the role of research Corporation and showed the universities' self-sustaining ability. Both, public and private US universities established their own technology transfer offices in late 1960s, and their willingness to manage their own inventions was rising as well. Therefore, the Bayh-Dole Act, 1980, which legitimated the ownership and licensing of inventions made with federal funding, was a reaction to the actual rising of universities' patenting and licensing as well as an institutional step for the active growth of university-industry interaction as independent units. The effect of the entry into force of the act was obvious, the number of university patents started to growth actively since 1980 and by 1999 the share of university patents among US patents increased from less than 0,01 to 0,04 (Appendix 3, figure 1 left). The growth of financial efficiency of university patents was registered as well (Appendix 3, figure 1 right).

However, in the recent years, researchers note the university patents number decline. Loet Leydesdorff & Martin Meyer in their study note this declining trend among not just exclusively US Universities' patenting, but among non-American universities also (Appendix 3, figure 2). In addition, specialists highlight that, the number of spin-offs from academia and volume of patenting through outsource organizations (as Oxford University operates with ISIS Innovation) are declining in the recent time too. Researchers explain this global trend not just by the fact that patenting is expensive and not always profitable, but by “structural” reasons as well. They found that the character of competition among universities had changed. Moreover, for not only US universities rates, as a level of attraction for students and significance in the world of science, are very important. At the same time, international collaboration and co-authorships are more vital for university rank nowadays (Leydesdorff & Meyer, 2010). Thus, the recent trend is not in keeping knowledge inside of the particular university patent, but in utilizing it effectively. Today there are some concerns among researchers about the Bayh-Dole Act. There is a conflict of interests between public investors and academia, which is in the lack of trust to the public based research and uncertainty of phase on which the research actually needs funding (Fins, 2010). Researchers name the Bayh-Dole Act in today’s economic and political terms as too neoliberal for the US (Valdivia, 2011) and highlight the risk of “patent-oriented” policy, which is dangerous not only for US innovation system, but for other countries’ ones in case of adapting of the Act there (Mowery & Sampat, 2005).

In 2003 other OECD countries took up US initiative of allowing universities to issue patents. There was made a decision to allow using of the patenting right by Public Research Organizations (PROs), and to provide to academic inventors the share of royalty from licensing the innovation (OECD, 2004). The decision making process of abolishing the so-called law about abandonment of “professor’s privilege” was slightly different in various European countries. While in Denmark (2000), Germany (2001) and Austria (2002) the professor’s privilege was abolished to improve the universities patenting one by one (Lissoni, et al., 2008), in Italy at first in 2001 the law with the reverse initiative was passed (383/2001), and it was based on the view that individual inventors would have more opportunities to profit from their innovations and that universities in Italy had no enough competences to promote patenting. However, this legislation was debatable already since the adoption, and all the sides said that it was discrimination between private and public employees and the law complicated the process of managing IP in joint public-private projects (Baldini, et al., 2006).

3.8. Problems in university-industry collaboration

Bruneel et al. (2010) in the study, exploring reducing barriers to cooperation and which is based on an analysis of UK companies working with universities, distinguish two types of barriers: orientation-related barriers and transaction-related barriers. The research was conducted among UK SMEs and large companies, but the authors highlight the absence of significant differences among companies of various size Researchers defined 7 barriers to collaboration, emanating from universities; these barriers are listed in the table 11.

Table 11. Barriers of collaboration, emanating from universities

Type of barrier	Barrier
Orientation-related barriers	University research is extremely orientated towards pure science
	Long-term orientation of university research (lower sense of urgency of university researchers compared to industry researchers)
	Mutual lack of understanding about expectations and working practices
Transaction-related barriers	Industrial liaison offices tend to oversell research or have unrealistic expectations
	Potential conflicts with university regarding royalty payments from patents or other intellectual property rights and concerns about confidentiality
	Rules and regulations imposed by universities or government funding agencies
	Absence or low profile of industrial liaison offices in the university

Source: Bruneel et al., 2010

According to findings, the most significant barriers are: long-term orientation of the university research (69% among analyzed UK SMEs and 59% of larger firms respectively indicated the existence of this barrier); rules and regulations imposed by universities or government funding agencies (58% and 53% respectively); potential conflicts with university regarding royalty payments from intellectual property rights, concerns about confidentiality (57% and 54%) (Bruneel et al., 2010).

The importance of mutual trust between university and industry is a separate factor in the study. Authors note that trust can help to reduce the worries that one of the partners will act opportunistically (Bruneel, et al., 2010). Santoro and Saparito (2003) highlight the critical importance of mutual trust between such communicating parties as university and industry, because their relationships determinate both knowledge-based and technological-based outcomes (Santoro and Saparito 2003). Moreover, companies and universities often need to share commercially sensitive information and tacit knowledge, that's why mutual trust is necessary (Bruneel et al., 2010). In general the barriers in university-industry collaboration are quite close to ones identified in inter-firm relationships: lack of trust, mutual understanding, transparency (Barratt, 2004), IP issues (Bader, 2008). The principle difference in barriers to collaboration in firm-to-firm and firm-to-university relationships arises from the difference in primary objectives and motives of these two types of partners. University, as a partner is more oriented to searching for new ideas and fundamental knowledge, at the same time, companies are more profit and practice oriented (Parker, 1992). That is why in collaboration with universities such specific problems as too long terms of research or lack of understanding in working processes and final outcomes arise. Another feature is a usually stronger link of the University, as an educational institution, with the state (government), which also gives rise to additional differences in the approaches of partners compare to inter-firm relationships – for instance, bureaucracy increases.

Hall et al. (2001) explore intellectual property concerns, preventing industry from partnering with universities. According to the findings, the probability of barriers is higher when the company is experienced in patenting with university and knows about associated problems, or when the ability of the firm to appropriate the scale of the scientific discovery is not enough. At the same time the less likelihood of barriers takes place, if the condition of IP is associated with uncertainty for the company. Another barrier, which is defined by researchers, is limitations of the intellectual property protection determined by inappropriate legal infrastructure created by government (Hall, et al., 2001).

Siegel et al. (2003, 2004) conducted the research of problems of university-industry technology transfer (UITT) and defines several problems. The study was based on a survey of three groups of stakeholders: (1) directors of technology transfer office (TTO) and university administrators, (2) academic scientists, and (3) managers/entrepreneurs. For the interview five US universities, which are defined as not in the top-tier group, were chosen and therefore they are more representative. Authors find such barriers as: "lack of understanding regarding university, corporate, or scientific norms and environments; insufficient rewards for university researchers; bureaucracy and inflexibility of university administrators; insufficient resources devoted to technology transfer by universities; poor marketing/technical/negotiation skills of TTOs; university is too aggressive in exercising intellectual property rights; faculty members/administrators have unrealistic expectations regarding the value of their technologies; "public domain" mentality of universities" (Siegel, et al., 2003, p.118).

According to research findings all three groups of stakeholders recognized a lack of understanding regarding norms as one of the most significant barrier to effective UITT. Authors explain the origin of the problem by lack of mutual understanding or respect for the culture between partners. Again, bureaucracy and inflexibility is defined as a serious barrier by managers and scientists (Siegel, et al., 2004).

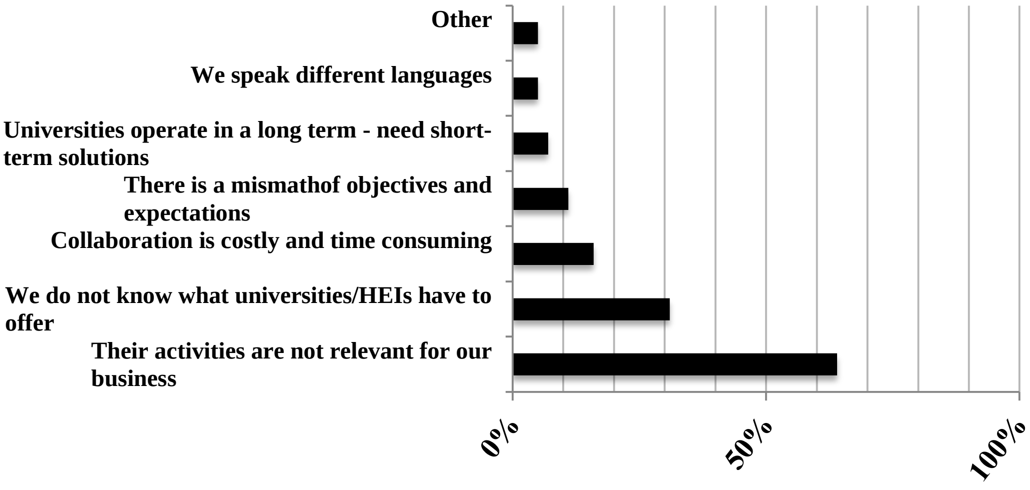
For university administrations and scientists rewards for university researchers seem insufficient and therefore are the significant barrier. In turn, the results of the interview of companies and entrepreneurs identified their dissatisfaction with marketing, technical, and negotiation skills of the TTO staff (Siegel, et al., 2004). The summary of improvements suggested by authors for both actors is given in the table 12.

Table 12. Suggestions for improvements in university-industry interaction

Improvements for university side	**Improvements for TTOs**
1) Universities need to improve their understanding of the needs of their true ''customers,'' i.e., firms that can potentially commercialize their technologies; 2) Adopt a more flexible stance in negotiating technology-transfer agreements and streamline UITT policies and procedures; 3) Hire licensing officers and TTO managers with more business experience; 4) Switch to incentive compensation in the TTO; 5) Hire managers/research administrators with a strategic vision, who can serve as effective boundary spanners (tie to boundary spanning literature); 6) Devote additional resources to the TTO and patenting; 7) Increase the rewards for faculty participation in UITT by valuing patents and licenses in promotion and tenure decisions and allowing faculty members to keep a larger share of licensing revenue (as opposed to their department or university); 8) Recognize the value of personal relationships and social networks, involving scientists, graduate students, and alumni	1) Be proactive in their efforts to bridge the cultural gap with academia; 2) Hire technology managers with university experience; 3) Explore alternative means for tapping into UITT social networks

Source: Siegel, et al., 2003

Observations made by Howells et al. (2012) based on the survey of UK companies, show that firms do not see the value of university R&D results and activities for their business. Sometimes representatives of business simply do not know about these results and activities (Figure 14) (Howells, et al. 2012). However, the market of technology exists, and the nature of the problem in such cases is in the lack of companies' openness and their absorptive capacity.



Source: Howells, et al., 2012

Figure 14. Reasons for not collaborating with universities

Hughes (2011) in the study based again on the survey of UK universities and companies found that firms see the main barrier for interaction with universities in *lack of resources* to manage this interaction (see table 13). It is naturally, that the larger the company, the more difficult it is to coordinate this management process.

However, all types of companies by size see the role of such institutional factors as *lack of regional programs* and lack of central government programs" at the more or less same level of importance (about 30-35% mark them as barriers for interaction).

As the other authors, Hughes highlights the problem of bureaucracy and inflexibility. Noteworthy that the difficulties in making agreement concerning IP were rated quite low compare to other problems. The author explains it not by well-organized IP management in the UK, but by the fact that in the most of analyzed interactions technical exchange did not take place (Hughes 2011).

Table 13. Have the following factors constrained your interactions with higher education institutions (HEIs) in the last three years?

	All (%)	Micro<10 (%)	Small 10-99 (%)	Medium 100-499 (%)	Large 500+ (%)
Lack of resources in the firm to manage the interaction	43,9	44,0	39,2	52,1	51,1
Lack of regional programs that encourage interactions	32,9	36,3	31,9	36,1	28,7
Difficulty in identifying partners	32,4	28,1	31,9	38,9	34,1
Lack of central government programs that encourage interactions	31,5	35,1	29,6	37,1	27,6
Insufficient benefits from interaction	31,2	30,4	28,3	41,7	32,2
Bureaucracy and inflexibility of HEI administration	25,4	26,3	23,2	26,0	30,2
Lack of experience dealing with academics and/or HEIs	24,9	19,0	21,7	28,8	38,6
Lack of interest by academics and/or HEIs	22,6	19,5	20,2	27,4	29,5
Incompatibility of timescales for deliverables	16,9	16,8	14,6	20,8	20,7
Cultural differences	10,6	10,3	7,1	9,7	22,4
Difficulty in reaching agreement on IP	8,2	6,2	7,9	6,9	12,6

Source: Hughes, 2011

It is not very difficult to find common features among problems or barriers for university-industry collaboration, defined by different researchers in various countries. For instance, both - Bruneel et al. (2010) and Siegel, et al. (2003) highlight such problem as a lack of mutual understanding between universities and industry. The great importance of this factor in Siegel et al.’ research compare to Bruneel et al’ could be explained by different conditions in USA and UK, but probably, the other reason is in participating of additional actor (tecnology transfer officies), which could cause the growth of misunderstanding and informational biases.

A major obstacle to cooperation may be psychological barriers, such as “Not Invented Here” (NIH) syndrome. The one of defenitions of this phenomena is given by Grosse Kathoefer & Leker (2010) with a reference to Mehrwald (1999): “NIH infection leads to an incorrect evaluation of external knowledge and a consequential suboptimal use of external ideas”. (Grosse Kathoefer & Leker, 2010, p. 660) According to Grosse Kathoefer & Leker (2010) findings it could be expressed in such factors (or syndroms) as: “preference for internally generated knowledge; perception of the professors on how important outsiders regard internal knowledge generation; reluctance to collaboration; reluctance to knowledge sharing” (Grosse Kathoefer & Leker 2010).

Researchers argue that NIH syndrome has no special connection with the area of science, but is “individual-based”. However, they note that scientist working in applied research are less susceptible to this syndrome than those who are engaged in basic research. Authors explain that by greater involvement of industrial scientists in communication with business on one hand and the desire of the basic scientists “to isolate themselves to avoid knowledge spillovers” on the other hand (Grosse Kathoefer & Leker 2010).

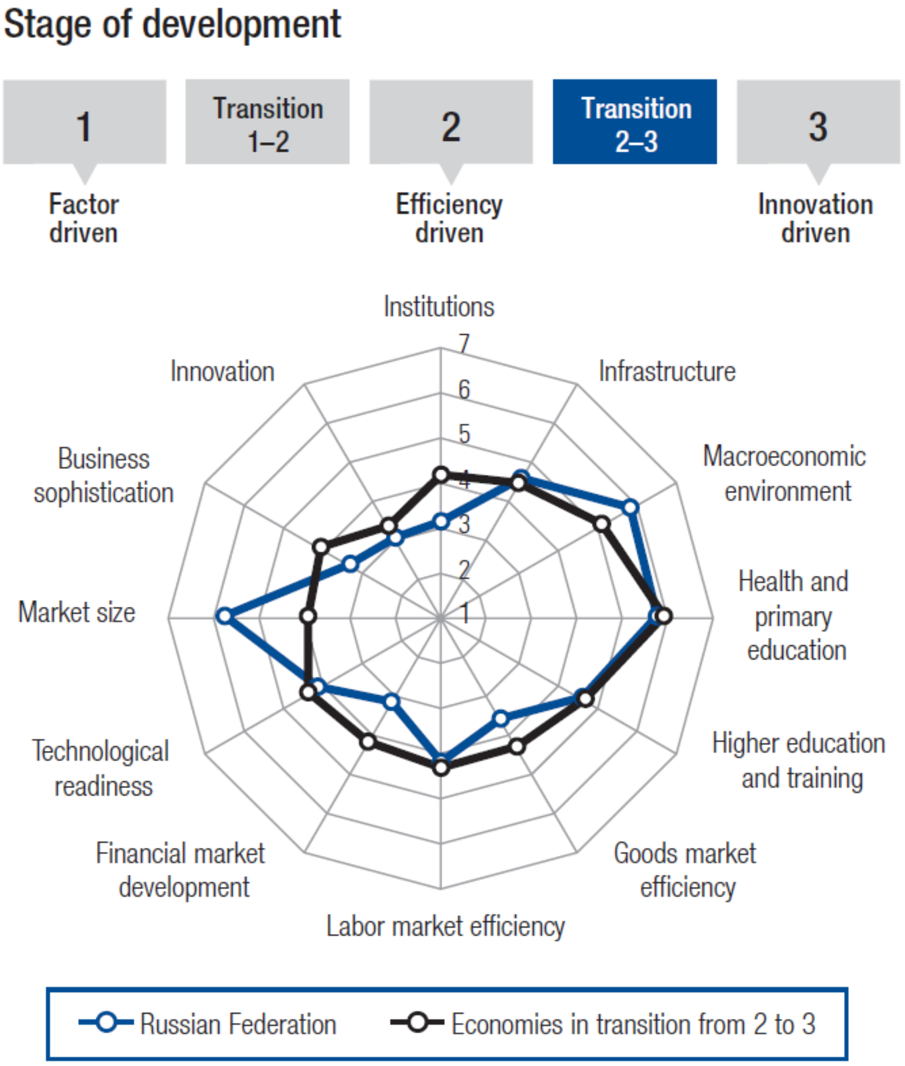
Another problem is in valididty of co-authorship, which was claimed by Bozeman et al. (2013) as “the dark side of research collaboration” (Bozeman et al., 2013). The main issue consists in the absence of objective and uniform requirements for identifying authorship and co-authorship. The research problem, resulting from this, is in lack of systematic analysis in the literature (Bozeman et al., 2013). In the context of university-industry collaboration, this problem could take place just because of difference of the nature of sides and difference in their respect to work on articles.

4. Analysis of secondary data

4.1. Global competitiveness of Russia

According to the Global Competiveness report 2012-2013, in its transition from efficiency-driven to innovation-driven stages, Russia does not look as the most competitive country within its group (see figure 15). Russia now is on 67th place and it lost one position compare to 2010-2011 by Global Competitiveness Index. Very weak public institutions (ranked just 133rd), feeble innovation capacity (lost 23 positions and dropped to 85th place) were not compensated by increasing of the rate of macroeconomic environment (up to 22nd from 44th - due to law government debt and switching of the government budget into surplus). Experts explained continuous decreasing of efficiency in different markets and falling level of competition (136th place) by unproductive monopoly policies (124th), restrictions on trade and foreign ownership and distrust in the financial system (134th place in trust' indicator).

For Russia, the most important barriers to innovation-based economy are the lack of business development (119th place) and the weak technological adaptation (137th place). However, Russia stays on a good position at level of tertiary education enrollment (rank of 12th overall) and has a very high potential in the size of the domestic market (World Economic Forum, 2012).



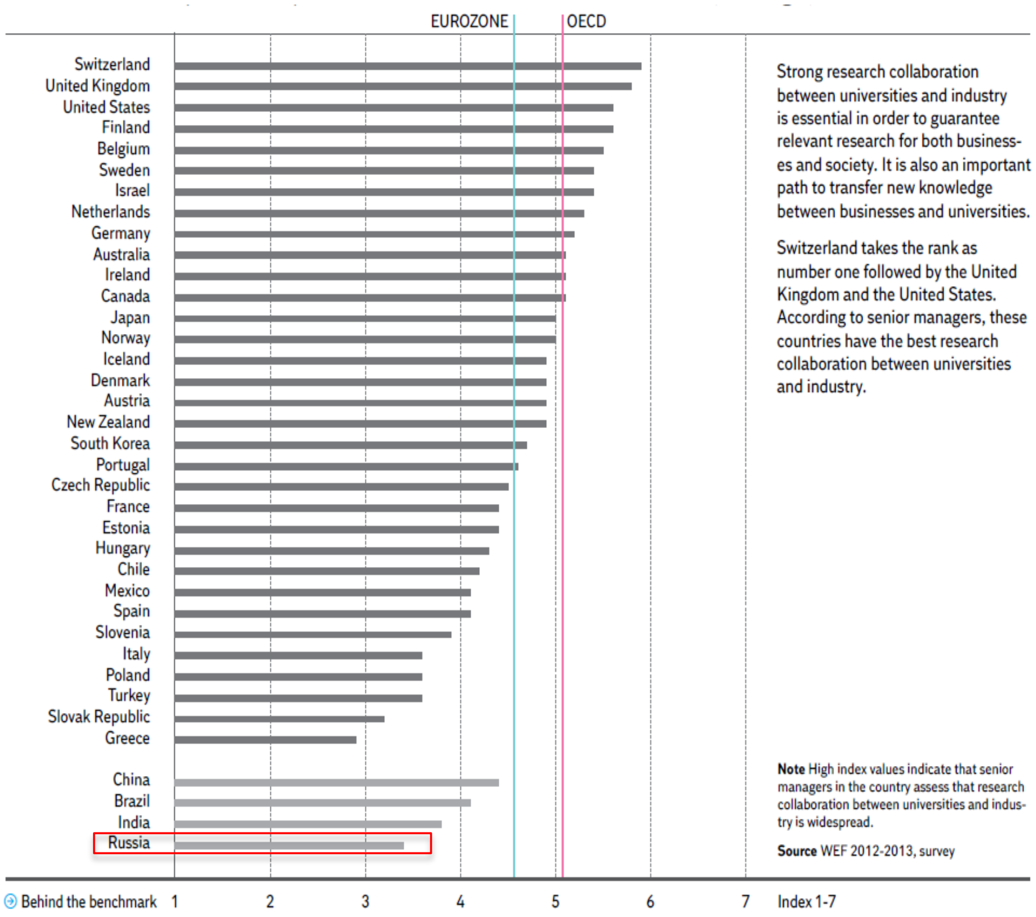
Source: World Economic Forum, 2012

Figure 15. Profile of Russia in Global Competitiveness Index

4.2. State of the art in university-industry collaboration in Russia

According to Global Benchmark Report 2013, Russia has a rather weak position in university-industry research collaboration in comparison to European and OECD countries: just 3,4 of total 7 scores, when the average European level is higher than 4,5 (see figure 16).

Regarding the rate of innovation development the Global Innovation Index decreased in 2013 compare to 2012 by 11 positions (from 51st to 62nd). Considering innovation linkages, there were not strengths highlighted for Russia in this sub indicator, and it has just 109 place overall. In comparison for instance with neighboring country Finland (which has a 4th place in university-industry collaboration), the weaknesses of collaborative mechanisms in Russia are becoming even more obvious (see figure 17) (Dutta & Lanvin, 2013).



Strong research collaboration between universities and industry is essential in order to guarantee relevant research for both businesses and society. It is also an important path to transfer new knowledge between businesses and universities.

Switzerland takes the rank as number one followed by the United Kingdom and the United States. According to senior managers, these countries have the best research collaboration between universities and industry.

Note High index values indicate that senior managers in the country assess that research collaboration between universities and industry is widespread.

Source WEF 2012-2013, survey

Source: DI, 2013

Figure 16. University/industry research collaboration, 2011-2012

Regarding Russian policies in knowledge triangle, assessment of it was structured by European experts. They highlight that in Russia ERI initiatives are not operating well enough yet. Summary of strengths and weaknesses is given in the table 14.

Table 14. Effectiveness of knowledge triangle policies of Russia

	Research Policy changes	Assessment of strengths and weaknesses
Research policy	Strengthen research at universities	S: opening up to international cooperation, new funding tools introduced for e.g. attracting foreign scientists and Russian scientific diaspora, focus on cooperation with EU W: HERD (Higher Education Research and development) rather low in international comparison, domination of government sector
Innovation policy	Flagship project Skolkovo	S: commitment of policy makers to modernization and innovation stimulation W: selective activities, without targeting the broader framework (e.g. legal framework); lack of evaluation of measures; weak R&D and innovation funding; by business enterprise sector
Education policy	Selecting an elite group of universities and enhancing it with specific funding tools	S: upgrading of equipment and curricula, Bologna process joined and transformation to two cycle system W: streaming of the university sector necessary
Other policies	Law on spin-offs issued in 2009	S: support tools for small innovative companies provided by FASIE (Foundation for Assistance to Small Innovative Enterprises in Science and Technology), venture funds through RVC (Russian venture company) and funding through Rusnano available, framework conditions for spin-offs improved W: industry structure marked by a lack of SMEs

Source: ERAWATCH, 2010

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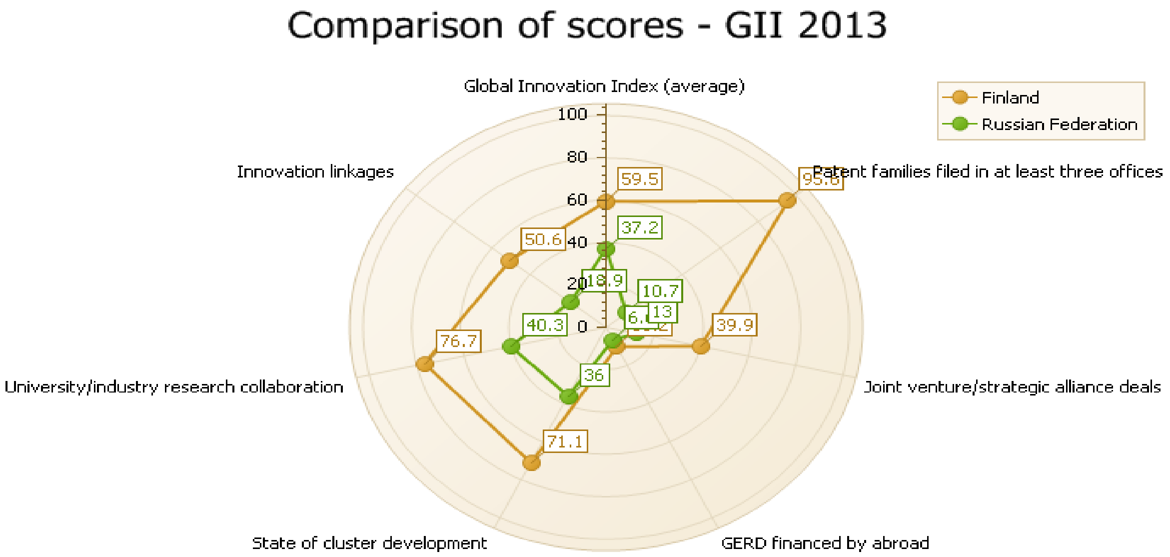


Finland

Innovation linkages	50.6	10	
University/industry research collaboration†	76.7	4	
State of cluster development†	71.1	1	●
R&D financed by abroad, %	6.5	51	○
JV–strategic alliance deals/tr PPP$ GDP	0.1	23	
Patent families filed in 3+ offices/bn PPP$ GDP	5.4	3	●

Russia

Innovation linkages	18.9	109	○
University/industry research collaboration†	40.3	83	
State of cluster development†	36.0	108	○
R&D financed by abroad, %	4.3	59	
JV–strategic alliance deals/tr PPP$ GDP	0.0	60	
Patent families filed in 3+ offices/bn PPP$ GDP	0.1	47	

NOTE: ● indicates a strength; ○ a weakness; * an index; † a survey question.

Figure 17. Comparison of Scores for Finland and Russia: Global Innovation Index and innovation linkages

4.3. The state of R&D sector in Russia

It is well known that Russian R&D complex is still under the influence of Soviet background (Dezhina 2012; Pospelova 2012; Klochikhin 2012; Cooper 2010). Extensive distance between R&D organizations and enterprises, large share of governmental ownership of R&D organizations, accompanied by very modest role of private sector, and low level of involvement of Educational Institutions in R&D – all these factors illustrate existence of system problems in Russian R&D sector, which still take place, when almost a quarter of a century after the collapse of the Soviet Union (Cooper 2010).

Table 15 illustrates the difference in funding R&D activities between Russia and some European countries. The table shows that structures of funding systems are rather stable during the recent years: in Europe business enterprises sector is dominating, in Russia almost the same share of R&D expenditures comes from the government. The other funding actors are higher education sector, private non-profit sector and foreign investors, but since their shares are not so significant, they are not presented in the table.

Table 15. Gross Domestic Expenditures on R&D (GERD) by sector of funds, in % of Total Gross Expenditure on R&D

Region	Business enterprise sector		Government sector	
	2005	**2010**	**2005**	**2010**
European Union (27 countries)	**54,2**	**53,9**	**34,4**	**33,5**
Russia	**30,0**	**25,5**	**61,9**	**61,1**
Euro area (17 countries)	56,2	55,7	35,2	34,3
Germany	67,6	65,6	28,4	27,5
United States	63,7	:	29,8	28,9
Finland	66,9	66,1	25,7	25,1
United Kingdom	42,1	44	32,7	31,9

Source: (Eurostat, 2013)

Moreover, Russian R&D had not become an attractive sector for foreign investors. For example, in 2011 42,5% of funds allocated to R&D in Russia came from foreign business enterprises. It doesn’t seem dramatically low, unless compared with developed EU countries. For instance, the same figure for Finland in 2011 was 82.9% of total expenditures from abroad (Dezhina 2012).

Decrease in funding and lack of significant changes in the R&D sector within the past 20 years resulted in substantial loss of personnel engaged in R&D, whereas in the EU the numbers have only been growing. However, the decline rate of R&D personnel in Russia has dropped down by 2011 as compared to 2010 (see table 16 below).

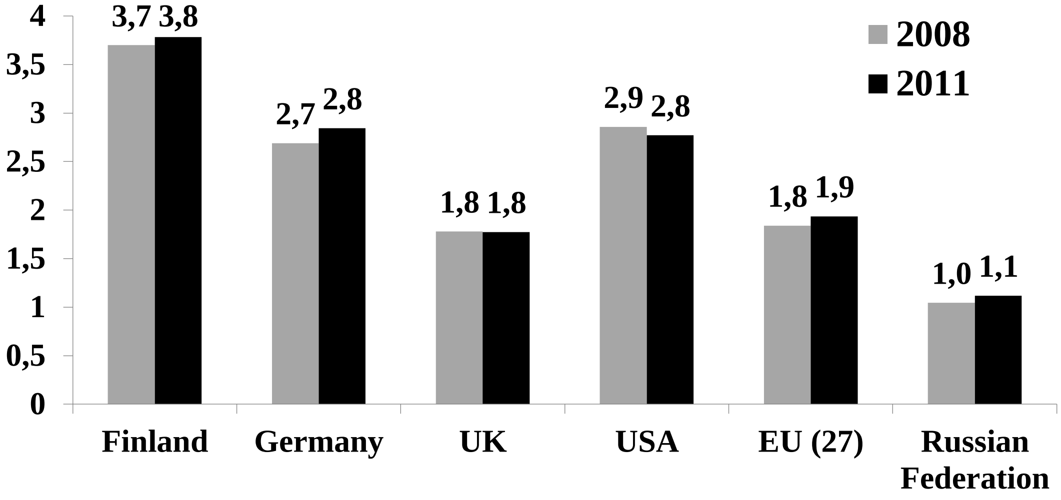
The brain-drain is a continuous problem in Russia. Unfortunately, researchers argue that it takes place not just as a conscience of collapse of the Soviet Union, but it a reaction on today's situation as well: younger generation who does not want "to waste their time in a naturally corrupt and inefficient science environment" leaves the country (Klochikhin 2012). The data of the of the Global Competitive Reports submits this unpleasant fact with negative dynamic: brain drain rank for Russia – fail from 82 in 2010-2011 to 98 position in 2012-2013. (World Economic Forum, 2010; World Economic Forum, 2012).

Table 16. Total R&D personnel - compound annual growth rate

Country	1991	2001	2010	2011
Finland	1,84	1,56	-0,31	..
Germany	..	-0,85	2,61	2,60
Korea	..	**20,02**	**8,47**	**7,80**
European Union (28 countries)	..	1,64	1,88	2,02
European Union (15 countries)	..	**1,99**	**1,63**	**1,62**
Non-OECD Member Economies				
China	..	3,73	11,46	12,89
Russian Federation	..	**0,08**	**-0,70**	**-0,10**

Source: OECD.org, 2013

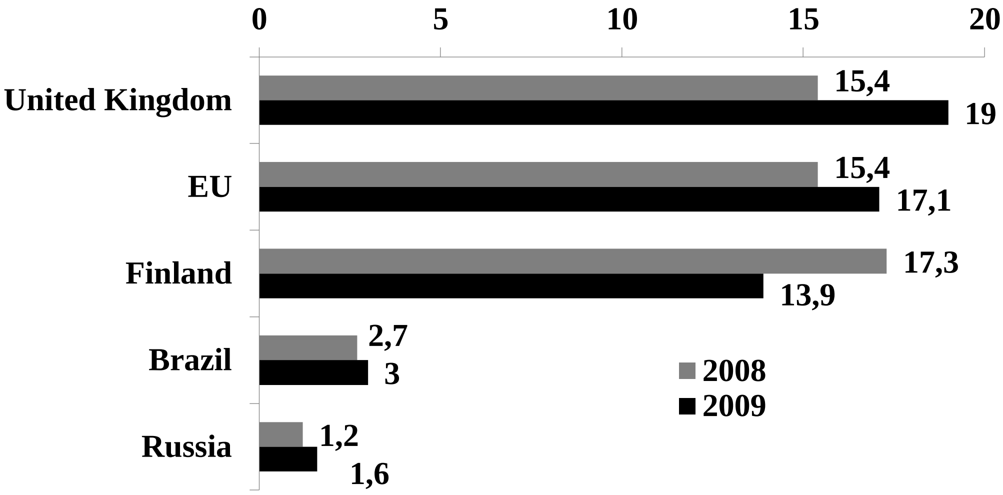
Specialists note a significant gap between Russian R&D input and output. Expenditures on knowledge creation processes are higher than in the most of the countries with similar levels of GDP per capita (Gianella & Tompson 2007). However, the share of Gross Domestic Expenditures on R&D (GERD) in GDP for Russia is low compare to developed countries (Figure 18).



Source: OECD.org, 2013

Figure 18. GERD as a percentage of GDP

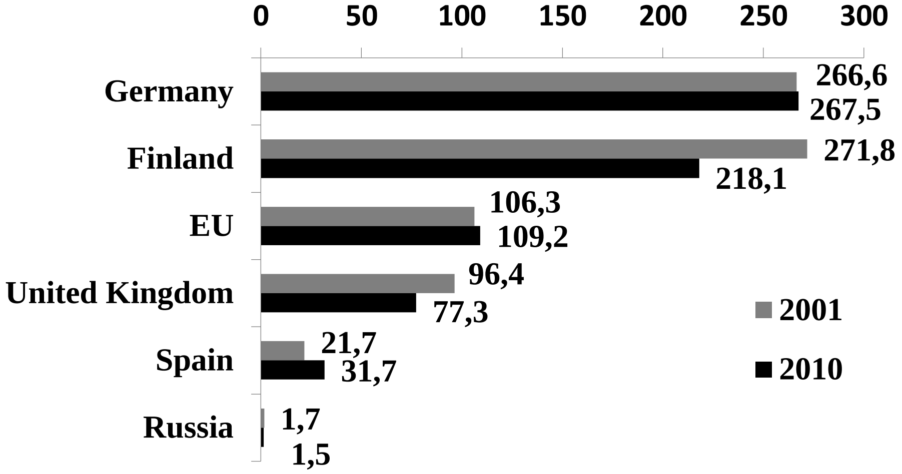
At the same time, exports of high-technology products still has a modest share in the total export compare to European countries, and even compare with other BRICs countries as India and Brazil (see figure 19).



Source: Eurostat, 2013

Figure 19. Exports of high technology products as a share of total exports

The number of patent applications to the European Patent Office (EPO) (as an indicator of innovation activity and one of the R&D output) has not decreased significantly in case of Russia during 2001-2010, and this indicator is still rather low compare to developed European countries and illustrates the gap between inputs and outputs of Russian R&D sector (figure 20).



Source: Eurostat, 2013

Figure 20. Patent applications to the EPO per million of inhabitants

Regarding the patent situation, in Russian legislation there is a concept of *employee's invention/utility model/industrial design*, which implies that *if the author got any result of intellectual activity, during performing his/her duties, the author of these results is employer. However, if the employer has not filed an application for a patent four month from the time of invention, the employee got the right to this invention* (ROSPATENT, 2011).

However, according to paragraph 298 of Civil Code of Russian Federation: "Private or budgetary authority shall not alienate or otherwise dispose of the property assigned to him by the owner or acquired by the agency from the funds allocated to it by the owner" (Civil Code of RF, 2006). Therefore, the final owner in case of State Universities is State, in case of private ones – owner. For now, there is no a systematic solution for this problem. In August 2009 the Federal Law number 217 was adopted, it allows scientific and higher education institutions to create commercial firms, which, according to the legislator must address the practical implementation of the results of intellectual activity. However, very quickly it became clear that the legislation governing the work of public research and educational institutions prevent the full implementation of the adopted law (Learn.IP, 2011).

Another indicator of the state of Russian science (number of publications) also shows disappointing values. According to analysis made by Thomson Reuters, the owner of Web of Science portal, during the last five years Russian scientists published 127 000 works, that is just 2,6% of the global total number of publications. That is more than in Brazil (102 000), but less than in India (144 000) and much less than in China (415 000). Just 20 years ago Russian scientists created more publications than these three countries taken one with another (Borisova, 2010).

4.4. Russian governmental programs for Innovation Development

4.4.1. Russian governmental program for Innovation Development in companies

The system problems have forced Russian politics to focus on the idea of *shifting from the resource-based economy to the innovation path*. In 2010 Russian government announced a program of R&D development. One of the actors, which could be influenced by government, is governmental companies. Therefore, state tried to obligate these companies (in which the share of governmental part in R&D expenditures is about 60%) to cooperate with universities. The idea of the project was to limit the R&D monopoly of such companies and development of R&D in High-Education Institutes. The method was in obligatory development of innovation policy for five years in such companies, and that policy should include collaboration with universities. By 2011, 47 large governmental R&D companies developed the requested program (Dezhina, 2012).

However, according to the research made by Dezhina (2012), problems and weak sides of the program showed up fairly quickly. The main of these problems were:

- programs were not coordinated with long-term strategies of the companies, because the financial plan, for instance, was developed for one year;
- the low quality of R&D at universities, which could not meet the requirements of the client– at least it was unsatisfactory for the companies;

- immature managerial skills in the state R&D sector;

- even if cooperation happens, most likely it would be an outsourcing, not a joint research product, because the survey results claim that just 17% of the companies were going to use the common laboratories and equipment with universities;

- problem of indicators of the program results: firstly, the government tend to use more quantitative indicators (such as evaluation of expenditures and consumed resources) instead of evaluation of the real R&D results, secondly, the big range of indicators (for various ministries) requires more labor from companies (even such as hiring a special staff for calculating these indicators) (Dezhina, 2012).

Therefore, this state instrument may be advantageous for individual companies, which will find a good partner among higher education institutes, and for Universities, which are ready to break their strictly academic nature and learn business realities and behavior. However, Dezhina tend to criticize the program as a global instrument and explains it with a common Russian practice of "increasing of volume" (volume of expenditure on R&D in particular) instead of "increasing the quality and efficiency", that refers us to a more general Russian problem as corruption (Dezhina, 2012).

4.4.2. Creation of technology platforms for innovation development in Russia

In September 2010 Economy Ministry of Russia announced the creation *Technology Platforms for innovation Development*. The definition of the concept "Technology Platform", given by Economy Ministry of Russia looks like: "The tool for joint efforts of various parties - government, business, science - on the identifying the innovation challenges, development of strategic research programs and finding the ways for their implementation" (Economy Ministry of Russia, 2010).

After approving the program by Governmental Commission on high technologies and innovations, the Ministry of Economic Development and the Ministry of Education and Science started to collect suggestions from different stakeholders – enterprises, research institutes, higher education institutions, associations of professionals (Dezhina, 2012). By April 2012, 30 technology platforms were approved by Economy Ministry of Russia for development. The spectrum of industries presented in the list is very wide and includes space, aviation, biotechnology, medicine, energy, nuclear power and others.

The idea of introduction of technology platforms in Russia was not completely new; it was adopted from the European countries, in which the project of technology platforms was officially started by European Commission in 2003.

Dezhina (2012) highlights, that in general technology platforms allow such development opportunities for stakeholders:

- “Access to new R&D resources;
- Participation in priority setting for industrial development;
- Lobbying the corporate interests for technical regulations and standards development ;
- Optimization of business planning due to the fact that among participants of technology platforms there are both producers and consumers of new technologies;
- Possibility to use wider approach called *open innovation*;
- Development of international cooperation;
- Solving workforce problems for science and business sector” (Dezhina, 2012).

It is noteworthy that the list of priorities in European practice is defined by the common decision of stakeholders during the discussion. While Russian technology platforms are defined in accordance with the already existing lists of priorities. At the same time there are two different lists of priorities defined by Russian government:

1) 8 priority directions of development of science, technologies and technics with the specification by the list of 27 critical technologies (Presidential order № 899 from July 7, 2011 “About approval of priority directions for the development of science, technologies and technique in the Russian Federation and the list of critical technologies for the Russian Federation”);

2) 5 *directions of technological breakthrough* (Offered by former President and current Prime Minister of Russia, Dmitry Medvedev on the first meeting of Commission for Modernization and Technological Development of Russia in 2009).

These two lists are very similar in their contents (although by no means do they duplicate one another), which results in numerous overlaps and contradictions, as the same items are present in both lists but not always in the same position (Dezhina, 2012).

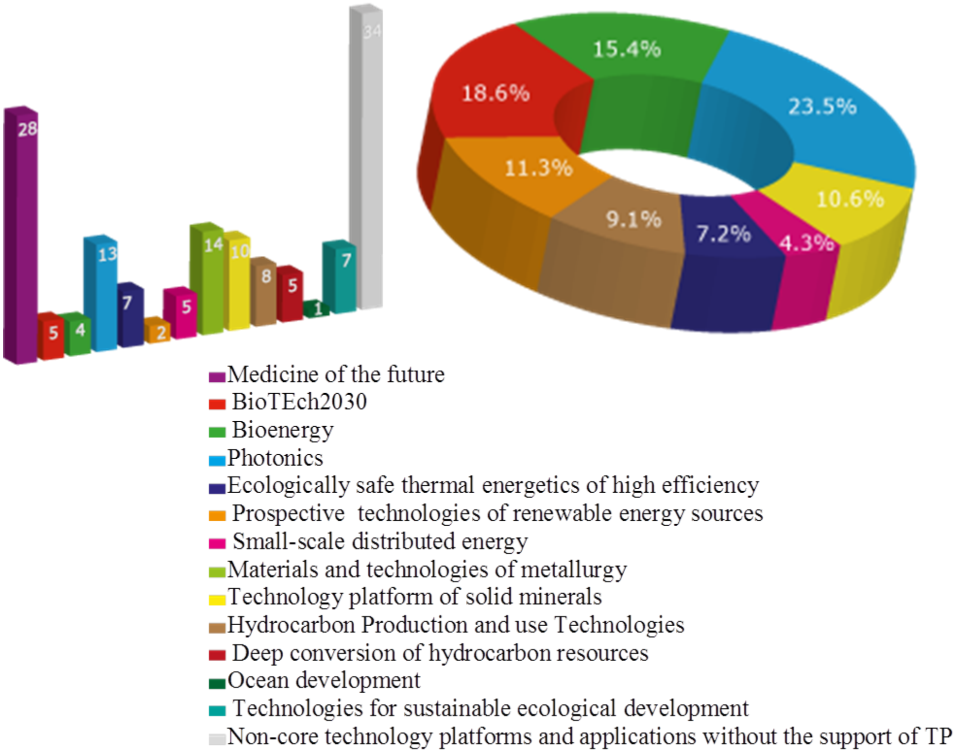
The next feature of the Russian version of Technology platforms is in obligatory participation of higher education institutions. Companies see this as a definite pressure, but according to survey by Klimov & Frumin (2011) universities are very interested in this kind of activities especially together with enterprises. At least among 30 active technology platforms coordinators there are 9 universities operating together with companies (Klimov & Frumin, 2011).

At this moment, the third stage of technology platforms development in Russian has just started. The central problem, which is not completely solved yet, is funding. Russian Fund for Technological Development (RFTD) is the main source of support for technology platforms. However, the financial opportunities of the fund are limited and RFTD is supporting just particular projects. The figure 21 below illustrates the distribution of applications to RFTD by technology platforms taking part in the competition for funding and distribution of this funding by these platforms. As it seems, the most supported projects by volume relate to “Photonics”, “BioTech2030” and “Bioenergy”. However, the biggest number of applications comes from projects, which do not relate to any platform.

Other possible sources of financing for technology platforms (as RUSNANO, federal programs, private investments, programs of fundamental research of national research institutes), which were noted in the documents, related to the financial support, are not participating in this yet (Dezhina, 2012).

Dezhina (2012) offered two different scenarios for the further development of the projects under technology platforms:

1) Once Technology Platforms reach the necessary official level of importance (*Federal* status), they will become eligible for governmental financial support, like it had happened with *Federal* research centers, *Federal* universities, *National Research* Universities and *National* Universities, all of which have had access to expensive resources since receiving the label 5 years ago;
2) Technology Platforms will get the combination of the status with special sources of financing for R&D projects, conducted under the platform. Dezhina implies that these specific programs might get financial support within new government Program of science and technology till the year 2020. This program was adopted in December 2011 and provides tax incentives for the projects within the framework of the technology platforms, as well as direct government support (funding) on the return (Russian Foundation for Technological Development) and non-return basis. The program states that the Fund should focus on supporting large and medium-sized businesses, and at the same time, program refers to the need of the grace of debt financing of innovation business in order to develop the Russian sphere of market oriented applied research.



Source: RFTD, 2013

Figure 21. Distribution of applications to RFTD by technological platforms and distribution of funding for technology platforms projects

4.4.3. Development of innovation infrastructure and attracting leading scientists to the Russian Universities

According to resolution of the Government of the Russian Federation dated April 9, 2010 N 219 "On state support of innovation infrastructure in the federal institutions of higher education", from the federal budget were allocated 8 billion rubles (1,8 billion EUR). Budget money were distributing on a competitive basis and could be directed to the creation of institutions of higher learning in business incubators, technology parks, innovation and technology centers and other innovation infrastructure, providing them modern equipment (rg.ru, 2010).

Resolution N 220 "On measures to attract leading scientists at Russian institutions of higher education" (dated also April 9, 2010) was created to attract the best researchers to the universities (from Russia and foreign countries as well). To do this, a system for grants of up to 150 million rubles (3,4 million EUR) (each for scientific research was planned. Total for this program, universities have received 12 billion rubles (273 million EUR) during the period of 2010-2013. Formally, the grants are allocated not to scientists, but to universities, in which the researchers are going to conduct research activities. However, universities are able to spend money only with the consent from this individual scientist, for whose project the funding is provided (rg.ru, 2010).

There are no yet official centralized results of the program, but in the part 3.4.2 there is a comment from a respondent about effectiveness of these programs.

4.4.4. Cooperation between companies and universities

The governmental program which deserves special attention in the context of this research is the one, which was announced by government Decree №218 “On measures of state support of cooperation of Russian higher education institutions and organizations implementing complex projects on high-tech production”. The goals of this program were defined by the Ministry of education and science as follows:

1) development of cooperation of Russian higher educational institutions and production enterprises;
2) development of scientific and educational activities in the Russian High Education Institutes;
3) Stimulating industrial companies to utilize the potential of universities for the development the research-based production and the innovation activity in Russian economy as a whole (Ministry of Education and Science of Russia, 2010).

The program is based on three the main principles: the winner (who gets the money) is selected by open competition, the financial support is provided just to the projects, which are evaluated as commercially effective and lead to the high-tech production, and for the last, the money first goes to the company and the company already manages the finances for the R&D project, which is conducted by university according to the company goals. The period of governmental support for the project is 1-3 years, and is up to 100 million rubles (2,3 million EUR) per project per year. The requirement for the company is 100% co-financing of the project, and at least 20% of this money should be spent on R&D.

Finally, 50% of the whole project budget should be spent on R&D. Concerning the implementation control companies should submit the reports about the current state and progress of high-tech production during five years after finishing the project (Dezhina, 2012).

According to data, published in reports on the web-site devoted to the Decree №218 about cooperation of Russian universities with industry, 213 projects won the competition in 2010-2013. In the last list of winners (for 2013) there are no Universities, taking part in the projects; probably, they will be announced later. However, for 2010-2012 years among winners were 21 universities located in Moscow and 11 Saint-Petersburg.

Dezhina I. (2012) has conducted the analytical survey of the results of the program by interviewing companies and universities. She divides the problems into two main groups: internal (related to communication problems between the actors) and external (economic, legal and other kinds of problems).

The most common claims on the part of the companies the author summed up as:

- university researchers are “too academic" and they have no the real view on the company’s needs;
- universities are not used to be responsible for the results of their research.

Dezhina sees the root of the problem in the fact that professors do not have enough time for research (Dezhina, 2012).

The universities’ representatives highlight these problems:

- the lack of quality in the applied research (the academic side supposes that the big amount of these skills was lost during the post-Soviet period);
- the lack of middle aged researchers.

The main problem is in a lack of highly qualified personal and brain drain. That is why universities see an opportunity of new people and skills coming from collaboration with industry (Dezhina, 2012).

Several companies interviewed by Dezhina offered the same solution: to diversify participants of the project by including not only employees of participating universities, but specialists from other higher education institutions as well. This solution may improve the R&D output of the universities (Dezhina, 2012).

The external problem was mostly in a big amount of paper work, bureaucracy, which were quite new for the companies, which were not experienced in applying for Russian governmental support. For universities this problem is quite common (Dezhina, 2012).

Dezhina highlights four side effects relating to the program realization:

1) at first, university' employees were excited by the company's interest to the research results, but some of them were frustrated by realizing, that in case of governmental project the result could be just a paper report;
2) the program forced the university-industry relationships to transform from the contract base and the division of labor to project groups or laboratories. In some cases, the representatives of the universities' spin-offs were taking part at these groups, that helped to develop horizontal linkages;
3) to some extent, the program stimulated the integration of education and research, because the real cooperation with industries firstly motivates the academic side to include the educational courses about collaboration and secondly facilitates the hiring of graduates by cooperating companies.
4) in most cases the process of mutual adaptation was successful and both sides found the complimentary skills and personal, and moreover, see the potential for further mutual R&D (Dezhina, 2012).

The general results of the interview shows that partners find the program as a good instrument and even more effective than federal tender procedures (Dezhina, 2012). This program was the first governmental tool of stimulating communication between Universities and Industry in Russia. Even though, a lot of problems exist, and that there was an artificial (by government action) convergence of the two actors, it is a good start that has already yielded results.

During the phone interview for this thesis representative of one university shared the information, that recently they received "a very familiar survey from Russian Ministry of education and Science". That reflects existing of the program evaluation from the side of Ministry.

5. Analysis of survey results

5.1. The current situation in university-industry collaboration in Russia

The survey of Russian universities was conducted in order to analyze, whether the undertaking governmental initiatives and the actual university-industry interaction were effective or not.

Regarding the government Decree №218 “On measures of the state support of cooperation between Russian higher education institutions and organizations implementing complex projects on high-tech production”, the most of the respondents (39%) found it quite effective. A slightly smaller share of people interviewed highlighted the critical importance of this program for universities (28%) – see figure 22 below.

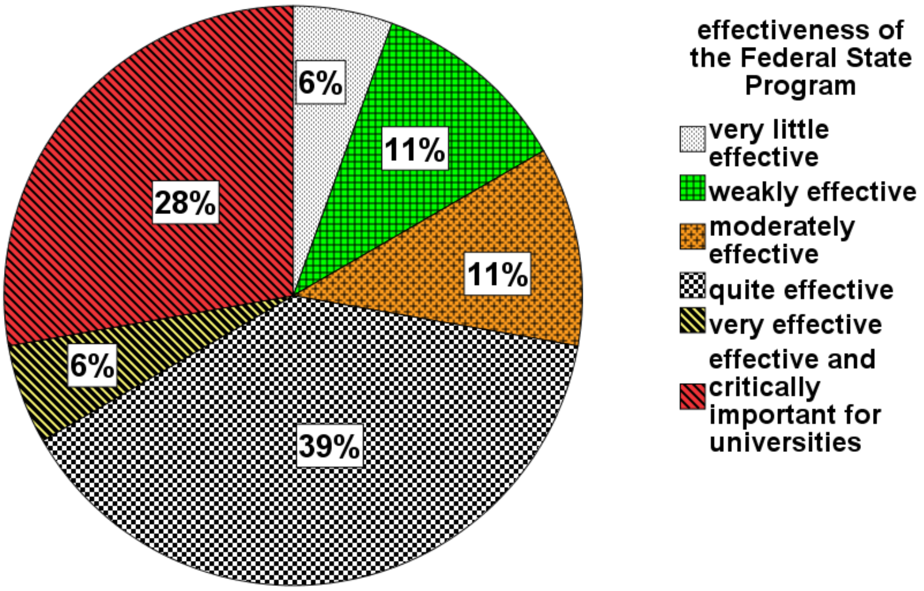


Figure 22. Effectiveness of the Federal State Program

The mean of the variable *Effectiveness of the Federal State Program* is quite high – 5,1, see the table 17 below, that implies that the program was quite effective.

In general, most of the interviewed universities noted the growth of number of cooperation partners (see figure 23 below).

Table 17. The mean of the State Program effectiveness

	N	Minimum	Maximum	Mean	Std. Deviation
Effectiveness of the Federal State Program	18	2,0	7,0	5,1	1,5
Valid N (listwise)	18				

Moreover, 64% of respondents highlight the increase of the number of projects co-funded together with business partners, that illustrates the collaboration progress.

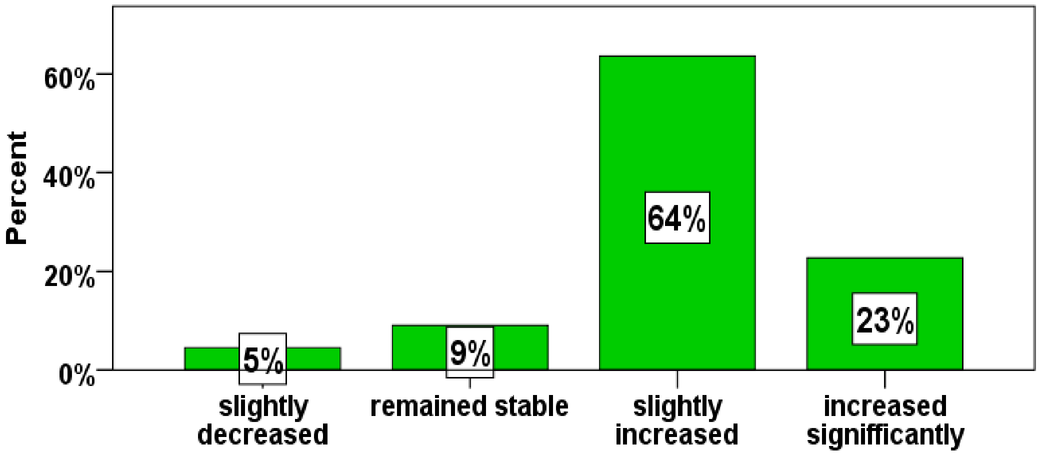


Figure 23. The dynamic of number of university partners

Half of the respondents note a positive dynamic in growth of the commercialization services related to cooperation (the establishment of a new business, sales of IPR and licensing) – see figure 24 below.

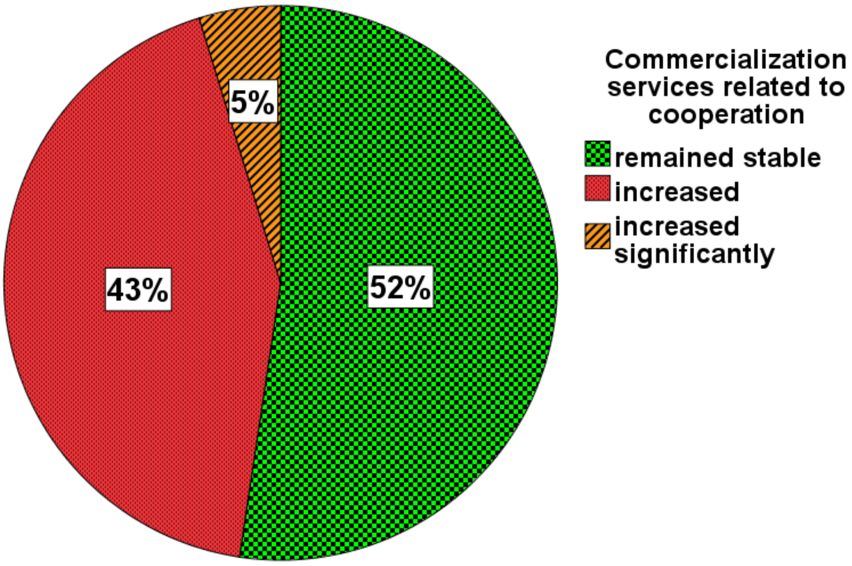


Figure 24. Commercialization services related to cooperation

The traditional direction of interaction (acquiring knowledge by business from university) takes place in Russian reality and according to respondents’ view it has become more intensive in the recent 3 years (see figure 25).

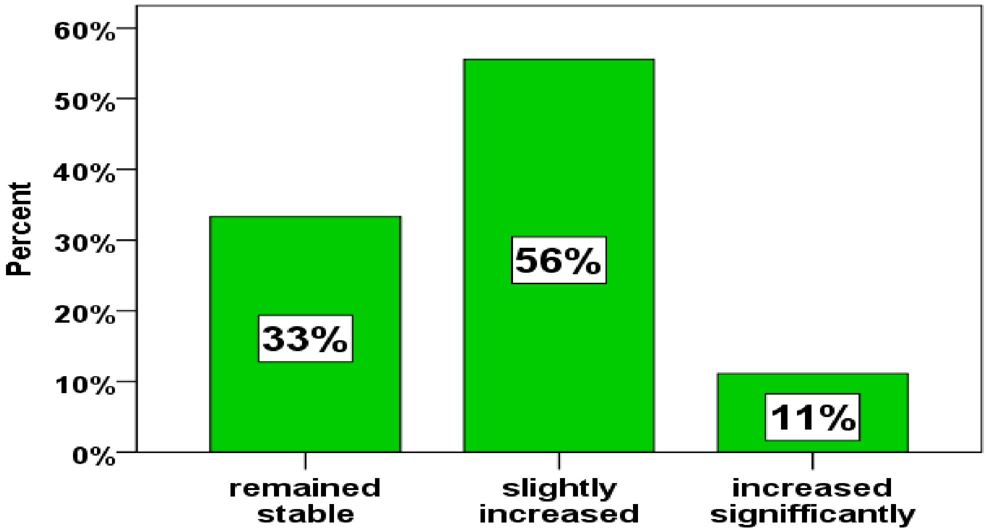


Figure 25. Dynamic of acquiring knowledge from universities by business

Regarding the links of interaction, representatives of the universities almost unanimously (84%) state that the role of direct contacts with people from companies has increased in the recent time.

None one of the respondents marked that the negative effect of collaboration with business on teaching or research process has increased. At the same time, 68% of respondents, state that collaborative projects were becoming a part of a curriculum more intensively in the recent 3 years, and 64% noted an increasing positive influence of cooperation on the university’ internationalization.

5.2. The reverse-direction of university-industry interaction in Russia

Obviously, universities’ representatives could not give an objective answer to the question about reverse-direction of interaction, because it has to be initiated by the business partner. However, responses received on indirect questions are helpful in picturing the situation. For instance, when industrial partners invite university research staff to conduct R&D, they give the researchers new challenges, access to valuable (partly marketing) information and by the end they create employment. According to the survey results, 36% of respondents saw the positive dynamic in this process of involvement of the university researchers into R&D projects in the companies. However, none of the respondents noted a significant growth of this practice and 27% were not able to answer this question (see figure 26).

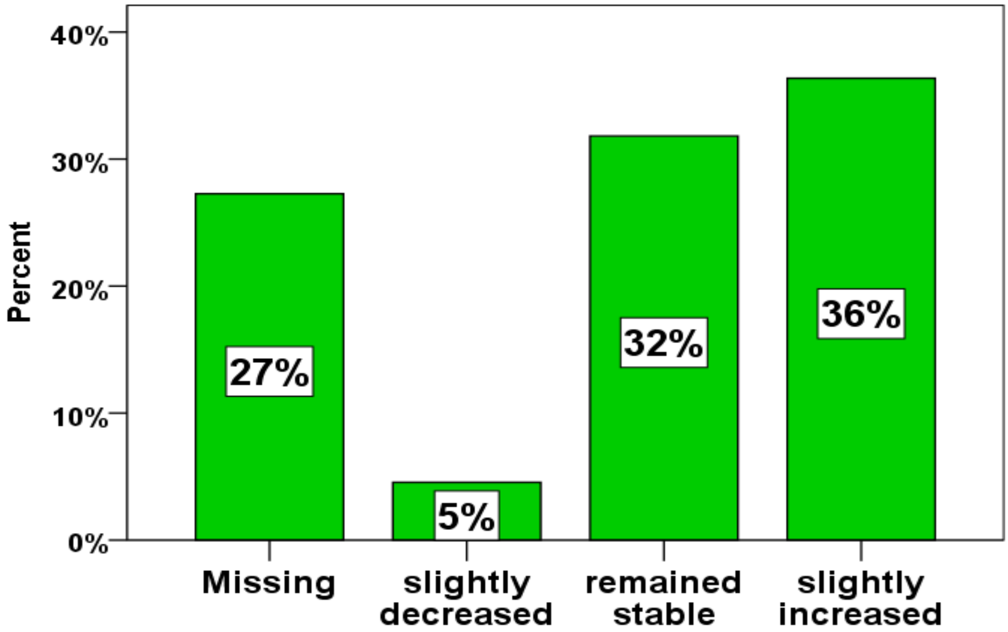


Figure 26. Intensity of involvement university researchers into business R&D projects

Another kind of initiative that could be undertaking by industrial companies is providing of equipment for students or university researchers in order to get the well-qualified specialists, which are experienced in working with specific facilities and are able to push the company's R&D forward. Taking into account the accrued demographic crisis and migration losses after collapse of the Soviet Union and as a result growing shortage of highly skilled labor force (Aleshkovski, 2011), the problem of attracting well-qualified staff and providing the training are crucial for companies in Russia. The one solution in this case could be giving special equipment to universities on preferential terms. The figure 27 shows that this practice exists and moreover 41% of the respondents note a growth spread of providing resources (equipment and laboratories) to the universities without requiring immediate compensation.

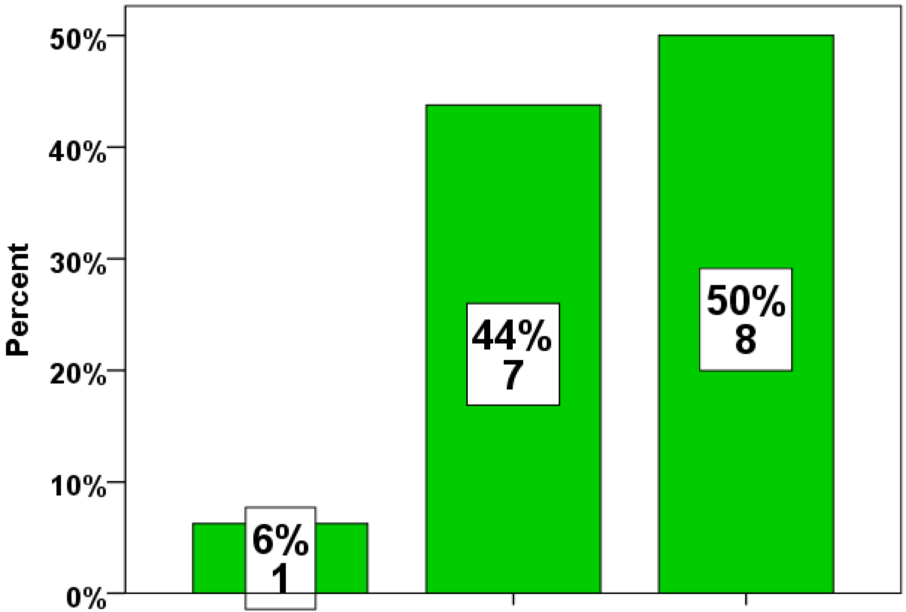


Figure 27. Providing of resources by companies

The question about the transfer of IP rights, created during the work in joint projects, is unclear for the large share of the respondents. Some of them commented that there is no such a practice at all, several respondents marked the dynamic of this process as remained stable, but noted that they are not sure about that, or just had no idea what to answer. Despite of the fact that 14% of survey participants (only 3 universities of 22) claimed that during the last 3 years companies were rather active in sharing IP with universities, no one noted the practice of sharing IP with students (see figure 28 below). That means that in the analyzed universities the practice of IPR transfer in reverse-direction almost does not exist.

Respondents were more confident with questions on the knowledge (ideas) flow from industry to university. According to the results, 53% of the respondents saw the progress in utilizing research ideas from business in the recent 3 years, and 73% highlight modest or significant growth of learning from collaboration and using the collaboration experience in further research (see figure 29).

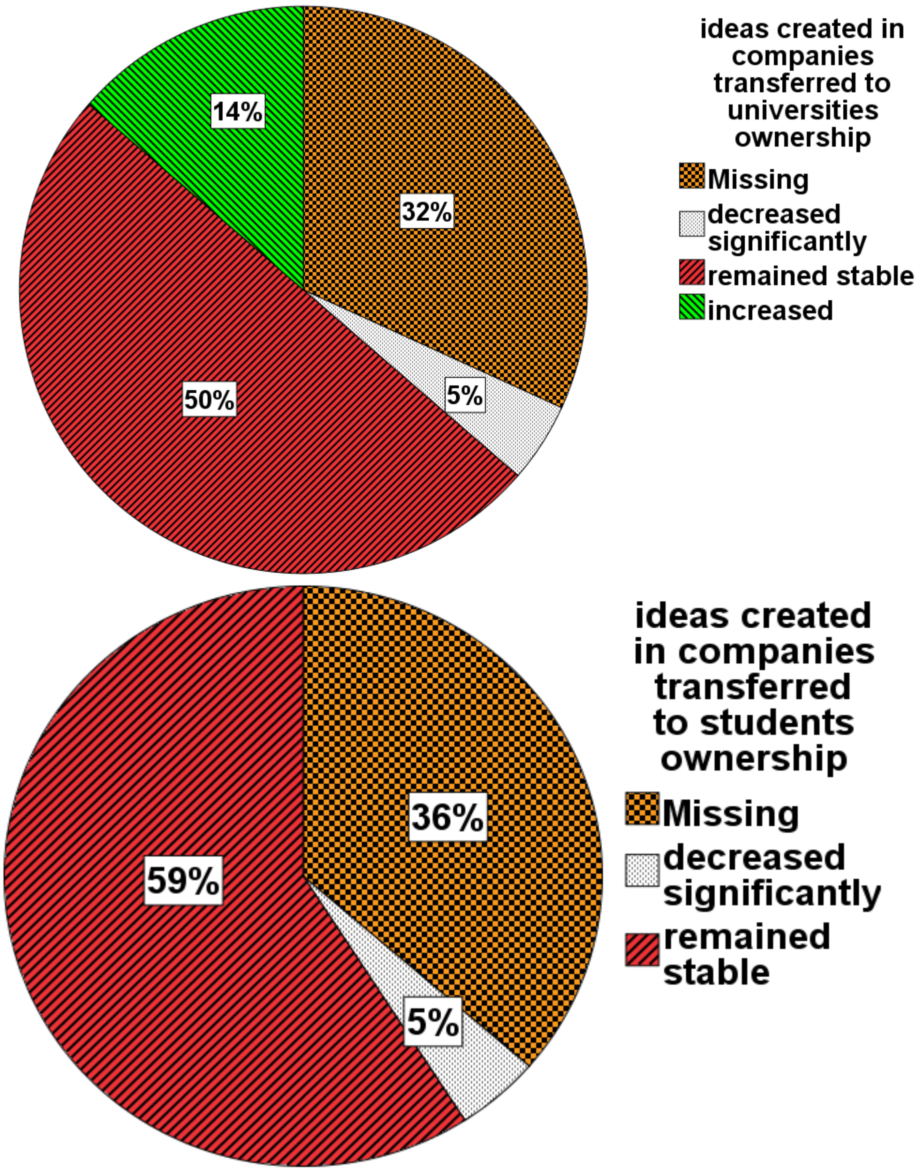


Figure 28. Transfer of IP rights from companies to universities' and students' ownership

In the e-mail interview regarding the question on existence and forms of reverse-directional interaction in Russia, the expert from the Ministry of Education and Science of the Russian Federation, Alexey Shmatko gave this kind of comment:

"Of course, there are benchmarking examples in this field. Many teachers in the nineties left the universities and research institutes and went to the industry, and they began to teach halftime or on an hourly basis, during the teaching process they were transferring the knowledge that they had acquired through practice. To be honest, the salaries in universities in comparison with salaries in the industry are much lower, so these processes are gradually decreased in volume.

Academics working in the universities on a regular basis rarely go into the enterprises and internships; this is due to the lack of funds allocated by the Ministry of Education and Science for these needs".

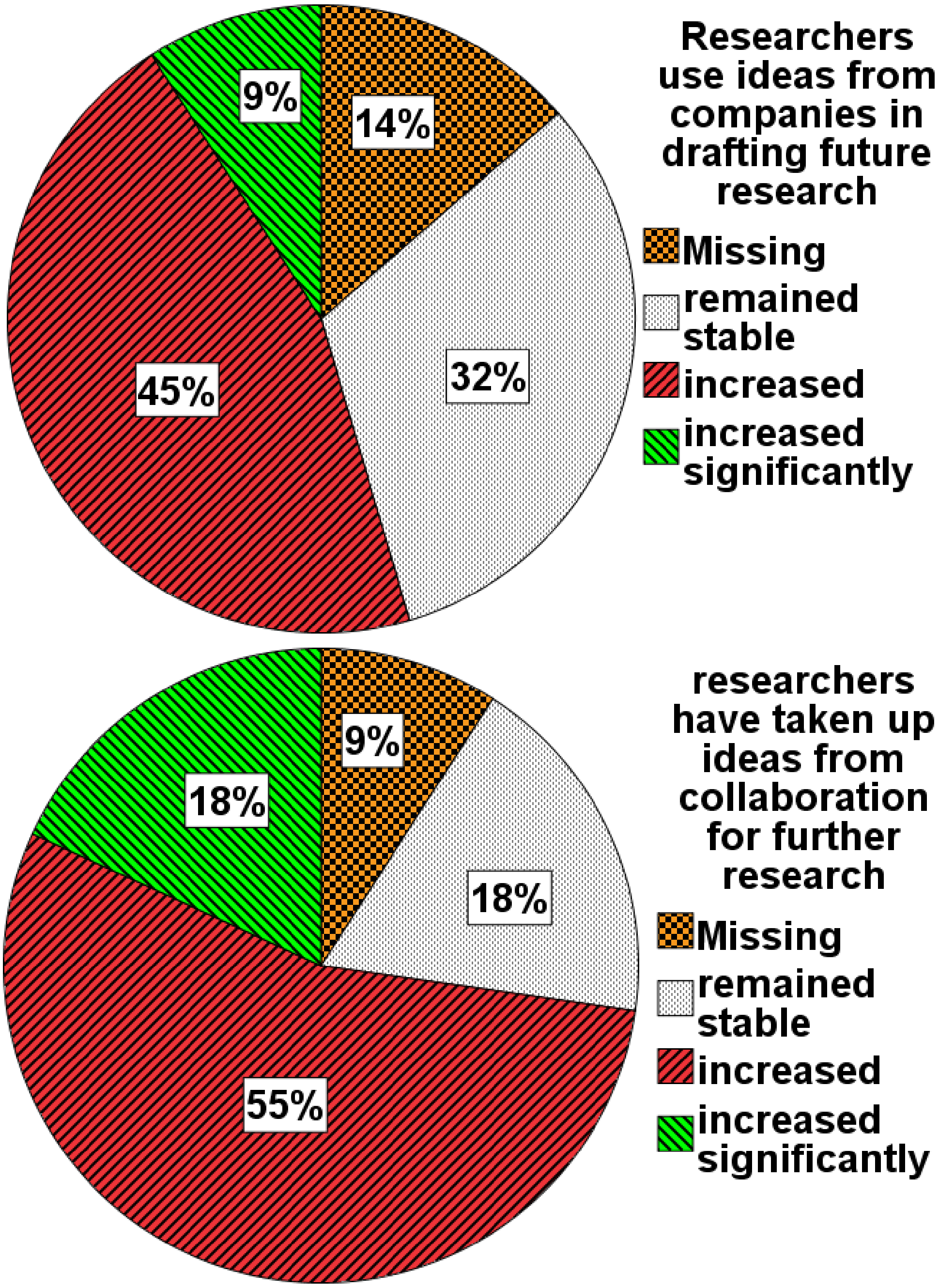


Figure 29. Utilizing of research ideas from companies and using of cooperation experience by university researchers

5.3. Problems in university-industry collaboration in Russia

The respondents of the survey were asked to name the significant problems or obstacles of university-industry cooperation. Some of the mentioned problems are common for the majority universities and some are unique. All of the problems and possible solutions to these problems noted by respondents are summarized in the table 18.

It is important to mention that one of the respondents talking about the necessary conditions of effective collaboration highlight the importance of identification of motivation for university researchers to use business innovations. Thereby he highlights another type of problem: search of motivation for knowledge and ideas acquisition in the reverse-directional relationships (by university from industry).

In the e-mail interview the expert from the Ministry of Education and Science of the Russian Federation, Alexey Shmatko, presented his opinion on the problems as follow:

"The main problem is that business' demand for innovations is quite low. Reasons for that being: lack of connection between science, education and industry; Industry's orientation on borrowing existing technologies instead of developing original ones".

The preference for foreign technologies diminishes the mere possibility of developing original ones. Rashidov discusses this problem in the book on the development of the Russian innovation center Skolkovo (Rashidov 2012). The representative of the Ministry of Education and Science also shared his ideas about possible solution for this external orientation:

'The solution to this problem is not obvious, as the problem itself is ambiguous. Meaning that in some cases, borrowing of technology by certain industries can be justified, primarily for industries in which other countries have made major progress and now are willing to sell their technologies. For other sectors, and also branches that define national security of the state, it is necessary to establish communication on the university - industry level to prepare specialists in accordance with demands of specific industries".

Table 18. Problems and obstacles in university-industry collaboration in Russia

Problem/obstacle	Suggested solution	The number of respondents highlighted this problem
Companies have very little influence on the graduates' qualification standards. That results in the gap between the actual level of training received by the graduates and the requirements imposed on them by the companies. Targeted training is conducted in insufficient quantity.	Not given	1
Business' tendency to underestimate universities' potential. Business does not see university as a business partner, the relationships are considered either as producer-consumer, or as a corporate social responsibility of business.	Not given	2
Higher education institutions' inability to move from theory to practice.	Not given	1
Unavailability of high education institutions to move from theory to practice	Not given	1
Extremely small number of investment programs in university science from the industry.	Not given	1
Enterprises have very little interest in inexperienced workers	Not given	1
Fall in university's prestige	Not given	2
A little interest in funding R&D and innovative ideas by companies - the potential unreadiness of individual businesses and organizations to innovate. There is no innovation ecosystem within corporations and no persons responsible for the innovative development within enterprises	Not given	1
Universities' employees do not have sufficient marketing skills and experience, which are needed to operate as a competitive production company.	Need to involve experts with marketing expertise, experience and skills, able to work with business and market of innovations. Also needed: understanding by university administration of for what and why commercialization is needed.	2
The industrial sector, in which university operates, is developing rather slowly nowadays, that reflects adversely on R&D funding in this sector.	Not given	1
Managers of Russian companies are not satisfied with the requirements claimed by Russian Ministry of Education and Science. Problems with the joint submission of applications.	Not given	1

Problem/obstacle	**Suggested solution**	**The number of respondents highlighted this problem**
The university’s research area is limited by one particular field, that bounds development of relationships with companies in other sectors (including a psychological barrier as well)	Not given	2
Bureaucratic aspects in IP commercialization processes	Making legal procedures more clear, creation (if there is no) a division of IP and TTO in the university	2

Alexey was also asked about the existence of psychological barriers in the minds of the Russian universities to the concepts such as *cooperation with enterprises*, *commercialization of university R&D results*, and *creation of business on the basis of such results*. He gave a rather structured answer:

“For the older generation of experts around the age of 40 years and above this barrier does not exist usually, at the same time, specialists of a younger age can have this kind of barriers, that could be explained by the fact that the links between production, education and research have already been largely destroyed when they were students, hence the emergence of barriers.

6. Discussion

This part of the thesis intended to answer the research questions through integrated discussion of the results gathered by analysis of three different sources of data: literature, secondary data, and survey results. To answer the main research question it is better to start with sub questions.

The first of sub questions is:

1) Does the reverse direction (industry-university) of knowledge transfer exist and, if yes, how is it implemented?

Even though the reverse-direction of university-industry relationships is disclosed enough as an academic topic, the results of this study show that this phenomenon exists in reality. It is proved by such cases as University of Zaragoza and Bosh and Siemens Home Appliances Group (Lucia et al., 2012), or case of Finnish-Russian University Cooperation in Telecommunication (FRUCT). In both cases, a large proportion of the initiative came from the companies, because they needed fresh ideas and young professionals, which could be nurtured under the companies' control. The reverse direction of knowledge flow in university-industry relationships is also represented by such practices as meetings (formal and informal) and conferences, during which university teams are getting ideas, probably knew knowledge, some marketing information and sometimes learn companies' strategic view. Another display of reverse-directional interaction is industry-to-academia job transitions, which were bigger, than academic-to-industry job transformations in case analyzed by Dietz & Bozeman (2005) in US. However, according to the interview with the expert from Ministry of Education and Science of the Russian Federation, in the last 20 years in Russia this transition had an opposite direction: university staff went to industry. The positive aspect here is that people, who stayed to teach halftime or on the hourly basis, during the teaching process were transferring the knowledge they had acquired from industry. This is a direct display of reverse-directional knowledge transfer in Russia. Unfortunately, according to the expert' view, these processes are gradually decreased in the recent time, and the further task is to find a motivation for business to invest into education of the future generations.

The next sub question of this study is:

2) What is the motivation of each side to initiate collaboration?

The motivation of each side in university-industry collaboration is different. For university the primary motives are recognition within the scientific community and receiving additional funding. Among other motives are acquisition of new knowledge and ideas and getting reference for public projects. In particular case of Russia, there is nowadays another motive for universities nowadays to collaborate with companies. This kind of collaboration creates a reference for students and university is considered with a higher educational institution with practical programs and clear career opportunities after graduation. In addition reference may contribute to getting a certain university status and growth in the universities' rating, to which Russian government represented by the Ministry of Education and Science pays a special attention due to the decline in the prestige of Russian universities.

For companies the primary motive is getting profit. Another motive for business side is recruiting the personnel. For companies that invest in R&D and innovations the very import motive for collaborate with universities is in ability to observe scientific development and receive a solution of technological problems from independent scientists. One of the most important problems in today's Russia is the lack of interest in innovation business between Russian enterprises, meaning that the government and the higher education institutions have to simultaneously carry out two missions: to provide companies with motivation to invest in innovations, and also to find and develop such sets of knowledge in universities as technologies, products, or intellectual potential, that could be profitable for businesses, thus creating interest in the partnership.

The answers to third and fourth research sub questions could be combined, since the one of them is an identification of problems and another one is a description of solutions to those problems. The questions are:

3) What are the key problems of university-industry collaboration in general and in the particular context of Russia?

4) Which solutions could better address these problems?

First of all, problems identified by researchers in the literature are quite close to problems named by respondents during the survey in Russia. Among these common problems are: *mutual misunderstanding, bureaucracy, underestimation of the potential of the university by business, unfamiliarity of industry with universities' activities, lack of resources, dissatisfaction of business with governmental regulations or state programs' requirements, lack of national and regional supportive programs in the field of university-industry collaboration, legal issues.* The specific findings from the literature analysis are in ultimate orientation of universities towards pure science and as a consequence - long-term orientation of university research in comparison with business research.

The problems in U-I collaboration in Russia, identified by the survey results, are discussed below one by one with proposed solutions based on the literature review, secondary data analysis and opinions of respondents.

1. Industry involvement in the development and adjustment of the educational and qualification standards.

The first problem is in *not enough industry involvement in the development of educational qualification standards*. The suggested solution is the creation the working groups (preferably on the local and global basis) including business' and university' representatives, which have to meet regularly to discuss the current industrial needs and their influence on graduates' employment. The idea is suggested by Barr (2008). Benefit for industry is in getting growing generation of high-qualified employees (especially during the demographic crisis in Russia (Tajurskij, 2011)). Benefits for university: nurturing in-demand professionals and possible receiving valuable ideas in R&D field. Possible place for meetings are science parks, offered by Henry Chesbrough on open innovation workshop 31.05.2013.

2. Role of industrial companies in practice-oriented education in universities

This problem is connected with two other problems named by the respondents of survey in Russia. The one is *weak interest of enterprises in inexperienced workers*. These working groups might help in solving this issue. When discussing educational programs the attendants should pay special attention to practical courses, specific training programs in companies. These references to companies *will improve university's image on the educational market* (Jalkala & Salminen, 2010).

3. Image of universities

The *underestimation of the potential of the university by business* is a rather global problem. The roots of this problem are in the difference of the private motives, understanding and languages used by actors. The one kind of solution for that problem could be in using of the opportunity given to universities by Federal Law number 217 which allows higher education institutions to create commercial firms. Of course, universities need time to become a fully functional market member and demonstrate its competitiveness. In addition such governmental initiatives as amendment to the Education Act adopted on 29th of December 2012 (which allows for all higher education institutions to dispose IP without any restrictions, and revenue resulting therefrom) should be used by these new firms.

4. Universities are too focused on theory

The next named problem is *unavailability of high education institutions to move from theory to practice*. In some extend it is a conscience of the first three problems. In this problem firstly the comprehension of this issue by representatives of the University and its' administration is needed. Given the strong dependence of universities on government programs and funding, government initiatives could affect the displacement of universities view into practice. Work in this direction has already begun. The intensity of this work has to be increased, to avoid the feeling of the one-time action.

5. Role of industry in financing R&D

The next problem is in extremely small number of investment programs in university science from the part of enterprises in the industry. The source of this problem is in the loss of competitiveness of Russian science, which was described in chapter 4. It is necessary to start with solving this basic problem, to invest in basic research, especially in the technological areas which are critically important for Russia (interview with the expert from Ministry of Education and Science;

Rashidov, 2012). However, there are now ideas, projects and technologies in Russian laboratories and in minds of Russian scientists. These ideas and projects need advertising and platform for meeting with business and transactions. This platform could be provided by innovative forums, business incubators, technology transfer centers that exist in Russia. For balanced development of these two elements of Innovation System (basic science and innovation infrastructure) the resources has to be balanced as well (Rashidov, 2012). *The lack of interest in funding R&D and innovative ideas by companies* is a global problem of the whole Russian Innovation ecosystem. Companies tend to buy, then to create something new in collaboration. However, that is reflected in the global Russian tendency – even Skolkovo, the main innovation center in Russia, buys technologies from abroad. It is illustrated in falling exports and rising imports of high-tech (chapter 4.3). This is a sophisticated, complex problem. One of its solutions is Skolkovo, which was created to be a model of innovation center, to show that technologies invented in Russia exist and entrepreneur could make money at them. However, it will take several decades to evaluate the results of this project. Taking into account a rather strong isolation of Skolkovo from the rest of the country (ERAWATCH, 2010), another large amount of time to adopt these practices outside of the Skolkovo will be needed. This isolation is used to prevent corruption, the penetration of other purely Russian concerns and implementation of foreign experience. Nevertheless, the question '*how long will it take?'* still does not have an answer.

6. Role of governmental support for U-I collaboration

The lack of tax benefits for the partner companies in the financial interactions with universities is explained partly by the fact that Russian legislation in the field of entrepreneurship is still under development, and that will be good if all of three stakeholders work together, meet, talk and share problems and ideas at the round table. This kind of events already exists in Russian practice (International Economic Forum; Days of entrepreneurship in Russia; working meetings and others), and it is extremely important from the governmental side to make business feel these kind of meetings useful and willing to share their problems. This open conversation might help *in improving satisfaction of business by state* *programs* through joint development. Problems with the joint submission of applications could be addressed by creation of consultancy in application process for both sides (university and business partners). Another kind of suggestion for governmental side in these problems is to make a more detailed evaluation of state programs through conducting a survey among companies taking part in these programs and getting a feedback, not just through collecting reports from them (Dezhina, 2012).

7. Universities are not enough market-oriented

The lack of sufficient experience and skills in universities to work in the market and sell products as a production company require involvement (hiring) experts with marketing expertise, able to work with business and market of innovations. Also needed: understanding by university administration of for what and why commercialization is necessary. That is good that the respondent see this solution by himself, and promotion of this idea in his own university could become a good history of success for others.

8. Industry sector is developing not quickly enough

This situation, when *economy of the industry, in which university operates, is developing not enough quickly, and it affects the funding of R&D*, is quite difficult for university. In addition, it is hard to imagine that institution, which relies primarily on funding from the government, can become a driver in a particular industry. However, if the university will be able to focus on the development of solutions for companies in other countries, in case of success, the university will receive a contract with a foreign company (additional funding), and university's own level of competitiveness on the market of technology and education will raise.

9. Companies cannot articulate their research problems

To help companies in articulation of their research problems universities as organizations on the path to independence from state have to develop their marketing skills in particular in creating commercial offer for companies, of cause after detailed marketing analysis skills.

10. Bureaucratic aspects of IP rights disposal

Making legal procedures more clear, and creation (if there is no) a division of IP department and technology transfer offices in the university might help in *the elimination of bureaucratic aspects in IP rights disposal*. In existing IP departments and TTOs it is necessary to improve the skills of staff (Learn.IP, 2012) also through the accumulation of experience in patent transactions with business.

The main research question is:

How is university-industry collaboration executed as a part of open innovation framework?

In the field of inter-firm collaboration inbound open innovation are more common than outbound (Chesbrough & Brunswicker, 2013). From the university perspective it is vice versa. The outbound open innovation practices are traditional and wide spread. These practices are represented by such kind of links with industry as *commercialization of property rights, research partnership or providing a research services to industrial companies*. In that case the knowledge flow is going from university to company and not in the reverse direction. The maximum that university receives is money. The *academic entrepreneurship* (spin-off) is also a kind of outbound open-innovation, when the knowledge is leaking into new company from university. In case of Russia commercialization of property rights is less developed than in European countries, this process still requires awareness from the university side according to the survey. Research services provided by Russian universities are growing in volume, but there is still a psychological barrier to commercial activities in Russian universities.

The reverse direction of knowledge flow in university-industry relationships as it was mentioned before is represented by such practices as *meetings, conferences, giving lectures in universities by companies' employees*. However, these links are not obligatory implying creation of innovation. Obviously, that knowledge acquired by university scientists could be useful for future research and innovations, but in the moment of interaction innovation is not created. That suggests that inbound practices in university-industry relationships are not very common as well as reverse-directional interaction, and both are quite intangible.

Successful cases of reverse-directional interaction are discussed in this study (FRUCT, for instance) and in analyzed cases the initiative came from business side and innovations were created during the interaction process. However, it still seems a not very common practice.

The results of this study suggest that open collaboration between not only university and industry, but also including of government in this open innovation process. It is crucially important for Russian case, where higher-educational institutions are subordinates of the government. Taking into account a strong apartness of Science sector (RAS) in Russia from other actors it is also important to work actively for reducing this distance. However, this is a separate topic for research in particular Russian context. Figure 30 represents integration of the Triple Helix model with open innovation model, where all of the actors of relationships (University, Business and Government) are sharing their ideas and using external ideas (knowledge). The same clue of integration of Triple Helix and open innovation model was promoted by Costello et al., 2007, but the authors do not use open innovation funnel in representation of their idea (see appendix 6). Carayannis & Campbell (2011) consider the integration of Quadruple Helix (university, industry, government, society) into Quintuple Helix, and researchers call it democracy of knowledge (Carayannis & Campbell, 2011). In the model proposed by the author of this thesis, outbound innovations from government could be Open Source projects (developing by plain users/citizens), state orders and tenders. From business it could be ideas about investments or co-investments, business plans of implementing new products or technologies (offering to government or to university directly) and proposals about political improvements to government. From the university side it is technical and technological innovations, absorption of marketing, manufacturing and interaction experience from companies (reverse-directional interaction), joint development of collaboration programs with government and learning of organizational and managerial mechanisms from government agencies. It is already not just realizing of the importance of interaction between these three actors, but even more necessity of open dialog for mutual development.

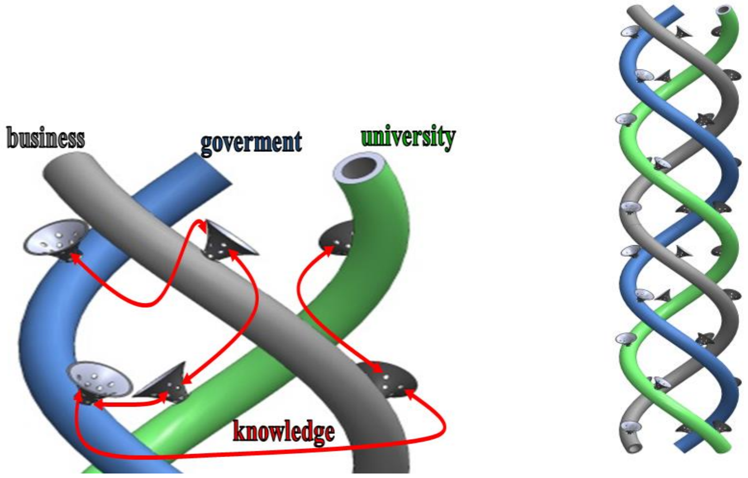


Figure 30. Integration of OI Model into Triple Helix model

Of cause, there are limitations for this model. The first one is in the level of analysis of different models integrated. For Triple Helix it is a system level, and open innovation model is usually considered on the company level. However as it was mentioned before Howells et al. (2012) already called it as research gap for the field of open innovation. Therefore, open innovation on the more global level is a direction for further research.

The summary of research questions, methods used and findings is given in the table 19 below.

Table 19. Summary of research questions, methods and findings

	RQ1	RQ2	RQ3	RQ4	RQ5
Objectives	To identify the forms of open innovations in university-industry collaboration in general and in the context of Russia	To test the existence of interaction with university initiated by industry (in theory and practice)	To identify the motives of both actors to interact	To find the problems in U-I collaboration in general and in Russia	To find solutions for general problems and for particular Russian problems
Method	Literature review	Literature review, case study, survey of 51 universities, e-mail interview	Literature review, survey of 51 universities	Literature review, survey of 51 universities, e-mail interview	Literature review, survey of 51 universities, interview
Data	academic literature and secondary data	academic literature, survey and interview results	academic literature, survey results	academic literature, survey and interview results	academic literature, survey and interview results
Findings	The outbound OI are traditional (commercialization of property rights, research partnership or providing a research services to industrial companies, academic spin-offs). Inbound practices are rare, but exist (meetings, conferences, giving lectures in universities by companies' employees) and imply a basis for future innovations; Model of Implementation OI and Triple Helix	Reverse-directional interaction exists. In the forms of meetings, conferences, giving lectures in universities by companies' employees.	For university the main motives are recognition within the scientific community, receiving additional funding and getting reference. For companies it is getting profit, recruiting of personnel, observation of scientific development and receiving a solution of technological problems.	Problems: lack of influence of companies on educational programs; underestimation of the potential of the university by business, bureaucratic aspects, lack of willing to invest in innovations from business side.	Solutions: working groups of business' and university' representatives; governmental initiatives; balanced development of basic R&D and innovation infrastructure through balancing resources; open dialogs & collecting a feedback from companies; Hiring experts with marketing skills in universities

7. Conclusions

7.1. General conclusions

Open innovation paradigm, which implies using external ideas as well as internal ones with the same level of importance, is rather new. This concept is even more new in the particular context of university-industry collaboration. The main purpose of this study was to explore how open innovation is implemented in university-industry interaction. According to the findings, from the university perspective outbound open innovation practices are traditional and have such forms as commercialization of property rights, research partnership, providing a research services to industrial companies by universities and academic entrepreneurship (spin-offs). In such kind of links the knowledge flow is going from university to company and not in the reverse direction, while university is just getting paid for the knowledge. In Russia the traditional direction of knowledge interaction (from university to industry) is still under development, and there are a lot of administrative, organizational and psychological barriers standing in the way of commercialization of knowledge.

However, this study shows that even though the reverse-direction of interaction is not widely discussed in the literature, it does exist, and even particularly in Russia. The analyzed cases of collaboration (University of Zaragoza with Bosh and Siemens Home Appliances Group; Finnish-Russian University Cooperation in Telecommunication (FRUCT)) demonstrate the initiative to collaborate from industry side in action. The motivation for business in such cases is in getting ability to acquire knowledge from the academia, share their own knowledge in order to achieve knowledge complementarity, create innovations and nurture the high-qualified professionals in collaboration. Other forms of reverse-directional interaction are meetings, conferences, lectures in universities by companies' employees. Despite the fact, that during the knowledge sharing process innovations are not created, the ideas for future innovations have a chance to appear already. This kind of open collaboration is a big step to innovation.

To get the open innovation going within university-industry collaboration, one should begin by solving the existing problems and barriers in these relationships. The number of the barriers were identified and discussed in this study. In general, these barriers are quite close to ones identified in inter-firm relationships: lack of trust, mutual understanding, transparency, IP issues. The specific issues in the collaboration with universities arise from close connection of university with governmental institutions and differences in primary motivation of the actors: profit for business and new knowledge for university. These specific barriers are: long terms university research (as opposed to industry research), lack of industry's understanding of university's working processes, and as is usually the case another barrier is bureaucracy. Possible solutions and suggestions for specific problems of university-industry collaboration, identified by Russian respondents were presented in this thesis. The general suggestion for all of the actors of Triple Helix model (universities, industry, and government) is to join hands in development of the basic science, the innovations and the innovation infrastructure. Since nowadays one of the most important problems in Russia is the lack of interest in innovation business between Russian enterprises, the government and the higher education institutions have to carry out two missions in parallel: the search for motivation for companies to invest in innovations and to search and to develop in universities, such a set of knowledge, technologies, products, or intellectual potential, which can be profitable for business and thus create interest in the partnership.

This study suggests an ideal model for implementation of open innovation concept into Triple Helix model, where all of the three actors take part in the open conversation, share their ideas and acquire ideas from others for innovation development. The transition from resource-based economy to innovation economy was announced as the global strategic goal by Russian government for the next 20 years. In the country where the government plays a role of intermediary between universities and business this three actor’s open dialog is critically important.

The thesis has a high value for the theory of university-industry collaboration as well as the theory of open innovation, looking at rather neglected link of university-industry interaction. The results presented in this thesis will significantly extend the understanding of industry-university collaboration for creating innovations globally and in Russia. This research contributes to filling in the research gap on reverse direction in U-I relationship. Even though the data was only collected in Russia, the findings of this research confirm the general challenges of U-I cooperation pointed out by other authors and therefore it is a useful contribution to the theory. As innovation is often a result of university-industry cooperation, fostering this cooperation would be beneficial for both parties, as well as for the governmental stakeholders. The Russian experience could be also very useful for the other countries.

7.2. Limitations

This study has encountered two types of limitations: the ones specific to the present research, these limitations have arisen in the process of conducting the survey just among universities' representatives, and the general ones, that had to do with the difficulties of data collection processes. Not all of the Russian respondents were open enough to take part in the survey. Some of them were willing to cooperate only in case of signing a contract, or some sort of additional agreement. For instance, the response from Vice-Rector for Research of one Russian University could be translated as:

"Hello, Ekaterina!

I read your questionnaire with interest. It seems to me that asked questions go far beyond bilateral cooperation between the two universities. I believe that the move towards a better and mutual understanding is possible only on the basis of firm agreements that define the objectives, tasks, tools, and resources required as well as through the implementation of joint projects".

Some respondents were even aggressive during the phone call and highlighted that they were not willing to share any information with a foreign university. While others quietly and regretfully responded that they cannot provide the information requested in the survey, because the top management of their university does not allow it. These cases illustrate two levels of closedness: personal and organizational.

7.3. Suggestions for further research

Even though this study contributes significantly to the research of reverse-directional interaction in university-industry collaboration, this sub topic requires deeper exploration of the process. That could be executed by collecting data from the business' side - conducting a survey or interviews amongst companies. This kind of research will contribute search for inbound Open Innovations for universities.

Another field for further research is looking for motivation mechanisms for business to collaborate with universities in general and in Russia.

According to findings of this study, one of the reasons for this lack of motivation in Russian companies is the shortage of interest in innovative business and investment in R&D. However, this observation came indirectly from the answers of universities, which have a tradition of misunderstanding business reality in Russia due to their relatively big distance from each other. Therefore, this global problem of innovation entrepreneurship' deficit in Russia requires a search for solution.

The model for implementation of open innovation concept into Triple Helix model, suggested in this study, could be used for a deeper research of particular links between three actors.

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APPENDICES

APPENDIX 1: The concept of open innovations

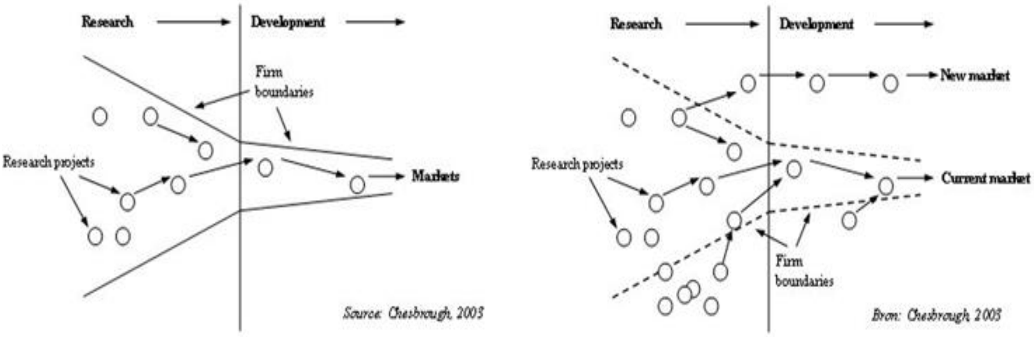
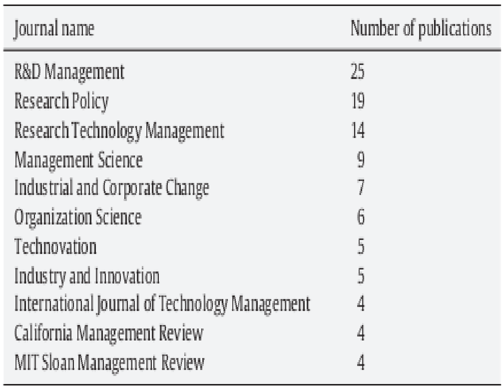


Figure 1. Closed innovation system and open innovation Paradigm (Chesbrough, 2003)



Journal name	Number of publications
R&D Management	25
Research Policy	19
Research Technology Management	14
Management Science	9
Industrial and Corporate Change	7
Organization Science	6
Technovation	5
Industry and Innovation	5
International Journal of Technology Management	4
California Management Review	4
MIT Sloan Management Review	4

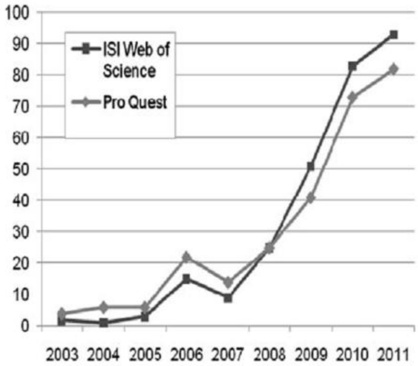


Figure 2. Number of published articles in scholary journals on open innovation over time (Schroll & Mild, 2012) and most common journals, including the topic (Dahlander & Gann, 2010)

APPENDIX 2: Questionnaires

Appendix 2.2: Questionnaire Russian version

Исследование процессов сотрудничества Российских ВУЗов и промышленности (бизнеса) 2013

Пожалуйста, отметьте правильный ответ удобным для Вас значком, например, **X**

1. Профиль респондента

1.1.	Пожалуйста, выберите позицию, занимаемую Вами в ВУЗе	
	Декан	__
	Проректор по науке или по развитию	__
	Заведующий кафедрой или другим подразделением	__
	Административный персонал по исследованиям, развитию, инновациям (например, работа с компаниями или лицензирование)	__
	Другое, пожалуйста, поясните ______________________________	
1.2.	Связана ли Ваша работа (формально/неформально) с сотрудничеством ВУЗа с промышленностью (бизнесом)?	ДА __ НЕТ __

2. Федеральная Государственная Программа "поддержки развития кооперации российских высших учебных заведений и организаций, реализующих комплексные проекты по созданию высокотехнологичного производства"

2.1.	Подавал ли Ваш ВУЗ заявку на участие в "конкурсе на право получения субсидий на реализацию комплексных проектов по созданию высокотехнологичного производства", организованном в соответствии с постановлением Правительства Российской Федерации от 9 апреля 2010 года № 218?	ДА __		НЕТ __	Затрудняюсь ответить __
2.2.	**Если 2.1. - «ДА»**, то победил ли проект в отборе? Если за последние 3 года победило несколько проектов, укажите (по возможности) количество победивших проектов Вашего ВУЗа.	ДА __	Кол-во проектов __	НЕТ __	Затрудняюсь ответить __
2.3.	**Если 2.1. - «ДА»**, то, как Вы оцениваете эффективность (текущую/потенциальную) Федеральной Государственной Программы "поддержки развития кооперации российских высших учебных заведений и организаций, реализующих комплексные проекты по созданию высокотехнологичного производства" *с точки зрения стимуляции сотрудничества ВУЗов и промышленности (бизнеса)*?	Укажите, пожалуйста, Вашу оценку эффективности программы от 1 до 7: __ 1 - абсолютно не эффективна __ 2 - очень слабо эффективна __ 3 - слабо эффективна __ 4 - умеренно эффективна __ 5 - достаточно эффективна __ 6 - очень эффективна __ 7 - эффективна и критически важна для ВУЗов			

continued on the next page

3. Развитие сотрудничества между ВУЗом и предприятиями

За последние 3 года, в Вашем ВУЗе…		Снизился		Остался без изменений	Вырос		Затрудняюсь ответить
		1	2	3	4	5	
3.1.	Объем совместного с компаниями финансирования исследований	—	—	—	—	—	—
3.2.	Объем работ (консалтинговых услуг), выполняемых Вашим университетом по заказу компаний	—	—	—	—	—	—
3.3.	Деловое сотрудничество, такое как создание нового бизнеса, продажа компаниям прав на интеллектуальную собственность или лицензирование	—	—	—	—	—	—
3.4.	Сотрудничество с другими организациями (например, государственными или региональными организациями)	—	—	—	—	—	—
3.5.	Количество предприятий-партнеров ВУЗа	—	—	—	—	—	—
3.6.	Спектр отраслей и размер компаний-партнеров	—	—	—	—	—	—
3.7.	Склонность бизнес-партнеров к более тесному и продолжительному сотрудничеству с Вашим ВУЗом (больше, чем к краткосрочным и маломасштабным контрактам)	—	—	—	—	—	—
3.8.	Доля проектов, совместно-финансируемых с бизнесом, в общем числе проектов ВУЗа	—	—	—	—	—	—
3.9.	Доля платных услуг, оказываемых ВУЗом компаниям, в общем числе услуг	—	—	—	—	—	—
3.10.	Сотрудничество с малым и средним бизнесом носит скорее случайный характер и в большинстве случаев имеет краткосрочную основу	—	—	—	—	—	—
3.11.	Междисциплинарность исследований, проводимых Вашим ВУЗом для бизнес-партнеров	—	—	—	—	—	—

continued on the next page

За последние 3 года, в Вашем ВУЗе…		Снизился		Остался без изменений	Вырос		Затрудняюсь ответить
		1	2	3	4	5	
3.12.	Степень конфиденциальности результатов совместных с предприятиями проектов (учебных материалов)	—	—	—	—	—	—
3.13.	ВУЗ (руководство факультета, исследовательские группы) стал более избирателен при выборе компаний-партнеров	—	—	—	—	—	—
3.14.	Число зарубежных партнеров ВУЗа или зарубежное финансирование проектов	—	—	—	—	—	—
3.15.	Инициатива ВУЗа по созданию новых организаций или программ для стимулирования сотрудничества с промышленностью (бизнесом)	—	—	—	—	—	—
3.16.	Компании-партнеры стали более внимательно относиться к проблемам управления нематериальными активами, созданными в результате совместной с ВУЗом работы	—	—	—	—	—	—
3.17.	Роль нехватки ресурсов в недостаточной коммерциализации[2] разработок ВУЗа (патентование, лицензирование, создание нового бизнеса)	—	—	—	—	—	—
3.18.	Уровень заинтересованности студентов в создании собственного бизнеса	—	—	—	—	—	—

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[2] Коммерциализация технологий (исследований и разработок) - это любая деятельность, которая направлена на создание дохода от использования результатов научных исследований, научных компетенций.

Appendix 2 continued

4. Новые формы сотрудничества ВУЗов с промышленностью

За последние 3 года, в Вашем ВУЗе		Снизился		Остался без изменений	Вырос		Затрудняюсь ответить
		1	2	3	4	5	
4.1.	Компании все чаще приобретают знания и технологии благодаря заключению контрактов на проведение исследований с Вашим ВУЗом или участию в совместных проектах	—	—	—	—	—	—
4.2.	Ваши бизнес-партнеры все чаще приглашают на работу Ваших ведущих научных сотрудников и специалистов	—	—	—	—	—	—
4.3.	Ваши бизнес-партнеры все чаще приглашают научных сотрудников или студентов Вашего университета для проведения исследований и разработок, которые до этого осуществляли собственными силами внутри компании	—	—	—	—	—	—
4.4.	Перед фактическим проведением научных исследований и разработок (создания нового бизнеса), партнеры все чаще привлекают Ваших научных сотрудников или студентов к написанию технико-экономического обоснования и экспертизы идей на предмет их технической (экономической) состоятельности	—	—	—	—	—	—
4.5.	Компании-партнеры предоставляют свои ресурсы (оборудование, лаборатории) в пользование Вашим научным сотрудникам (или студентам), не требуя немедленной компенсации	—	—	—	—	—	—

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За последние 3 года, в Вашем ВУЗе		Снизился		Остался без изменений	Вырос		Затрудняюсь ответить
		1	2	3	4	5	
4.6.	Ваш ВУЗ приглашает на работу представителей бизнеса (промышленности) для повышения качества проводимых научных исследований и разработок	—	—	—	—	—	—
4.7.	Ваш ВУЗ активизирует процессы коммерциализации своих разработок и технологий путем их продажи или лицензирования	—	—	—	—	—	—
4.8.	Ваш ВУЗ активизирует процессы коммерциализации своих разработок и технологий путем поощрения и стимуляции создания нового бизнеса	—	—	—	—	—	—
4.9.	Научные сотрудники и студенты Вашего ВУЗа все чаще используют идеи, исходящие от компаний, при планировании будущих исследований и разработок	—	—	—	—	—	—
4.10.	Прямые контакты научных сотрудников Вашего ВУЗа с бизнесом становятся все более важным условием при получении финансирования исследовательских проектов или других видов научно-исследовательской деятельности, осуществляемых совместно с бизнес-партнерами (частных и совместно-финансируемых)	—	—	—	—	—	—
4.11.	По результатам совместных проектов, права на интеллектуальную собственность, созданную сотрудниками компании, перешли в собственность ВУЗа	—	—	—	—	—	—

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За последние 3 года, в Вашем ВУЗе		Снизился		Остался без изменений	Вырос		Затрудняюсь ответить
		1	2	3	4	5	
4.12.	По результатам совместных проектов права на интеллектуальную собственность, созданную сотрудниками компании, перешли в собственность/в распоряжение студентам	—	—	—	—	—	—
4.13.	Научные сотрудники и студенты пользуются лабораториями и оборудованием совместно с компаниями	—	—	—	—	—	—
4.14.	ВУЗ организовывает и/или активно поддерживает конкурсы бизнес-идей и инноваций среди студентов для решения проблем бизнеса	—	—	—	—	—	—
4.15.	ВУЗ все больше инвестирует в экономическое использование (получение прибыли от продажи) прав интеллектуальной собственности (патентов и др.)	—	—	—	—	—	—
4.16.	В ВУЗе существует устойчивая система оценки и контроля использования прав на результаты интеллектуальной деятельности	—	—	—	—	—	—
4.17.	ВУЗом разработана система диверсификации (разделения) рисков от проведения совместных проектов, а также оценки прибыли для каждой из сторон, участвующих в проекте (существуют четкие "правила игры")	—	—	—	—	—	—

continued on the next page

5. Результаты сотрудничества ВУЗа и промышленности/бизнеса

За последние 3 года, в Вашем ВУЗе		Снизился		Остался без изменений	Вырос		Затрудняюсь ответить
		1	2	3	4	5	
5.1.	Объем прибыли от продажи ВУЗом интеллектуальной собственности (лицензирования и др.)	—	—	—	—	—	—
5.2.	Наличие нематериальных активов в ВУЗе, которые потенциально возможно коммерциализировать	—	—	—	—	—	—
5.3.	Активность участия ВУЗа в инкубационной деятельности	—	—	—	—	—	—
5.4.	Бывшие и нынешние исследователи и студенты основали успешные spin-off компании [3], созданные с целью коммерциализации технологии/идеи, разработанной в университете	—	—	—	—	—	—
5.5.	Число случаев, когда spin-off компании, созданные при ВУЗе, становятся банкротами из-за нехватки финансирования или других важных ресурсов	—	—	—	—	—	—
5.6.	Влияние сотрудничества Вашего ВУЗа и предприятий на возникновение новой отрасли (сферы бизнеса) в регионе	—	—	—	—	—	—
5.7.	Число идей и ноу-хау, разработанных в совместных проектах, и используемых научными сотрудниками ВУЗа в качестве тем дальнейших научных исследований	—	—	—	—	—	—
5.8.	Количество курсов по управлению инновациями, включенных в учебный план Вашего ВУЗа	—	—	—	—	—	—

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[3] Spin-off компания – компания, созданная на базе университетской технологии

За последние 3 года, в Вашем ВУЗе		Снизился		Остался без изменений	Вырос		Затрудняюсь ответить
		1	2	3	4	5	
5.9.	Негативный аспект влияния сотрудничества с бизнесом на качество преподавания, подготовку специалистов и проведение исследований в Вашем ВУЗе	—	—	—	—	—	—
5.10.	Роль отдельных партнеров ВУЗа в учебной программе	—	—	—	—	—	—
5.11.	Роль сотрудничества с бизнес-партнерами в развитии интернационализации ВУЗа	—	—	—	—	—	—

6. Ваше мнение

6.1. Какие, по Вашему мнению, существуют наиболее значимые проблемы и барьеры в сотрудничестве Вашего ВУЗа с предприятиями? На что они влияют?

6.2. Назовите сотрудника/сотрудников Вашего ВУЗа, наиболее компетентного в обсуждаемых вопросах

6.3. Хотите ли Вы что-то еще добавить или прокомментировать? Критика опроса приветствуется

Большое спасибо за Вашу помощь.

Пожалуйста, сообщите адрес Вашей электронной почты, чтобы мы могли отправить Вам результаты нашего исследования

continued on the next page

Appendix 2.2: Questionnaire English version

Research of the processes of cooperation between Russian universities and industry (business) 2013

Please mark the correct answer by icon, which is convenient for you, for example, X

1. Profile of the respondent

1.1.	Please select the position taken by you in high school	
	_Dean	__
	_Director of Research and development (R & D) activities	__
	_ Director of the Department	__
	_ Research, development and innovation management personnel (for instance, cooperation with industry, licensing services, etc.)	__
	Other, please specify here____	
1.2.	Is your work connected (formally / informally) with the cooperation of the university with industry (business)?	YES __ NO __

2. Federal Governmental Program "to support the development of cooperation of Russian higher education institutions and organizations implementing complex projects on high-tech production"

2.1.	Did the university apply to participation in the "competition for the right to receive subsidies for the implementation of projects aimed at the creation of high-tech manufacturing", organized in accordance with the Government of the Russian Federation dated April 9, 2010 № 218?	YES __		NO __	Do not know __
2.2.	If **2.1. - "YES",** then did the university win in the selection? If the last 3 years has won several projects, specify (if possible) the number of the winning projects of your university.	YES __	# of projects __	NO __	Do not know __
2.3.	If **2.1. - "YES",** then how do you assess the effectiveness (current / potential) of the Federal State Program "Support the development of cooperation of Russian higher education institutions and organizations implementing complex projects on high-tech production" in terms of stimulating cooperation of universities and industry (business)?	Please indicate your assessment of the effectiveness of the program from 1 to 7: __ 1 - is not effective __ 2 - very little effective __ 3 - weakly effective __ 4 - moderately effective __ 5 - quite effective __ 6 - very effective __ 7 - effective and critically important for universities			

continued on the next page

3. The development of cooperation between university and businesses

Regarding your university, during the recent 3 years…		Decreased		Remained stable	Increased		Do not know
		1	2	3	4	5	
3.1.	Research projects co-funded with industry	—	—	—	—	—	—
3.2.	The scope of work (consulting services) performed by your university for companies	—	—	—	—	—	—
3.3.	Commercialization Services related to business co-operation (for example, the establishment of a new business, IPR and licensing of sales)	—	—	—	—	—	—
3.4.	Cooperation with other companies (eg public administration)	—	—	—	—	—	—
3.5.	The number of industrial partners has increased	—	—	—	—	—	—
3.6.	The diversity of industrial partners has increased either by size or by sector	—	—	—	—	—	—
3.7.	More companies have begun to conduct continuous collaboration with us	—	—	—	—	—	—
3.8.	The share of projects, co-funded with industry, in the total number of university projects has increased	—	—	—	—	—	—
3.9.	Paid services have increased	—	—	—	—	—	—
3.10.	SME cooperation is changed to the occasional short-term basis	—	—	—	—	—	—
3.11.	The research, undertaken by the university for business partners, is increasingly cross-disciplinary	—	—	—	—	—	—
3.12.	The results from industrial collaboration are more often confidential (e.g. secrecy of a Master's Theses) than before	—	—	—	—	—	—
3.13.	Our university has become more selective in its industrial partnerships	—	—	—	—	—	—
3.14.	The number of foreign partners or corporate funding has increased	—	—	—	—	—	—

continued on the next page

Appendix 2 continued

Regarding your university, during the recent 3 years…		Decreased		Remained stable	Increased		Do not know
		1	2	3	4	5	
3.15.	New organization(s) or program(s) has been established on the university–industry interface to foster collaboration	—	—	—	—	—	—
3.16.	Business partners have become increasingly more sophisticated in cooperation concerning the management of intellectual property rights arising from joint work with the university	—	—	—	—	—	—
3.17.	Our commercialization services (patenting, licensing and new business generation) have proven to be inadequately resourced	—	—	—	—	—	—
3.18.	University students are increasingly interested in setting up their own businesses	—	—	—	—	—	—

4. New forms of university-industry Collaboration

Regarding your university, during the recent 3 years…		Decreased		Remained stable	Increased		Do not know
		1	2	3	4	5	
4.1.	Businesses acquire knowledge and technology for research services or joint collaboration projects more often through contracting us	—	—	—	—	—	—
4.2.	Our business-partners are recruiting more and more key researchers and experts from our university	—	—	—	—	—	—

continued on the next page

Regarding your university, during the recent 3 years…		Decreased		Remained stable	Increased		Do not know
		1	2	3	4	5	
4.3.	Our business partners are increasingly inviting our research staff or students to conduct research and development that that they have previously conducted in-house	—	—	—	—	—	—
4.4.	Before initiating formal R&D, business partners increasingly involve our researchers / students in feasibility studies / projects to verify the (commercial or technical) applicability of their ideas	—	—	—	—	—	—
4.5.	The partner companies are providing their resources (equipment, laboratories) in the use to our researchers (or students) without requiring immediate compensation	—	—	—	—	—	—
4.6.	Our university offers a job representatives of business (industry) to improve the quality of the research and development	—	—	—	—	—	—
4.7.	Our university has stepped up the processes of commercialization of its technologies and inventions through selling or licensing them	—	—	—	—	—	—
4.8.	Our university has stepped up the process of commercialization of their products and technologies by promoting and stimulating creation of new business	—	—	—	—	—	—
4.9.	Researchers and students are using more and more ideas from companies in drafting / planning future research and development projects	—	—	—	—	—	—

continued on the next page

Regarding your university, during the recent 3 years…		Decreased		Remained stable	Increased		Do not know
		1	2	3	4	5	
4.10.	Direct contacts between our scientists and business are becoming increasingly important prerequisites for funded research projects or other privately (co-)funded research activities together with business partners	—	—	—	—	—	—
4.11.	There are collaborative projects with the industry in which ideas created in companies have been transferred to our university's ownership	—	—	—	—	—	—
4.12.	There are collaborative projects with the industry in which ideas created in companies have been transferred to some of our students' ownership	—	—	—	—	—	—
4.13.	Researchers and students share the same equipment (or laboratory) with companies	—	—	—	—	—	—
4.14.	University organizes student competitions or actively support ones to develop innovation solutions for solving problems of business (industry)	—	—	—	—	—	—
4.15.	The University invests more in the economic exploitation of intellectual property rights (eg patents)	—	—	—	—	—	—
4.16.	The University has created a standing practice that allows to evaluate and monitor the use of intellectual creatures	—	—	—	—	—	—
4.17.	The university establish clear rules of the game of economic benefits and risk sharing with companies in common projects	—	—	—	—	—	—

continued on the next page

5. Impacts of the university-industry Collaboration

Regarding your university, during the recent 3 years…		Decreased		Remained stable	Increased		Do not know
		1	2	3	4	5	
5.1.	Our university has increasingly gained profit from selling its IPR (licensing etc.)	__	__	__	__	__	__
5.2.	The University has not yet been used in full intellectual property rights for commercial purposes	__	__	__	__	__	__
5.3.	The university is actively involved in incubation activities	__	__	__	__	__	__
5.4.	There are successful start-up companies* established by our (former or existing) students (knowledge is to a large extent created by higher education institutions)	__	__	__	__	__	__
5.5.	Spin-off companies fail often, because of lack of financing or other important resources	__	__	__	__	__	__
5.6.	A new industrial sector has born in the region for which our university has significantly contributed to (by provision of skilled labour, R&D collaboration etc.)	__	__	__	__	__	__
5.7.	University researchers have taken up ideas and know-how from collaboration to develop them further as a part of the university's own research activities	__	__	__	__	__	__
5.8.	Innovation management–related courses are included in the curriculum	__	__	__	__	__	__
5.9.	Collaboration has too big impact on our teaching and/or research activities	__	__	__	__	__	__
5.10.	Collaborative projects have steadily become a part of a curriculum within courses	__	__	__	__	__	__
5.11.	Collaboration has considerably contributed to our university's internationalization	__	__	__	__	__	__

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6. Your opinion

6.1. What are the most significant problems or obstacles of university-industry cooperation? On what do they affect?

6.2. What are the employee / employees of your university, the most competent in the issues being discussed?

6.3. Other issues related to the survey and criticism:

Thank you very much for your help.
Please, give us your email address so we can send you the results of our survey

APPENDIX 3: University patenting

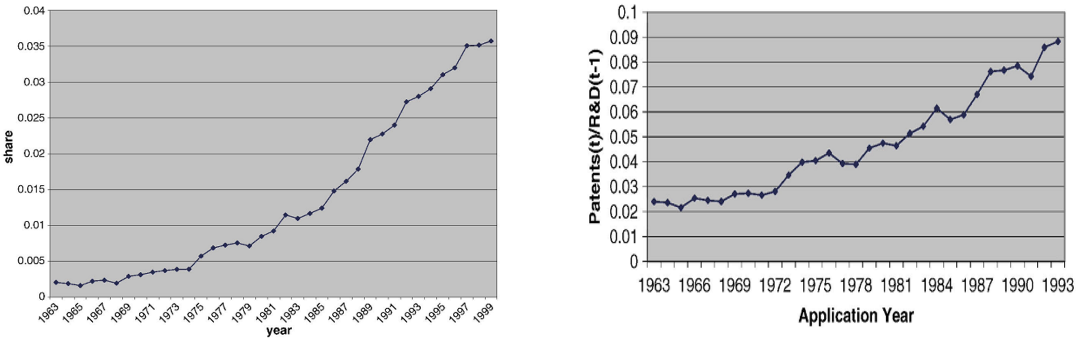


Figure 1. US research univ. patents % of the domestic –assignee US patents, 1963-1999 and university patents per R&D Dollar (Mowery & Sampat, 2005)

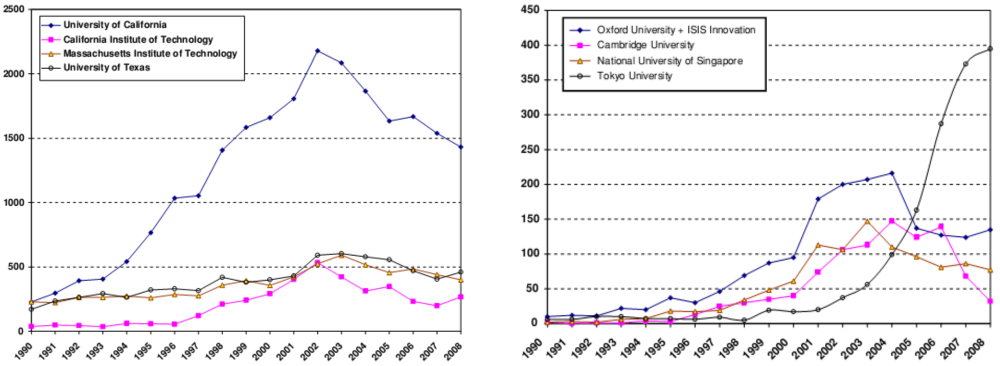
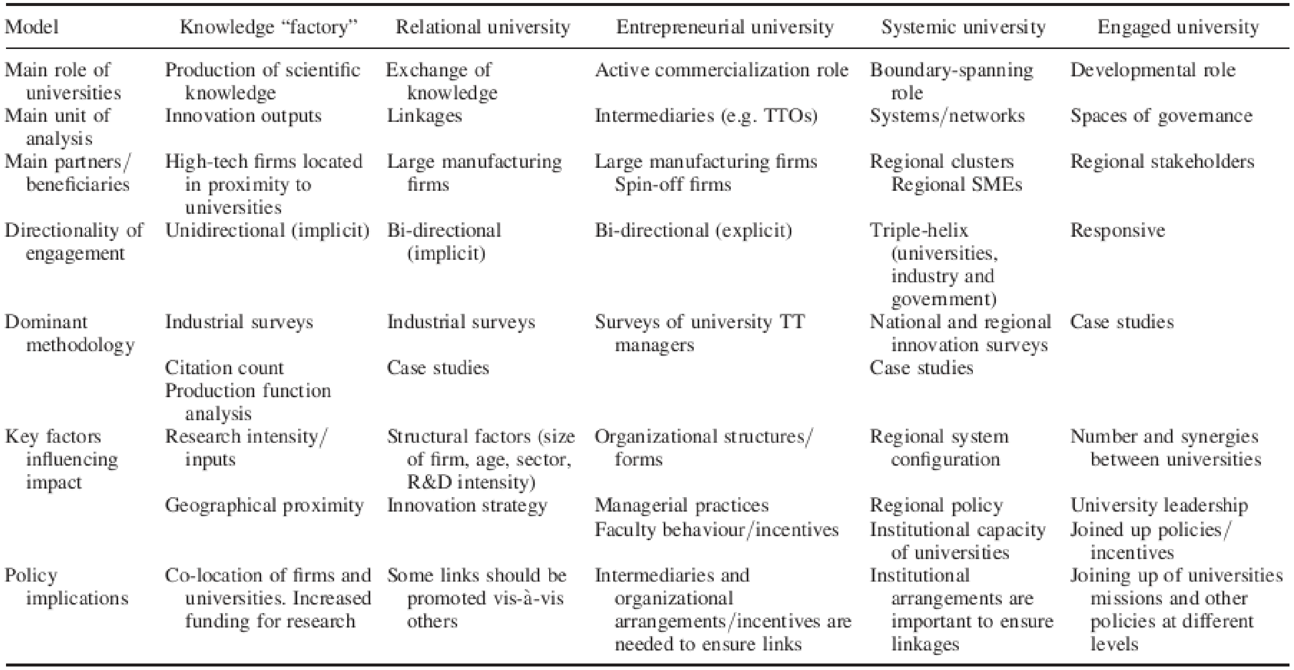


Figure 2. Worldwide patents of four leading US universities and patenting by leading non-American universities (Leydesdorff & Meyer, 2010)

APPENDIX 4: Links of interaction

Table 1. Summary: roles, determinants and engagement modes of universities (Uyarra, 2010)



Model	Knowledge "factory"	Relational university	Entrepreneurial university	Systemic university	Engaged university
Main role of universities	Production of scientific knowledge	Exchange of knowledge	Active commercialization role	Boundary-spanning role	Developmental role
Main unit of analysis	Innovation outputs	Linkages	Intermediaries (e.g. TTOs)	Systems/networks	Spaces of governance
Main partners/ beneficiaries	High-tech firms located in proximity to universities	Large manufacturing firms	Large manufacturing firms Spin-off firms	Regional clusters Regional SMEs	Regional stakeholders
Directionality of engagement	Unidirectional (implicit)	Bi-directional (implicit)	Bi-directional (explicit)	Triple-helix (universities, industry and government)	Responsive
Dominant methodology	Industrial surveys Citation count Production function analysis	Industrial surveys Case studies	Surveys of university TT managers	National and regional innovation surveys Case studies	Case studies
Key factors influencing impact	Research intensity/ inputs Geographical proximity	Structural factors (size of firm, age, sector, R&D intensity) Innovation strategy	Organizational structures/ forms Managerial practices Faculty behaviour/incentives	Regional system configuration Regional policy Institutional capacity of universities	Number and synergies between universities University leadership Joined up policies/ incentives
Policy implications	Co-location of firms and universities. Increased funding for research	Some links should be promoted vis-à-vis others	Intermediaries and organizational arrangements/incentives are needed to ensure links	Institutional arrangements are important to ensure linkages	Joining up of universities missions and other policies at different levels

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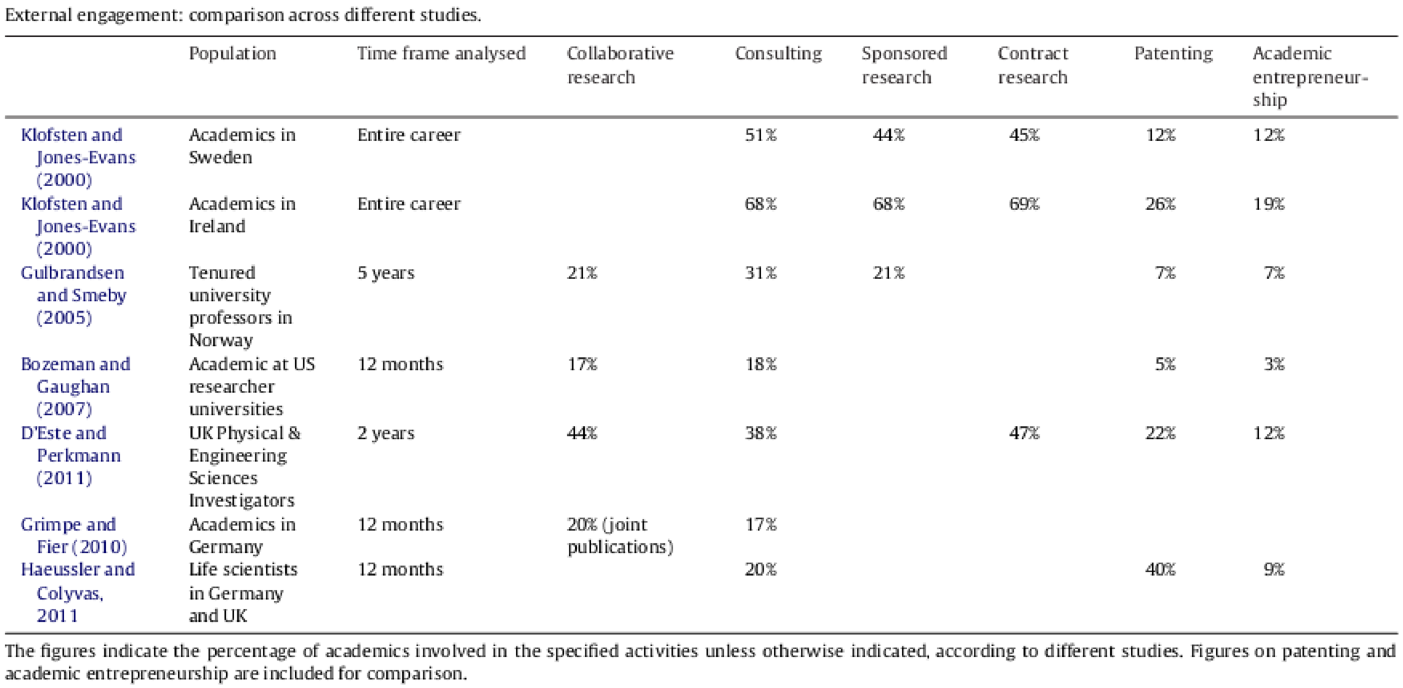
Table 2. External engagement of academia by types of collaboration (Perkmann, et al., 2013)

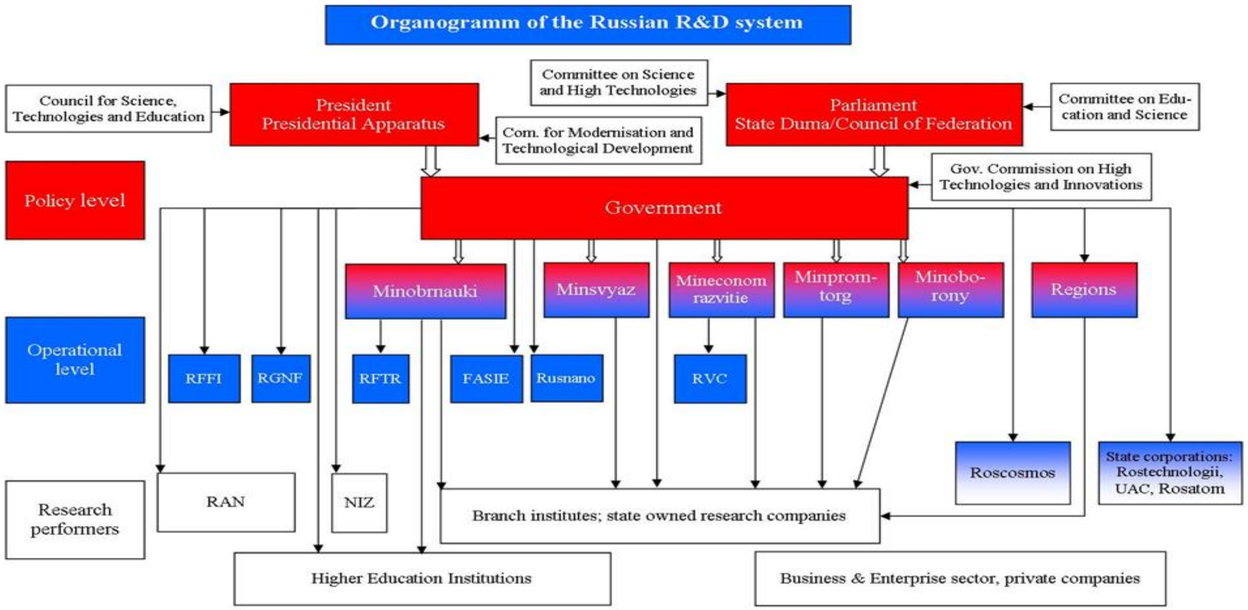


External engagement: comparison across different studies.

	Population	Time frame analysed	Collaborative research	Consulting	Sponsored research	Contract research	Patenting	Academic entrepreneur-ship
Klofsten and Jones-Evans (2000)	Academics in Sweden	Entire career		51%	44%	45%	12%	12%
Klofsten and Jones-Evans (2000)	Academics in Ireland	Entire career		68%	68%	69%	26%	19%
Gulbrandsen and Smeby (2005)	Tenured university professors in Norway	5 years	21%	31%	21%		7%	7%
Bozeman and Gaughan (2007)	Academic at US researcher universities	12 months	17%	18%			5%	3%
D'Este and Perkmann (2011)	UK Physical & Engineering Sciences Investigators	2 years	44%	38%		47%	22%	12%
Grimpe and Fier (2010)	Academics in Germany	12 months	20% (joint publications)	17%				
Haeussler and Colyvas, 2011	Life scientists in Germany and UK	12 months		20%			40%	9%

The figures indicate the percentage of academics involved in the specified activities unless otherwise indicated, according to different studies. Figures on patenting and academic entrepreneurship are included for comparison.

APPENDIX 5: Organizational Structure of Russian R&D system

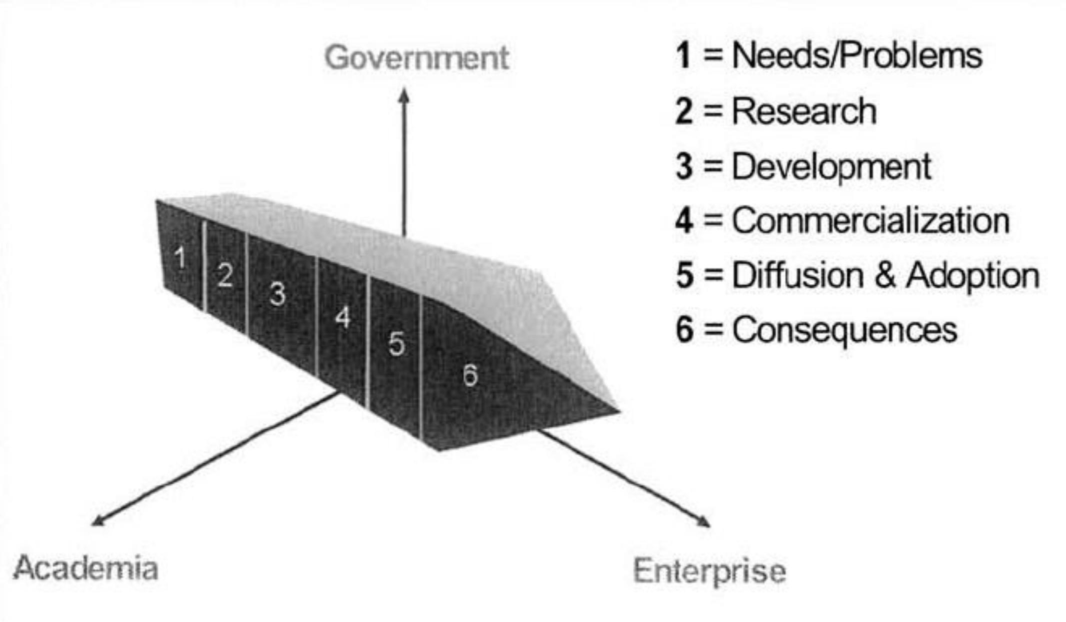


Abbreviations:

Minobrnauki - Ministry of Education and Science,
Minsvyaz - Ministry of Information Technologies and Communication
Mineconomrazvitie - Ministry of Economic Development
Minpromtorg - Ministry of Industry and Trade
Minoborony - Ministry of Defence
RFFI - Russian Foundation for Basic Research
RGNF - Russian Foundation for Humanities
FASIE - Foundation for Assistance to Small Innovative Enterprises
RFTR - Russian Fund for Technological Development
NIZ - National Research Centres (pilot: Kurchatov Inst.)
Rusnano - Russian Corporation of Nanotechnologies
RVC - Russian Venture Company
RAN - Russian Academy of Sciences (RAS)
Roscosmos - Federal Space Agency
Rostechnologii - State Corporation Russian Technologies
UAC - United Aircraft Corporation
Rosatom - State Corporation for Nuclear Energy

Source: European Commission, (ERAWATCH, 2013), note: some structures are abolished (eg. Gov. Commission on High technologies and innovations)

APPENDIX 6: 3-D representation of Rogers' Innovation-Decision process



Source: Costello et al., 2011