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Levels of Science-Business Collaboration and Roles of Participants: Theoretical Aspect

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Abstract

In this article, the levels of science-business collaboration are analyzed; the roles of participants (sectors) and limits of responsibility delegated to and accepted by each of these levels are identified in theoretical aspect. Science institutions should not only traditionally teach and do research, but also undertake the "third" mission, the aim of which is to intensify the collaboration between science and business. In this article the concept of collaboration between science and business is understood as continuous process of science-business interaction when seeking common aims, which consists of a certain content and organization elements. The literature on management, sociology, economy, public policy, psychology is analyzed and systemized by using methods of classification, simplification, and interpretation.

Keywords: science-business collaboration, collaboration levels, university, company, governmental institutions, commitments, responsibility.

Introduction

This theoretical article summarizes the insights of different authors into levels of science-business collaboration and commitments of respective participants of the process, which get formed at these levels.

Novelty and relevance of the article. *Science-business interaction* is regarded as an instrument of knowledge and technology transfer; therefore recently much attention is being paid to these relationships that are very important due to their effect on economic development and welfare (*European Commission*, 2008). This explains the interest of governmental institutions, public organisations as well as business sector (e.g., industrial associations and research centres) in this process (Spithoven, Vandecandelaere, 2009). Relationship between science and business, between high technologies and economic growth increasingly more often is the subject of scientific research and public discussions (Carayol, 2003; Schiller, Diez, 2007; Etzkowitz, 2008; Spithoven, Vandecandelaere, 2009).

Science institutions (specifically universities) play the decisive role of knowledge creators and disseminators in society. It is more and more often said that science institutions should not only traditionally teach and do research, but also undertake the "third" mission, the aim of which is to intensify the collaboration between science and business (D'Este, Patel, 2005; Giuliania, Arzab, 2009). Transfer of knowledge and technologies between science and business acquires increasingly greater significance as *the factor of economic development of regions* (Etzkowitz, Klofsten, 2005). The collaboration concept as such can be analyzed from very different perspectives, but in this article *collaboration is understood as continuous process of science-business interaction when seeking common aims, which consists of a certain content and organization elements*.

One of the essential elements of organization of collaboration process is levels of collaboration as well as roles and responsibilities of the participants of this process. Science-business interaction is determined by many factors, the identification of which depends on various levels of interaction. Here the higher level of interaction becomes important; this level is called collaboration between different sectors. The collaboration can be at many different levels, that is, at individual, group, institution, sector and national level, whilst its forms may be "intra-forms" or "inter-forms" (Inzelt, 2004).

The scientific **problem** of the article can be defined as follows: classification of levels of collaboration is complicated, because respective form can be attributed to both internal (intra) and interpersonal (inter) categories, therefore it is considered appropriate to theoretically concretize the levels of the process of collaboration according to models of roles of participants, allowing for respective limits of responsibility.

Talking about the **level to which the scientific problem has been researched**, Santoro (2000); Santoro and Gopalakrishnan (2000); Carayol (2003); Monjon and Waelbroeck (2003); Inzelt (2004); Etzkowitz and Klofsten (2005); Eun, Lee and Wu (2006); Leydesdorff (2006); Ahmad, Junaid (2008); Etzkowitz (2008); Cao, Zhao and Chen (2009); Ponomariov and Boardman (2010); Bruneel et al. (2010) and

others should be mentioned, as in their publications and research results interpretations the levels of collaboration, responsibility, roles and commitments can be identified. Nevertheless, in the research works by Lithuanian authors these aspects are rarely found (e.g., Maurusaitiene (2007) analyzes interaction between vocational training and science, where specific levels of collaboration are emphasized).

Research subject: levels of science-business collaboration, roles and responsibilities of participants.

Research aim: having analyzed the levels of science-business collaboration, to identify the roles and limits of responsibilities of participants in theoretical aspect.

Research objectives:

1. to review levels of science-business collaboration,
2. to analyze different roles of participants (sectors) of the process of collaboration in this interaction,
3. to identify commitments and limits of responsibilities of science and business.

Research methods: analysis and systemization of literature on management, sociology, economy, public policy, psychology by using methods of classification, simplification, and interpretation.

Levels of science-business collaboration

Science-business relationship is constantly changing, because it is determined by many factors, therefore it is necessary to identify various levels of interaction, especially bearing in mind that the process of collaboration as a continual interaction. Accordingly, it is discussed in this article about the higher level of interaction, namely collaboration between different sectors. Having summarized researches by different authors, Inzelt (2004) claims that collaboration can occur at different levels, i.e., individual, group, institution, sector and national level, whilst its forms may be "intra-forms" or "inter-forms". Sometimes, however, levels of collaboration cannot be classified accurately since a certain form may be ascribed to both an intra- and inter-category. This article details respective levels of science-business collaboration, without paying much attention to macro- and mega-levels. Classification of levels of collaboration, which is given in Figure 1, has been made with reference to levels of interaction as described in the article by Maurusaitiene (2007) as well as to conclusions and insights of other researchers. Therefore it is possible to distinguish the following levels of process of science-business collaboration: micro-, meso-, macro-, echo-, and mega- levels (see Figure 1).

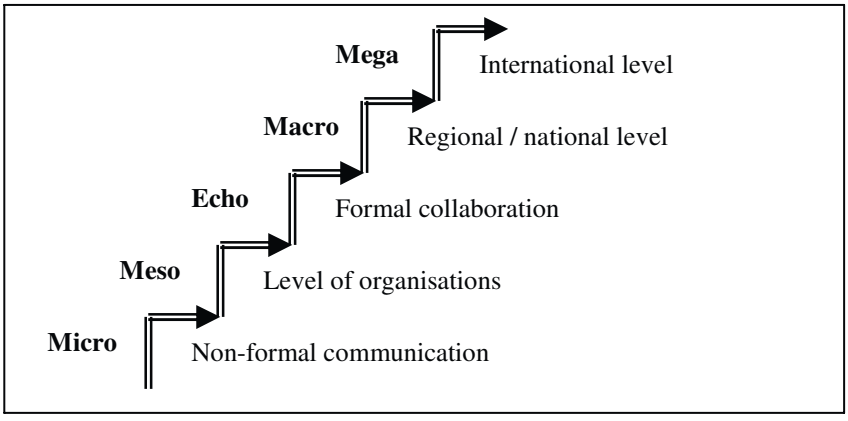

Fig. 1. Levels of science-business interaction (collaboration)
Source: made by the authors of the paper with reference to Maurusaitiene (2007).

On microlevel science-business interaction encompasses individual collaboration between representatives of different sectors. It must be noted that in this case very important is direct and indirect communication between persons as well as reciprocal trust. This becomes a starting point of each level of collaboration (Inzelt, 2004) and an impulse to exchange knowledge in the process of innovations (Schartinger *et al*., 2002). On individual level of science-industry interaction there are *ad hoc* consultations of company employees at universities, lectures of company employees at universities, lectures of faculty members, regular (informal) discussions between faculty members and company employees at conferences, seminars, meetings of professional associations, and purchasing of results of university research (patents) on *ad hoc* basis (Inzelt, 2004). According to the latter author, such an interaction can be considered to be rather isolated.

On mesolevel the real collaboration between universities and industrial companies begins. In this interaction Schartinger et al. (2002) see significance

of personal and non-personal communication. Meanwhile having summarized the publications by many scientists, Kitagawa (2009) emphasizes experience of organizational learning and knowledge management in cooperation between universities and industrial companies.

But interaction, let alone collaboration, will not necessarily manifest only when people meet. According to Melin (2000), cited from Ponomariov and Boardman (2010), at first the interested parties have to clarify the mutual interests. Although many interaction subjects and interested parties carry out activities on the same geographical plane, their activities are not of the same type. According to Inzelt (2004), through direct interaction business companies and scientific institutions ensure that lecturers are employed as regular consultants at business companies, that university researchers or lecturers teach and instruct company employees, that joint publications by university teachers and company employees are prepared, that members of university and companies jointly act as advisers for doctoral dissertations and master theses, that shared intellectual property rights of university professors and company employees are protected.

On echolevel of science-business sectors interaction the following forms of collaboration can be distinguished: possibility to use special equipment belonging to company or university and research results; investment into university infrastructure; formal collaboration in the field of R&D, e.g., contractual research or joint research projects, knowledge dissemination through continuous or temporary mobility from universities to companies or by establishing new spin-offs (Inzelt, 2004). The latter two forms of interactions between institutions and persons are of unique character.

On macrolevel the education and "business systems interaction manifests in formation of strategies and policy" (Maurusaitiene, 2007), e.g., participation in discussions when deliberating issues of program, sector, or national level (Shapiro, 2007); creating "technology areas" at regions or establishing national-level "Modern Research Fund" (Daujotis et al., 2006). To this level can also be assigned scientific research centres at the U.S. universities, which have been analysed in the article by Ponomariov and Boardman (2010). These authors consider the programmes of these universities to be the hallmark of policy of science and technologies of national and regional levels of developed countries. Various programmes and mechanisms envisaged in them are aimed at ensuring interaction and collaboration between different institutions and sectors.

We support the view of Hennemann, Rybskib, Liefnera (2010) that National research policies seem to interfere with supra-national measures, at least in case of the EU. The intrinsic motivation of international collaboration in the scientific arena is opposing national policies that remain within the countries' borders (Wagner, 2002). More and more countries, including Germany, are pursuing the establishment of clusters of excellence in recent years to increase the competitive state of their science-base.

Besides, according to van Geenhuizen (2010) the national innovation system needs also to be mentioned, as it influences for example how science and technology policy, particular public R&D spending, is organized, and how entrepreneurship and knowledge valorization are valued in society […], nowadays national regulation partly originates from European Union regulation (Rathenau Institute, 2009).

On megalevel, which is regarded as international, global level (e.g., on EU level), there are obvious differences among policies and priorities of individual states, which later determine other differences as well, e.g., differences in structure of investments aimed at innovative activity and so on (Melnikas, Jakubavicius, Strazdas, 2000).

Hennemann, Rybskib, Liefnera (2010) maintain that scientific knowledge creation is a socio-economically desired process to improve the pool of available technologies, techniques and methods that eventually lead to innovation and create economic progress, i.e. welfare. Policy is highly motivated to integrate research teams to reduce costs, to pool ideas from heterogeneous research environments. One source of motivation is to be found in research policy itself, another one stems from equalization policy ambitions. While the former can be found in almost all countries, the latter is unique to supranational organizations like the European Union. Policies to promote science and technology (S&T) can potentially lead into opposing directions in terms of collaboration distance. [...] Today, up to 20% of national S&T budgets are attributed to international science activities (Wagner, 2002). At the same time national funds are trying to out-compete research organizations from other countries to preserve or improve the competitive advantage and prestige of their own organizations. [...] Especially the European Union (EU) pays very much attention on collaboration and on international joint projects at the same time (Hennemann, Rybskib, Liefnera, 2010).

Examples from the US National Science Foundation (NSF), according to Hennemann, Rybskib, Liefnera (2010), show that international research collaboration is also encouraged by funding opportunities through a large pool of counterpart science funding agencies (cp. NSF Office of International Science & Engineering OISE). Summarizing the insights of other researchers, the latter authors maintain that

today, international collaborations with US research organizations are steadily increasing and are most common for researchers world-wide, and examples from China show the implementation of measures to support international joint projects with EU partners in the context of the 973 Program1 and by the Ministry of Science and Technology (Hennemann, Rybskib, Liefnera, 2010).

Science-business collaboration problems on mega level are the subject of the book *Responsible Partnering* (in German: Verantwortungspartnerschaften) by European Union interest groups EIRMA (European Industrial Research Management Association), EUA (European University Association), EARTO (European Association of Research and Technology Organisations), PROTON (knowledge transfer centres network). The aim of this book is to improve the organization, management, and efficiency of strategic transfer of knowledge in partnership with companies and organizations. The book offers recommendations for managers of research institutions, directors of companies and must help them to generate, transfer, and apply knowledge in public and private sectors (Responsible Partnering, 2009, 6).

To summarize we can say that input of universities and science into economic growth and national and regional systems of innovations is very important (Kitagawa, 2009). This achievement is possible when knowledge transfer mechanisms successfully operate on local, national and international levels.

Roles of different participants (sectors) of the process of collaboration

As knowledge economy forms, relationships between science, business and governmental sectors change. Due to intensifying commercialization of and changes in academic knowledge the government, industrial sector and academic society absorbs the roles of each other. Until now, the boundaries of these roles were "very clear" (Mali, 2006) and collaboration was static, with no clear interaction between subjects (Mets, 2009). The new interaction between universities, industry and government was termed by Leydesdorff (2006) and Etzkowitz (2008) the triple helix that is understood as structure of concurrent spheres and forms of "hybrid" organisations (see Fig. 2). The appearance of the triple helix (interaction between university, industry, and government) is identified by Etzkowitz and Klofsten (2005) with the main factor of regional development, i.e., collaboration of university, industry, and government in establishing companies in result of academic research (Etzkowitz, Klofsten, 2005). As abilities to commercialize the results of interdisciplinary scientific research improve, there appear more opportunities to efficiently use these knowledge resources.

The mentioned triple helix model (Etzkowitz, Klofsten, 2005) comprises three basic elements. *First*, it presumes a more prominent role for the university in innovation, on a par with industry and government in a knowledge-based society. *Second*, there is a movement toward collaborative relationships among the three major institutional spheres in which innovation policy is increasingly an outcome of interaction rather than a prescription from government. *Third*, in addition to fulfilling their traditional functions, each institutional sphere also 'takes the role of the other' operating on a y-axis of their new role as well as an x-axis of their traditional function. An entrepreneurial university, taking some of the traditional roles of industry and government, is the core institution of an Innovating Region (Etzkowitz, Klofsten, 2005).

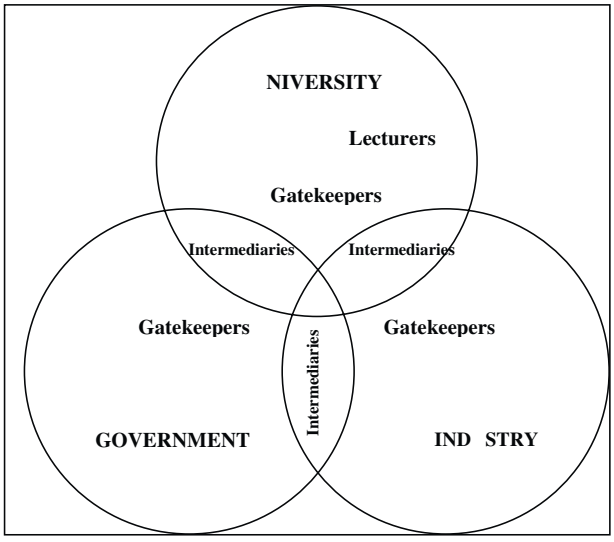

Fig. 2. Structure of the Triple helix

Source: modified by the authors of the paper with reference to Etzkowitz (2008).

Meanwhile Leydesdorff (2006) details the triple helix model by characterizing every sector by the aims: the aim of industry is to generate assets, of academic community – to produce innovations, and the aim of government is public management. The mentioned sectors being involved into joint activity, interaction of bilateral and trilateral relations can be expected. Nevertheless, it must be stated that in the triple helix model very important is active role of the government policy. Therefore, we can say that spheres with distinctly different functions, e. g., academia: basic research; companies: product development should each concentrate on their traditional functions and interact across distinct, strongly defended, boundaries (Etzkowitz, 1998).

The "triple helix" concept recently becomes the manifestation of technologies transfer departments at universities, incubators for supporting technology-oriented companies, and science parks establishment (Schiller, Diez, 2007). Universities were established as long ago as the Middle Ages and in the feudal and industrial society they performed the role of supporters only (Etzkowitz, Klofsten, 2005), but now they become equal to industry and government – the most important institutions of the industrial society – and together with them they solidify the main institutional system of post-industrial, knowledge society.

When continuing the started detailing of the triple helix model, the reliance is on its components that were distinguished by Etzkowitz and Klofsten (2005). *First*, knowledge society admits the more important role of a university (than of industry or government) in the process on innovations. *Second*, a tendency appears to build relationships between the three main institutional sectors when innovation policy more and more often becomes the result of interaction, not the government's instruction. *Third*, without the traditionally performed functions each institutional sector "assumes the role of the other" as well. Therefore by undertaking the traditional roles of industry and government an entrepreneurial university becomes the main institution of an innovative region. Knowledge region is a deliberately created construct in which there are many subjects, including the triple helix of government, industry and university, the engine of which is a "collective entrepreneur". Therefore the differences in motives, activities and organizational cultures among the parties interested in collaboration highlight the organizational and managerial factors that are important in transfer from university to industry (Siegel et al., 2004).

When seeking to describe the role of each of the interested parties of the triple helix, peculiarities of their activities are often analyzed. One of the main differences between a company and a university is that when making decisions at a company economic efficiency is the basis, while at university it is not always so. Analyzing various publications, Eun, Lee and Wu (2006) define the role of a university in society not only by economic logic, but also by "social contract" related to work distribution between different organizations (e.g., universities, public research institutes, industrial companies, etc.). These authors maintain that various forms of management of knowledge industrialization can appear in *two-dimensional space* one axis of which reflects attention to economic efficiency, and the other one – social contract in a certain society. Furthermore, it is assumed that attention to economic efficiency is reflected by choosing management from orientation to *market* and *hierarchy*, and social contract in certain society can evaluate how entrepreneurial the university is. Entrepreneurship of universities of different levels could be classified by different management of universities: "Science university", "Research university", and "Entrepreneurial university". A question arises of how to define the roles of a university (e.g., should a university establish university-managed companies or not); this question is analogous to the question on company limits.

Referring to Sedlacek (2010) who has summarized the conclusions of other researchers, on the one hand universities are sometimes seen as the linking or bridging element between "the state as a single provider of knowledge as a public good, and the corporation as the appropriate institution for the provision of knowledge as a quasi-proprietary good", on the other hand universities are facing increased political pressure to raise research funding from industry and contribute actively to economic development. So, "university roles: Human resource, science findings and technology inventions, spin-offs / start-ups" (Etzkowitz, Zhou, 2007). According to Petrauskaite (2010), the university is also responsible for forming new firms in incubator facilities. To put that simply, in the words of Kitson et al. (2009) "[...] the university's role is bringing people and universities together".

Etzkowitz (2008) also notes that reciprocal interaction between *universities and government*, between *university and industry*, and between *government and industry* increases with assuming respective **roles**. Although identity of each institution is maintained, the collaboration with other sectors just makes it stronger. Therefore at incubators a **university** teaches the organizations, and at lecture halls – the persons. Additionally, when a university is engaged in technology transfer, it becomes a type of development of a new product, which is called the traditional function of industry. Academic mission of entrepreneurship is integrated with teaching and research. When a

university assumes the role of an entrepreneur, it naturally becomes closer to industry, especially if there is no large geographical distance between institutional sectors. However, as noted by that author, not everybody agree that a university should take the role of an entrepreneur. Many academicians are of opinion that a university carries out its mission best by teaching and doing research, and thus avoiding broader role in economic and social development. Agreeably to this view, a university carries out the third mission best through the first two in the first place. But even the scientists holding the most sceptical view towards commercialization of knowledge are increasingly more interested in practical application of scientific research (Etzkowitz, 2008).

According to Bramwell and Wolfe (2008), in the regional context universities can be seen as multifaceted economic subjects, not only creating non-expressed knowledge and human capital, but also acting as important institutions. Their activities encompass local networks creation and development and knowledge dissemination by connecting these networks to worldwide networks. Florida (1999), Betts and Lee (2005) emphasize that it is important to discover and retain current talents who are important factor of dynamics of growth of regional economy (Bramwell, Wolfe, 2008).

Furthermore, according to Noseleit, Slavtchev (2010), "in a more systemic view of regional innovation, Graf (2010) shows that universities, through their pronounced degree of interregional linkages, may absorb globally generated knowledge and circulate it regionally, thereby reducing the risk of regional technological lock-in (Grabher 1993; Bathelt et al. 2004). The new technological knowledge and opportunities may create new technological pathways that cause new industries to emerge and to grow".

Meanwhile the role of universities in the regional innovation process depends on the local economic structure and on the strengths of the university in question. Richard Lester, the MIT industrial innovation specialist, has argued that there are four types of local economic evolution that can be influenced by university-business interactions (Kitson et al., 2009):

- New industry formation;
- Industry transplantation;
- Diversification into technologically-related industries;
- Upgrading of existing industries.

Thus, universities and other knowledge producing institutions play a new role in society, not only in training students and conducting research, but also in making efforts in seeing that knowledge and human capital is effectively put to use (Etzkowitz, 2004).

In the previously mentioned recommendations book *Responsible Partnering* (in German: Verantwortungspartnerschaften) (2009) it is emphasized that in interaction of science-business collaboration higher schools through their activities and research serve the public interest, therefore they are expected to take the role of knowledge imparters. Consequently the academic institutions feel pressure to strengthen their independence towards application in the first place. They must prove that knowledge can be used widely and managed in professional way.

The new role of universities is also emphasized by Cao, Zhao and Chen (2009). They maintain that universities have understood their commercial role and are important participants in many science and technology parks despite their limited influence on innovations and entrepreneurship. The greater part of academic transfer of technologies is not the commercialization of research products, but rather the transfer of personnel from academic to business sector. Hershberg, Nabeshima and Yusuf (2007) agree with this by claiming that in science-business interaction the role of a university is to teach the employees of industrial companies. Because links between universities and industrial companies are very weak, there are attempts to strengthen them through contractual research and consultations. In addition, it must be noted that universities ensure other mechanisms of knowledge transfer that are also important (Bramwell, Wolfe, 2008). *First*, they generate and attract talented people who contribute both to evaluation of non-expressed knowledge in local economy and to stratification of local labour market. *Second*, besides doing fundamental research, universities also formally and informally, by specialized competence and equipment support companies the activities of which are based on the R&D work in progress. *Third*, universities act as a channel enabling companies to access "global pipes" of international academic knowledge research networks. Finally, without isolating themselves from the community in an "ivory tower", they can act as "good members of society", i.e., support establishment and growth of companies by facilitating exchange of the non-expressed knowledge through networks of innovative companies.

Generalizing the statements of other authors as well, Monjon and Waelbroeck (2003) note that universities have *two different roles*: propose new ideas and help to finish the projects that are in progress. *Lecturers* have an important role in commercializing the academic research. According to Cao, Zhao and Chen (2009), involvement of lecturers takes place together with disclosure of research, and application of licences – together with working under licences in further development of activities. Faculty employees

who specialize in fundamental research may not reveal new ideas, because they do not want to do applied R&D activities that are often necessary for business so that it is interested in obtaining licences for university inventions. Another case can be that university employees may not understand the commercial potential of their ideas. We have to note that scientists often do not reveal their inventions because they do not want to risk by postponing publications in the process of patenting and licensing. Spin-offs founded by enterprising members or students of the faculty also licence the intellectual property of the university, commercialize inventions that are often helped by incubators, risk capital funds or funding from own capital (by covering all expenses on establishment of companies), and business support systems founded by universities. Such policy together with commercial orientation of university research and its intellectual heights explains why some universities generate more spin-offs than others. Additional incentives must attract faculty members to commercialize important inventions, including royalties and capital. Distribution of royalties among inventors and university can also impact establishment of spin-offs at the faculty so that university inventions are used.

Although some academics and industrialists wish the university to return to its traditional role of training students and publishing research findings, [...] academics would prefer to return to an era when federal support was sufficient to meet the needs of their research enterprise, few see this as a realistic possibility. The conflicts are no longer about whether the university should pursue knowledge for profit, but over the shape that organisational innovations to accommodate industry connections will take (Etzkowitz, 1998).

The authors of the article could not find many roles analyzed as widely as university role is discussed, which reflect responsibility of ***industrial companies*** in science-business interaction. Yet certain peculiarities of roles will be highlighted in this article. In the opinion of Santoro and Chakrabarti (2002), larger, more mechanistic companies (especially in resource-intensive industries) use knowledge transfer and research support relationships to develop competence in the technology areas that are not the main ones. On the contrary, small companies, particularly in the sector of high technologies industry, pay more attention to the main technology areas through technology transfer and cooperated research. In another publication Santoro and Gopalakrishnan (2000) maintain that university research centres have access to intellectual resources and infrastructure of world-class fundamental research, and industrial companies usually have practical experience, financial resources, possibilities for placements for students as well as to employ university graduates and students. Therefore, looking from business perspective, the main contribution from industrial companies to this interaction is to create and help maintain the infrastructure for collaboration and to fund scientific research programmes of mutual interest (Lovrek, Kos, Mikac, 2003).

The companies the aim of which is to be innovators or early adopters on the market prepare their strategy of collaboration with the university after reflecting upon current and future knowledge (Bekkers, Bodas Freitas, 2008). One strategy is more oriented towards research based on collaboration and agreements by encouraging absorption of interrelated knowledge, another is more dependent on patents, licences, and specific organized activities to increase the possibility to access and absorb the systemic knowledge. In both cases, when companies need to adapt the published scientific knowledge for specific needs of their products and market, they also need to rely on the scientific publications, informal contacts with university researchers and students (Bekkers, Bodas Freitas, 2008).

Therefore, to summarize we can state with reference to Etzkowitz, Zhou (2007) that industry's roles are goods, tax, R&D investment, venture capital. When detailing roles of industry it must be noted, according to Petrauskaite (2010), that "industry, in this case, is responsible for economic production and trade. Its main goal in expansion of high technologies is to absorb university-generated knowledge for improvement of technological productivity. Technological productivity is associated with the science-intensity of patents (Leydesdorff, Meyer, 2007). A firm can enhance its absorptive capacity by training its personnel, by carrying out R&D, and by using advanced manufacturing equipment (Schiller, Diez, 2007)" (Petrauskaite, 2010).

At the same time it can be said that industry usually acts as a knowledge recipient, and universities or other science and research institutions act as knowledge holders, therefore to realize these roles it is necessary for both the holder of knowledge and the recipient to have certain qualities which facilitate the knowledge exchange between them. First of all, according to Delfmann, Koster (2010), knowledge holders must be willing to share their knowledge. Usually it is within the power of the knowledge holder to regulate the amount and quality of the knowledge they share. Secondly, knowledge recipients must have sufficient absorptive capacity and must be open to new influences that are potentially capable of increasing their efficiency (Cowan et al., 2000). This role classification is not static; the holder can become the recipient, just like the recipient can become the knowledge holder (Delfmann, Koster, 2010).

To conclude this chapter, it is necessary to discuss the role of one more participant (sector) of the process of collaboration: it is not possible to develop a university-industry relation without considering the role of government. According to Brouwers, van Duivenboden and Thaens (2009), "more and more government acts as public entrepreneur and venture capitalist in addition to its traditional regulatory role of setting the rules of the game (Etzkowitz, 2005)".

With reference to van Geenhuizen (2010) local/regional authorities may – in a collaborative effort – connect their thematic interests with the ones at university and other higher educational institutes in a broader context of cluster formation, in such a way that there is sufficient alignment of themes and activities. This role of *connector* also involves bringing together other main players in valorisation in the region, particularly larger firms. A few municipalities/regional authorities are already quite experienced and successful in this role in the Netherlands (like the region of Eindhoven); for most municipalities/regional authorities, however, the role is new and often highly complicated due to the involvement of more than one large city, a number of (different) universities and higher educational institutes, and a large diversity of themes that are difficult to connect (Geenhuizen, 2010). The latter author also states that municipalities/regional authorities could also act more actively as an *initiator* of new policy tools, particularly new financial incentives in responding to the need for easy access to venture capital (later stages of technology-based spin-offs) (Geenhuizen, 2010). Therefore, as noted by Etzkowitz (2004), government programs have an important role to play, not only from the national level – top down – but also from the regional and local level – bottom-up. When top down policies meet bottom-up initiatives in cooperating in these efforts, that is perhaps the most dynamic and fruitful result. In Brazil, after the failure of science parks, university initiatives to establish incubators were supported by national, regional and local governments as well as industrial associations" (Etzkowitz, 2004). It follows that "government's roles: funding, policies and laws, information networks" (Etzkowitz, Zhou, 2007).

To elaborate on the roles of this participant, the authors of the article referred to Etzkowitz (2008), so the author concludes that this encouragement can be manifested in the following means (Etzkowitz, 2008):

1. Establishment of a legitimate authority within a territory is extended from the public sphere to the private sector, promoting stability and reducing uncertainty in interaction (e.g. government guarantees are given to private capital so that with such insurance it may take greater risks in investing in new ventures);
2. Levying of taxes to support protection of the nation and promotion of the general welfare is extended by using the tax system in a targeted fashion to provide special incentives and benefits;
3. Establishment of rules to support the economic life including laws to charter firms and foundations and to regulate the conduct of markets and currency systems (e.g. new (hybrid public-private) agencies are established to promote innovation);
4. Use of a legal system to establish special rights such as patents or temporary monopolies to promote innovation;
5. Provision of basic research funding to establish a linear model of innovation (e.g. provision of public venture capital to create an assisted linear model of innovation).

To summarise, we can bring in Petrauskaite (2010), who maintains that the government supports development of high technologies through funding programs and changes in the regulatory environment.

Another important aspect of participants of science-business interaction and their roles is possible ***advocates of such interaction***. Summarizing researches by many authors, Ahmad, Junaid (2008) state that such persons perform the main role in partnership, because they understand the character of differences between university and industry as well as have insight into how one has to work at these essentially different environments. The advocates demonstrate the ability to stimulate the appearance of mutual communication, make additional efforts for long-term relationships. An advocate is a leader of the team who is rather skilled, very experienced in working in both sectors, attractive, arousing interest and having a strong will to overcome challenges. An advocate is able to stimulate the appearance of relationship. Talking about participants of the process of collaboration it is also necessary to mention one more role: that of ***intermediaries***. It must be noted that as intermediaries can be seen various knowledge and technology transfer institutions and other establishments. According to Hofer (2006), many universities have centralized technology transfer institutions related to science-industry collaboration. Most of them offer the following services: intermediation relations, support for industry and university scientists when setting up joint projects. Depending on the size of these institutions and specialization of the university, technology transfer institutions may offer additional

services, e.g., patents, licences, and consultations on entrepreneurship issues. As state funding decreases scientists urge to reduce the central university personnel and cut bureaucracy. At the same time universities and their central service departments (including technology transfer institutions) attempt to centralize information about current and potential partners in collaboration seeking to rationalize efforts for professional collaboration and to boost funding from the third party (industry). Nevertheless, because in this article important are only science-business collaboration levels, therefore, despite involvement of advocates, intermediaries or government, the emphasis is on the two participants most widely analyzed in this article: science/universities and business/industry. Concluding this chapter it must be said that it is necessary to briefly introduce the commitments of the main participants as drawing of limits of responsibility, although it is possible to claim that responsibility, in part, becomes apparent through disclosure of roles of participants as well. For this reason in the following chapter we will only briefly review the mentioned aspects that are related to roles of individual participants of the process in collaboration.

Commitments of business and science and limits of responsibility

Continuing the discussion on commitments and responsibility that accompany collaboration it must be noted that "these relationships involve different levels of commitment financial and otherwise by industrial sponsors, including the involvement of industrial sponsors in problem selection and research collaboration. Conversely, the level of commitment required of a university and its faculty in the commercialisation of research varies in intensity according to the mechanism selected […] each concentrates on their traditional functions and interact across distinct, strongly defended, boundaries" (Etzkowitz, 1998).

Santoro (2000) notices that industrial companies and universities may collaborate maintaining various links: by communicating formally and informally, by funding various activities, by lending resources and by committing to each other. Although at first the subjects gather for collective actions, this usually does not yield a collective result. The subjects may be reluctant *to commit* to each other, and sometimes it happens so that joint efforts and integral nature of projects become scattered. According to Klijn and Teisman (2003), results can be achieved only after responsibilities have been clearly separated, when subjects of both parties (as a rule, public and private) focus on their tasks. This determines the organized contracts-based collaboration, but not partnership.

Bruneel, D'Este, Salter (2010) also note that many university departments have connections with industrial companies, therefore the latter could commit to university more and follow many of its rules and procedures, by informally communicating with university teachers the representatives of the companies could discuss the education-related issues (e.g., students' placements), communicate with university administration closer (rather than, for example, only with university research services departments through joint research projects).

As to commitments, Etzkowitz (1998), summarizing researches by other authors proposes that science-business relations can encompass levels of industrial commitment (financial and other), including involvement of industry into problem solving and cooperation in the area of scientific research. And vice versa: the level of commitment of a university or its faculty to commercialize research depends on the selected mechanism of collaboration. Sufficiently detailed business commitments and their explication are given in the Table 1.

Often the collaboration itself and hence the commitments and responsibility are formalized. In agreements between business and research institutions the responsibility is split taking into account current institutional fragmentation in both private and public sectors. Such agreements, according to Klijn and Teisman (2003), are a known, tried, and proven method of management of public-private relationship. Furthermore, agreements reduce risk and opportunism. Yet in practice different rules that are more appropriate for the specific situation are often followed.

Summarizing the opinions of other authors (Geisler, 1995; Azaroff, 1982), Santoro (2000) says that highly intensive industry-university relations are characterized by high level personal interaction and resources allocated by industrial companies. Because in more intensive collaboration more resources are allocated and personal interaction of higher level appears, an assumption can be made that because of this tangible results of higher level should be produced. The latter author claims that industrial companies will intensify relations with universities only when they see that in the past these relations have been successful in creating next generation knowledge and technologies. A strong reciprocal relationship between intensity of relations and tangible results demonstrates that gradual interaction exists. This gradual interaction has influence on what role each party plays in technological changes.

Table 1

Logical explanation of commitments on business side

Commitments	Business rationale
Commitment one Sponsor students studying business relevant subjects (such as STEM)	To encourage young people to study the subjects that business values.
Commitment two Provide financial support to new graduate recruits (through sign-on bonuses to reduce student loans, for example)	Young people should not be deterred from acquiring a degree by the prospect of accumulating debt. Sign-on bonuses would help with finances and send a signal to graduates that business values their abilities.
Commitment three Commit time and resources to participating in degree programme advisory boards	Greater business involvement in programme advisory boards will help improve the business relevance of courses, and build on the successful example of Foundation degrees where businesses and universities have worked together to design degree courses.
Commitment four Provide work experience opportunities for students at the pre-university stage, as well as during and after university	Offering placements through organisations such as The Year in Industry would develop young people's employability skills at an early stage and give them a better understanding of the world of work.
Commitment five Offer more internship or placement opportunities	Short-term internships give young people opportunities to shadow staff and gain some knowledge of the workplace. Longer-term sandwich placements – of six months to a year – allow students to work on real projects and can be a useful recruitment tool.
Commitment six Give students access to real-life projects or resources during their time in HE	This will build the development of practical skills and is often a feature of MBA programmes and should be extended to more undergraduate degrees. Such partnerships will help students relate their knowledge to a work-based environment.
Commitment seven Offer students jobs at the end of their penultimate year of study	Graduates would enter employment more 'job ready' and could receive a partial salary in their final year of study to support their finances.
Commitment eight Business to develop relationships with universities and explain what type of skills they need to develop for their workforce	Universities can be important providers of workforce training. The CBI-UUK Stepping Higher report on developing workforce provision showed that while universities had to be more responsive to employers' requirements, business also needed to take a lead in developing these relationships.
Commitment nine Working with universities as a core part of their innovation activity	Evidence strongly suggests that the most innovative companies find their work with universities helps them to boost their competitive advantage, but the UK continues to lag behind some of its European neighbours in the overall proportion of businesses engaged in innovation-related links with universities.
Commitment 10 Working with public funders to plan research projects that meet business needs	Collaborating with research funders will help in planning projects which better meet business needs, and help equip young researchers with skills which business will value.

Source: Stronger together: Businesses..., 2009.

Although, according to Quetglas and Grau (2002), university teachers/researchers are stimulated to participate in professional activities outside the university, the *duty* of every member of the faculty is to ensure that such additional activities do not interfere with a university's commitment to teach, carry out research and provide public services. And university's responsibility is to ensure that its relations to private industries do not interfere with relations between lecturers and students. Faculty members can allow themselves no professional activities outside university or outside interests, which would negatively affect responsibility to students of them as lecturers and research advisers.

To conclude, it should be mentioned that all parties of collaboration not only have clear roles that often overlap, which requires flexible reaction to various circumstances and situations, but also these roles, in certain sense, define responsibility of those participants, hence also the commitments that in each case can be elaborated on various aspects.

Conclusions

Analysis of science-business interaction being completed, we can distinguish several levels of collaboration: micro-, meso-, echo-, macro-, and mega-le-

vels. Each level is characterized by different intensity of relations and character of communication.

Important roles of university, lecturers, interaction advocates, intermediary institutions, industrial companies, and government in science-business interaction have been identified. The new interaction between universities, industry, and government is reflected in the triple helix that is understood as structure of concurrent spheres and forms of "hybrid" organisations. The appearance of the triple helix is identified with the main factor of regional development, i.e., collaboration of university, industry, and government in adapting results of academic research to companies.

Each of the interested parties of the process of collaboration assumes appropriate responsibility and commits itself to seek satisfaction of interests of all the parties. The results can be achieved only after responsibilities have been clearly separated, when subjects of both parties (as a rule, public and private) focus on their tasks. In agreements between business and research institutions the responsibility is divided taking into account current institutional fragmentation in both private and public sectors.

A strong reciprocal relationship between intensity of relations and tangible results demonstrates that there is gradual interaction that has influence on roles of each participant of the process of collaboration that are played in changes in knowledge and technologies.

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Mokslo ir verslo bendradarbiavimo lygmenys ir dalyvių vaidmenys: teorinis aspektas

Santrauka

Mokslo ir verslo sąveika, kuri laikoma žinių ir technologijų perdavimo instrumentu, ryšys tarp mokslinių tyrimų, aukštųjų technologijų ir ekonominio augimo, vis dažniau tampa viešųjų diskusijų objektu. Mokslo institucijoms priskiriamas ne tik tradicinis mokslą ir tyrimus vykdančios institucijos vaidmuo. Jos raginamos imtis „trečiosios“ misijos, kurios tikslas – intensyvinti bendradarbiavimą tarp mokslo ir verslo. Bendradarbiavimo tarp mokslo ir verslo konceptas šiame straipsnyje suprantamas kaip nuolatinis sąveikos tarp mokslo ir verslo procesas siekiant bendrų tikslų, kurį sudaro tam tikras turinys ir organizavimo elementai. Vieni esminių bendradarbiavimo proceso organizavimo elementų yra bendradarbiavimo lygmenys ir to proceso dalyvių vaidmenys bei atsakomybė.

Mokslinę straipsnio **problemą** galima nusakyti taip: nors teorijoje išskiriami bendradarbiavimo tarp mokslo ir verslo lygmenys, lygmenų klasifikavimas, tuo labiau, kad atskirų bendradarbiavimo formų priskyrimas lygmenims yra sudėtingas procesas. Taip atsitinka todėl, kad nėra aiškių ribų tarp atskirų bendradarbiavimo lygmenų formų: atitinkamą formą galima priskirti tiek vidinės, tiek tarpasmeninės sąveikos kategorijai. Teoriniu požiūriu pasidaro tikslinga bendradarbiavimo proceso lygmenis struktūrizuoti pagal dalyvių vaidmenų modelius, numatant atitinkamas dalyvių atsakomybės ribas.

Tyrimo objektas – mokslo ir verslo bendradarbiavimo lygmenys, dalyvių vaidmenys ir atsakomybė.

Straipsnio tikslas – išanalizavus mokslo ir verslo bendradarbiavimo lygmenis bei identifikuoti dalyvių vaidmenis ir atsakomybės ribas teoriniu aspektu.

Straipsnyje apžvelgiami mokslo ir verslo bendradarbiavimo lygiai; išanalizuoti skirtingi bendradarbiavimo proceso dalyvių (sektorių) vaidmenys mokslo ir verslo sąveikoje; nustatyti mokslo ir verslo įsipareigojimai ir atsakomybės ribos. Nagrinėjama ir susisteminama vadybinė, sociologinė, ekonominė, viešosios politikos, psichologinė literatūra taikant klasifikavimo, simplifikavimo, interpretavimo metodus.

Įvertinus įvairius požiūrius pirmojoje straipsnio dalyje išskirti šie bendradarbiavimo tarp *mokslo ir verslo proceso lygmenys*: mikro-, mezo-, echo-, makro- ir megalygmuo. Bendradrabiavimo mikrolygmuo atskleidžia tiesioginės ir netiesioginės komunikacijos tarp asmenų bei pasitikėjimo svarbą: individualus bendradarbiavimas tampa kiekvieno aukštesnio bendradarbiavimo lygio atspirties tašku. Straipsnyje aprašytas mezolygmuo išskiriamas kaip „tikrasis“ mokslo ir verslo bendradarbiavimo lygmuo, apimantis nuolatines abiem interakcijos dalyviams priimtinas bendradarbiavimo formas: bendras mokslininkų ir verslininku publikacijas, mokslininkų darbą įmonėse, bendrus projektus ir tyrimus. Literatūros analizė rodo, kad echolygmeniui būdingos šios bendradarbiavimo formos: galimybė naudotis specialia įmonei arba universitetui priklausančia įranga ir tyrimų rezultatais; investicijos į universiteto infrastruktūrą, formalus bendradarbiavimas MTTP srityje. Strateginei mokslo ir verslo partnerystei svarbūs du straipsnyje išskirti bendradarbiavimo lygmenys: mezo- ir echolygmuo.

Antrojoje straipsnio dalyje pateikiamas naujas požiūris į mokslo ir verslo bendradarbiavimo proceso dalyvių vaidmenis. Naujoji sąveika tarp universitetų, pramonės ir valdžios apibrėžiama remiantis „trigubos spiralės“ konceptu, kuris suvokiamas kaip sutampančių sferų struktūra ir „hibridinių“ organizacijų formos. Be mokslo ir verslo sąveikos „trigubos spiralės“ modelyje akcentuojamas ir valdžios vaidmuo. Sąveika tarp *universitetų ir valdžios*, tarp *universiteto ir pramonės*, tarp *valdžios ir pramonės* straipsnyje išryškinama aprašant suinteresuotųjų šalių vaidmenis. „Trigubos spiralės“ modelis leidžia išryškinti naujus sąveikos aspektus: svarbesnį universiteto vaidmenį inovacijų

procese; inovacijos suvokiamos kaip sąveikos rezultatas; akcentuojamas pasikeitimas vaidmenimis tarp institucinių sektorių. Apibendrinant skirtingas įžvalgas universiteto vaidmuo sąveikos procese suprantamas kaip universiteto tarnavimas visuomenės interesams perduodant žinias ir pritaikant jas konkretiems visuomenės poreikiams. Pramonės vaidmuo sąveikoje išlieka labiau tradicinis – kurti ir padėti išlaikyti tyrimams skirtą infrastruktūrą bei finansuoti abipusio intereso mokslinių tyrimų programas. Dėmesys straipsnyje skiriamas valdžios institucijų bei tarpininkų institucijų vaidmeniui.

Trečiojoje straipsnio dalyje aptariami mokslo ir verslo bendradarbiavimo įsipareigojimai. Teigiama, kad įsipareigojimai priklauso nuo pasirinktų bendradarbiavimo formų. Išanalizavus literatūrą daroma išvada, kad labai intensyvūs pramonės ir universiteto santykiai pasižymi aukšto lygio asmenine sąveika ir ištekliais, kuriuos skiria pramonės įmonės. Rezultatų galima pasiekti tik aiškiai atskyrus atsakomybę, kai abiejų šalių (dažniausia – viešosios ir privačios) subjektai susitelkia į savo užduotis. Sutartyse tarp verslo ir mokslo įstaigų atsakomybė paskirstoma atsižvelgiant į esamą institucinę fragmentaciją tiek viešajame, tiek privačiame sektoriuje. Stiprus abipusis ryšys tarp santykių intensyvumo ir apčiuopiamų rezultatų rodo, kad egzistuoja laipsninė sąveika, kuri turi įtakos kiekvieno bendradarbiavimo proceso dalyvio vaidmenims, kurie sąlygoja pokyčius žinių ir technologijų srityje.

Bendradarbiavimas gali vykti skirtingais lygiais, t. y. individualiu, grupiniu, instituciniu, sektoriaus ir nacionaliniu lygiu, o jo formos gali būti vidinės (intra-) ir tarpasmeninės (inter-). Visos bendradarbiavimo tarp mokslo ir verslo formos yra būtinos sąveikai sukurti, tačiau realiausias bendradarbiavimas vyksta mezo- ir echolygmenyse. Nustatyti reikšmingi universiteto, dėstytojų, sąveikos šalininkų, tarpinių institucijų, pramonės įmonių ir valdžios vaidmenys sąveikaujant mokslui ir verslui. Naujoji sąveika tarp universitetų, pramonės ir valdžios atsispindi „trigubos spiralės“ modelyje (angl. *Triple helix*), kuri suvokiama kaip sutampančių sferų struktūra ir „hibridinių“ organizacijų formos. „Trigubos spiralės“ atsiradimas tapatinamas su pagrindiniu regioninio vystymosi veiksniu, t. y. universiteto, pramonės ir valdžios bendradarbiavimu pritaikant įmonėms akademinių tyrimų rezultatus. Kiekviena suinteresuotų bendradarbiavimo proceso šalių prisiima tam tikrą atsakomybę ir įsipareigoja siekti visų šalių interesų patenkinimo. Rezultatų galima pasiekti tik aiškiai atskyrus atsakomybę, kai abiejų šalių (dažniausia – viešos ir privačios) subjektai sutelkia dėmesį į savo užduotis. Sutartyse tarp verslo ir mokslo įstaigų atsakomybė paskirstoma atsižvelgiant į esamą institucinę fragmentaciją tiek viešajame, tiek privačiame sektoriuje. Stiprus abipusis ryšys tarp santykių intensyvumo ir apčiuopiamų rezultatų rodo, kad egzistuoja laipsninė sąveika, kuri turi įtakos kiekvieno bendradarbiavimo proceso dalyvio vaidmenims, kurie lemia pokyčius žinių ir technologijų srityje.

Pagrindiniai žodžiai: verslo ir mokslo bendradarbiavimas, bendradarbiavimo lygiai, universitetas, kompanija, valstybinės įstaigos, įsipareigojimai, atsakomybė.

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