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Geographic and Technological Pattern of Knowledge Spilloversas Evidenced by Technical Universities in CEE Countries

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Along with the process of the EU enlargement came a possibility to use cohesion funds for building knowledge infrastructure in the CEE states and stimulating localized knowledge spillovers, especially on the part of universities. This included establishment of supporting innovation infrastructure (scientific parks, scientific incubators) and intermediaries (mostly TTOs or R&D services), which focused on building ties with industry. The aim of this research is to analyze the existing patterns affecting knowledge spillovers from technical universities in the selected CEE countries. The latter couldn't be achieved without using qualitative methods of research. Therefore the major method of this research is the qualitative survey research based on interviews with Heads of R&D departments at selected technical universities in the CEE countries. The research findings indicate the importance of interaction and complementarity between local and distant sources of knowledge. Furthermore, the role of local knowledge sourcing (home universities and other R&D institutions within the region) seems to be determined by the type of knowledge itself and may vary from one scientific field to another. For example, the local sourcing of knowledge in the fields such as IT and chemistry is particularly important for space engineering research; electronics, telecommunications, computer hardware and software for communication research or biochemistry, pharmacology, agriculture and IT for biotechnology research.

Keywords: *knowledge spillovers, universities, R&D networks, innovation system, university-industry collaboration.*

Introduction

The role of universities has evolved over the last decades. Where once largely focused on teaching and research, universities are adopting a third role - recursive and re-shaping regional economic development (Etzkowitz & Leydesdorff, 1999). The role of universities in the development of regional innovation system (RIS) can be categorized based on the triple helix model and the literature on university engagement. The triple helix model sharpened the focus on the role of universities in regional economies, pointing to the anticipation of hybrid university, industry, government relationships that involved the multiplication of resources and capital formation projects, e.g. science parks and firm formation in incubator facilities (Etzkowitz, 2002, p. 14). The interaction between universities and industry are considered to be an important channel of potential localised knowledge transfer and spillovers. Whereas the approach of an 'engaged university' is broader and goes beyond issues connected with setting up firms and the direct impact on economic growth. This, as Gunasekara (2006) describes, is the "regionally focused teaching and research, not necessarily linked to capital formation projects. It stresses the significance of the capability of the university to attune to the region's needs and the willingness to cooperate with the environment.

Most of the knowledge produced by the "engaged universities" may flow and spillover to local economy by means of university-industry knowledge transfer involving knowledge capitalization and other research collaboration (university spin-offs, mobility of university graduates) as well as shaping regional social and industry networking. Murray (2004) argued that academic inventors bring not only their technological knowledge, but also their social capital contacts, which enable the companies to build networks with other scientists and research laboratories. This was also shown in the study of (Formahl *et al.*, 2005), which emphasized the role of graduates in knowledge dissemination in more informal way, e.g. through the public meetings, conferences, consulting or information exchange. Most of the empirical studies find the evidence of positive impact of universities on localised knowledge spillovers (LKS) (Almeida & Kogut, 1997; Saxenian, 1994). Their results showed that firms are more likely to quote research from a co-localized university that conducts relevant research than from similar universities located elsewhere. Despite the importance of university-industry knowledge flows for the local knowledge diffusion, the empirical studies of this phenomenon remain very limited in the EU context and almost non-existent in regards to CEE. (Anselin *et al.*, 1997) and, more recently, (Greunz, 2003) tested a sample of EU-15[1] Member States regions and suggested the following: the patenting activity in European regions depends on both local business and university R&D efforts. Relatively more studies consider sector based approach. (Grimpe & Patuelli, 2011), proved that both universities and private R&D are relevant for nanomaterial patenting in interactive way. They suggested that, from

[1] *EU15 Member States include - Austria, Belgium, Luxembourg, Denmark, France, Germany, Ireland, Italy, The Netherlands, Spain, Portugal, Greece, Sweden, Finland, and the United Kingdom. They joined prior to 2004*

2000 to 2004, co-located R&D provided opportunities for knowledge spillovers and collaboration between the actors in the relevant German regions. (Olechnicka, 2012) when analyzing regional potential of Polish science concluded that co-operation of industry with universities has local character compared to the cooperation of industry with other non-academic actors. The results by (Bajmoczy & Lukovics, 2009) showed that the presence of universities in 1998 and 2004 in Hungarian regions did not increase knowledge transfers and its exploitation to the local business sector. Furthermore, study findings by (Runiewicz Wardyn, 2013) on a broad sample of EU-25[2] Member States regions suggests that geographical clustering matters for successful university-industry collaboration, and more generally for knowledge transfer in high-tech fields. The results also supported the idea that high-tech innovations require integrating intra- (local) and extra (European) regional R&D efforts. However, the results turned out to be a significant but negative function of knowledge spillovers from geographical neighbours. The latter may indicate little synergistic gains in exchanging knowledge (too much overlapping or too different technological skills) among them. The estimated results of the role of the academic sector (share of students of tertiary education programs) in high-tech patenting turned out to be insignificant. This outcome is quite surprising and is not in line with the evidence provided by a number of studies on smaller sample of the US and the EU regions (Anselin *et al*., 1997; Bania *et al*., 1993; Baptista, 2001; Adams, 2002; Trajtenberg *et al*., 1997; Ponds *et al.,* 2010). All the same, the above mentioned study results could only capture the general trend for the high-tech fields in the EU and the US regions and didn't explain the different patterns of knowledge spillovers from universities in these regions. The latter couldn't be achieved without using qualitative methods of research.

The main object of this research is a study of university knowledge spillovers based on the experience of selected sample of technical universities in CEE countries. The special emphasis is given to the source of university R&D funding, major channels of knowledge diffusion, types of knowledge, the spatial dimension of knowledge spillovers and R&D networks.

The aim of this research is to test empirically the geographic and technological patterns of knowledge spillovers in technical universities in CEE countries.

The methods of this research include the analysis of scientific literature and bibliometric indicators, and a qualitative survey research based on interviews with Heads of the R&D departments of technical universities in CEE countries. The paper limits itself to the CEE as the region including Baltic States (Estonia, Latvia and Lithuania), Poland, Czech Republic, Slovakia, Hungary and Slovenia. The CEE countries have recently observed systemic transition that affected their innovation systems: the transformation of their innovation systems; administrative decentralization; and the increasing role of clustering and universities in LKS, especially in knowledge intensive sectors. Furthermore, their just evolving regional innovation strategies and high-tech clusters have been shaped by the advanced regional integration process going on in the EU, internalisation of productive systems and improving ICT infrastructures. Increasing understanding of the nature of local academic knowledge spillovers provides an important empirical support for both the innovation policies in these countries and theoretical discussion in the field of "innovation systems" and "new economic geography".

The paper is organized as follows. The first section reviews the innovation systems of the CEE countries from historical perspective. The second section presents comparisons of university-industry inter-linkages in CEE countries based on selected bibliometric indicators. The interview results with the selected Heads of R&D departments in high-tech fields are examined in the third section of the paper. The paper is ended by a set of important conclusions.

Innovation Systems of the CEE Countries Considered from Historical Perspective

In general, the CEE countries inherited quite large R&D systems and have good R&D capacities in terms of university and laboratory infrastructure (Radosevic & Auriol, 1999). The major focus was on military and space research, while other fields - like IT, biotechnologies - were neglected. Basic research was carried out in the institutes of Academy of Sciences and their role was not primarily focused on collaboration with industry. The major focus of universities was teaching, whereas the collaboration with industry was facing many organizational and administrative constrains (Gal & Ptacek, 2010). As a result applied research was limited and concentrated mostly in technical universities and the R&D capacities were not directly related to the needs of the local productive capacities. Because of a considerable brain-drain of scientific personnel, who moved to other spheres of activity, bigger metropolitan areas or other countries, knowledge stock available in regions and necessary for the generation of innovation has been significantly reduced (Nesvetailov & Artyukhin, 1995). As a result, the role of capital cities represents the highest potential for RIS. For example, 77 per cent of research personnel in Hungary are located in the Budapest region (Radosevic, 2000). In addition, the lack of knowledge networking and spillovers at the regional level hindered the remedying of the shortage of knowledge by potential intra or extra-regional sources of R&D.

In the 90s. universities were mostly facing the pressure of the state to increase their educational role. The collaboration with industry was still limited. Both universities and R&D institutes of Academies of Sciences were still in lack of managerial, organisational, institutional and financial limitations of research commercialisation (Gal & Ptacek, 2010). In better cases more efficient scientists were running private businesses using "state" equipment and were one of the key persons enabling knowledge spillover from universities into industry. Furthermore, the process of transition increased centralization at the territorial level and limited self-government to the municipal level (Gorzelak, 1996).

[22] *EU25 refers to all present EU Member States excluding Bulgaria and Romania.*

Along with the EU enlargement process and possibility to use cohesion funds for building of knowledge infrastructure CEE states elaborated their national and regional innovation strategies considering an active approach from the side of universities. The latter included establishing of supporting innovation infrastructure (scientific parks, scientific incubators), intermediaries (mostly TTOs or R&D services) which focused on building of ties with industry. The latter had created a critical mass for tacit and codified knowledge transfers activities and embraced the main elements of the RIS framework.

University-Industry Collaboration and R&D Networks in CEE countries

The progress has been also observed by European Innovation Scoreboard (EIS), that provides a comparative assessment of innovation performance along with the relative strengths and weaknesses of the CEE countries research and their innovation systems. According to the benchmarking results in 2011 and 2007 some CEE countries - Cyprus, Estonia and Slovenia – advanced from the "moderate innovators' to the group described as 'innovation followers' along with the UK, Austria, Belgium, France, Ireland, Luxembourg and Netherlands. All showing a performance close to that of the EU average. These countries share a number of strengths in their national research and innovation systems with a key role of business activity and public-private collaboration, which suggests good linkages between the science base and enterprises. Another group of CEE countries include 'Moderate innovators', whose innovative performance is below that of the EU average include Czech Republic, Malta, Poland Hungary Slovakia along with Greece, Italy, Portugal, and Spain. This is an advancement for Poland, Malta and Slovakia, which were qualified as "moderate innovators" in 2007. Whereas Lithuania, Latvia, Bulgaria and Romania haven`t changed their rank since 2007 and are still qualified as the "modest innovators", whose performance is still well below that of the EU average (*European Innovation Scoreboard 2011 and 2007*).

However, comparisons of university-industry inter-linkages in CEE based on bibliometric indicators such as Innovation Union Scoreboard 2011 (IUS) show that specialization patterns of university-industry collaboration – joint R&D projects resulted in co-publications is rather weak. Almost all CEE countries have public-private scientific co-publications rate below the EU average (100) (except for Slovenia). Slovenia is the only country in the region acceding EU average (141), followed by Czech Republic, Hungary and Estonia. Poland along with some smaller countries such as Malta, Lithuania and Latvia takes the lowest position in this indicator. However, when the dynamic analysis is considered in 2004–2008 Cyprus, Lithuania, Slovakia Estonia and Czech Republic were leaders and achieved the highest dynamics in number of public-private scientific co-publications, 14,7 %, 9,4 %, 8,9 %, 8,4 % and 7,4 % respectively.

The relative comparison of university performance in terms of their intensity of university-industry collaboration is presented in Leiden University Ranking 2011/2012 containing the ranking of 222 best universities across Europe. The best CEE performing universities among CEE countries include two Hungarian universities: Eotvos Lorand University and University of Szeged taking 26 and 67 position, Czech university: Charles University in Prague on 87 position); Slovenian university - University of Ljubljana on 194 place and three Polish universities - University of Warsaw, Jagiellonian University in Krakow and Adam Mickiewicz University (93, 117 and 220 positions respectively (www.leidenranking.com/ ranking.aspx). Generally, it shows that the role of universities in CEE countries is weaker than in more developed countries of the EU. Only few metropolitan and capital areas (Budapest, Warsaw, Prague, Ljubljana) possess the "critical mass" to absorb university generated knowledge spillovers.

Along with the enlargement European research policies focused on building R&D networks around EU have become more formalised and, therefore, possible to track due to the EU funded Framework Programs (FP). Ten new CEE member states of EU have been associated to the FP since FP6 and another two since FP7. Their ability to obtain FP funding has varied Participants from CEE tended to have a 'follower' role in FP6 projects (they had few network initiators or coordinators in FP6 but more in FP7). The statistics on FP7 suggest that the 'performance' of most of the new Member States (NMS) falls short of that of the old Member States (EU15). Two types of problems can be identified with the NMS participation in FP7 so far. First, the overall share of NMS participants in all projects is low. This probably stems from the smaller number of world-class research institutions in these countries than in the EU15. Second, the funding of successful projects per participant to NMS countries is lower than for EU15 countries. For example, in biotechnology only 8 % of partners are from NMS, they receive only 5 % of the budget. Lower cost levels can account for some of the difference, but not all of it. The success rates for applicants from Estonia, Latvia and Czech Republic are comparatively high better than for Portugal, Luxembourg or Italy among the EU15, but for the other NMS Member States are disappointingly low (*Interim Evaluation of the 7th Framework Programme*, Report of the Expert Group Final Report 12 November 2010).

University Based Knowledge Spillovers in High-tech Fields. The Interview Results

To understand the complex system of university based knowledge spillovers in the CEE regions the author conducted 20 in-depth interviews with Heads of R&D units (usually Doctors or Professors) in the selected CEE technical universities according to their highest performance in their respective scientific fields (Aerospace, Biotechnology, Communication technologies, Computers, Semiconductors and Lasers). Interviews were conducted in September – October 2011 by personal contact, email and phone call. The purpose of the interviewing was to answer the following questions: What is the role of geographical space in knowledge spillovers and R&D networks? To what extent are engineers in a high-technology disciplines sourcing and diffusing knowledge through seminar and conferences events, collaboration with the business sector or social networks with researchers? What is the attitude of researchers towards the open science and research results sharing?

The criteria for the selection of the case studies that were used for the research project was mainly geographic since this group of regions has the biggest shortages in the empirical literature. Even though, the case study selection attempted to get an equal amount of examples from each CEE country, some CEE regions turned up to be represented more extensively, because of their higher patent performance in several high-tech disciplines. The brief results of the cross sectional survey study of the R&D units in the selected CEE universities are presented in Figures 1–5. The survey questionnaire consisted of five sections denoted as A, B, C, D and E.

The first section (A) contained the general information about the respondent (names, scientific title), their S&T field as well as their major source of R&D funding. The second section (B) aimed to capture the main channels of knowledge diffusion (Seminars, conferences, workshops, collaboration with business sector, publishing activity, patents and informal (face to face) contact). The third section (C) covered questions related to geographically and technologically mediated knowledge spillovers, such as the significance of intra-(local), inter-extra- (European) and global source of knowledge and asks about the type of knowledge: technological, market related, managerial and other. Technological knowledge refers to all kinds of technical information, specifications and know-how necessary to create and produce a product. Innovation and the exchange of technological knowledge are of utmost importance. Market knowledge refers to information on future market developments, potential customers and demand, which is crucial for firms to create and sell their products. The fourth section (D) assessed the participation of the respondent in an R&D unit/lab in the knowledge and technological networks within the home institution and in the home region institutions, other institutions within its national boundaries, other institutions in the EU and also in other countries. Finally, the fifth section (E) treated the issues related to secrecy in university research, such as access and sharing the research results or materials (software, genetic sequences, data) with the other scientists. The brief overview of the survey results for each technological field is discussed below.

The R&D Funding and Major Channels of Knowledge Diffusion

The results for the entire sample of respondents showed that government, university and industry/business were the major sources of R&D funding in their respective order (Figure 1). In terms of *space* and *aviation* fields the Heads of R&D units considered public funds (including EU funding) as dominant ones in financing R&D activity. In the view of the field experts, for the space engineering R&D activity, the major knowledge diffusion channel was through publishing and informal (face to face) contacts, whereas in the field of aviation, the experts mentioned that collaboration with business along with workshops related activities were the major forms of knowledge diffusion.

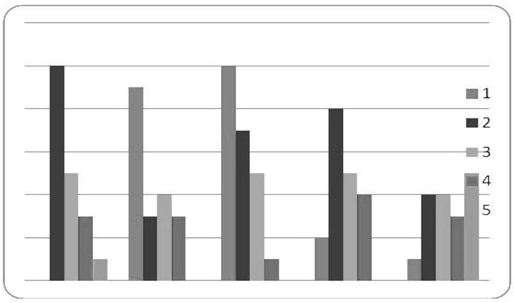

Figure 1. Major source of R&D funding (scale of significance from 1 to 5, where 1 - very significant and 5 - least significant)
Source: based on the author`s interview survey.

Similarly, the major source of financing of *biotechnology* related R&D activities were public funds, with the major portion of biotechnology research conducted in the university labs. Industry financing of R&D in biotechnology labs was dominant only in the case of Transdanubian region (Biotechnology Innovation Cluster).

All the questioned R&D departments representatives in *computer and communication industries* have had their R&D activity financed by the public, EU (in telecommunication field) and private business/industry. In terms of major forms of knowledge diffusion in the field of communication, collaboration with the business sector (both formal and informal) and publishing activity respectively were the most important ones. Because the communication field is not a single technological domain but an aggregation of electronics, telecommunications, computer hardware and software, internet-based contents, applications and services, innovation may to a great extent stem from the combination or integration of different pieces of knowledge residing in various sources spaced out across sectors and industry segments.

Finally, the R&D financing was one of the biggest challenges in *semiconductor* and *laser* technology industries, since such activities require huge capital investments. In both fields public sector was responsible for the bulk of R&D funding for the selected R&D units, followed by industry private R&D and EU funds.

Seminars, conferences and workshops along with the publishing activity, informal contacts and collaboration with the business sector were the most common channels of knowledge diffusion in the broad group of selected R&D departments (Figure 2).

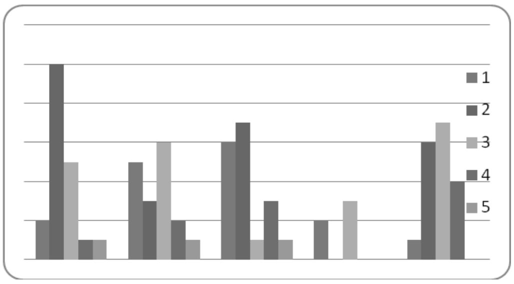

Figure 2. Most common forms of knowledge diffusion (scale of significance from 1 to 5, where 1 - very significant and 5 - least significant)
Source: based on the author`s interview survey

The technological convergence in the biotechnology-pharmaceutical industry and that fact that *biotechnology* relies very much on basic research, signify the growing importance of university-business R&D partnerships as one of the knowledge diffusion channels. The social networking and informal contacts seem to be a more important process at the beginning the R&D collaboration, as it allows for building credibility between potential partners, but does not always lead to common research projects.

According to the respondents from *computer* related R&D departments social networks and informal contacts between engineers in private firms and university researchers serve as a channel of sharing knowledge about market characteristics and innovation opportunities. Many of such meetings serve as a platform to exchange views and opinions with regards to the major developments taking place in the industry and the Internet, the technology and the Internet in the society, its major challenges, etc. Publishing, collaboration with the business sector and informal face to face contacts were the most common modes of knowledge diffusion in the s*emiconductor* and *laser* technology fields.

Geographically and Technologically Mediated Knowledge Spillovers

All interviewed scientists considered local knowledge to be significant. Roughly, for 85 % of respondents local institutions, companies and social networks were considered to be the major source of technological knowledge (Figure 3).

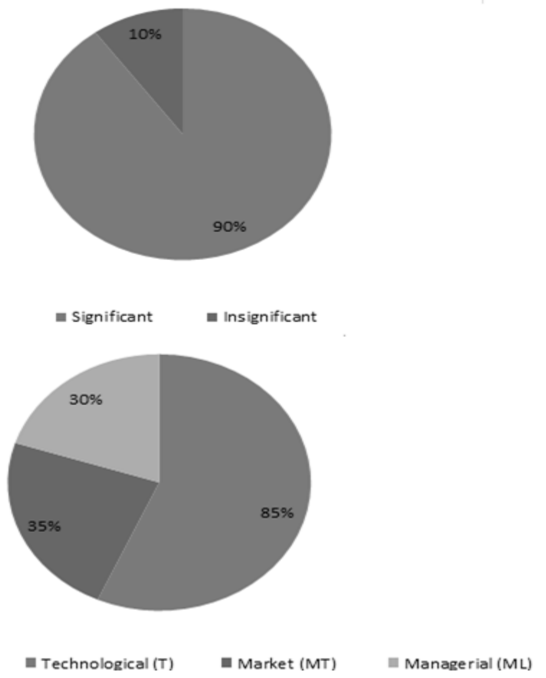

Figure 3. Significance of local (intra-regional) source of knowledge by type of knowledge
Source: based on the author`s interview survey

The exceptions were the *space* and *aviation* research related R&D departments for which both local and global sources of technological and scientific knowledge were of great importance. In collaborative relationships with the industry, the interviewed R&D units exchanged technological knowledge together with market and managerial knowledge. The latter could be explained by a complex nature of the innovation processes in aviation field and their stronger relationship with the business sector, which requires access to diverse knowledge.

For the *biotechnology* R&D units, local technological knowledge was found to be a major source of knowledge spillovers. Additionally, market and managerial types of knowledge turned out to be equally important, for those R&D labs located near biotech clusters.

As for the *communication* and *computer* related R&D activities, both local (companies and R&D institutions), extra-regional (European) and global technological and scientific knowledge flows were important for all the interviewed respondents (Figure 4). This is especially true for the tacit (informal) nature of technical and scientific knowledge. The exception was Tallinn University of Technology (TUT), who considered inter-regional knowledge flows as important source of R&D. TUT caries out contract research for large multinationals like Nokia and smaller companies like Fincitec in Finland that provide the university with relevant technological knowledge.

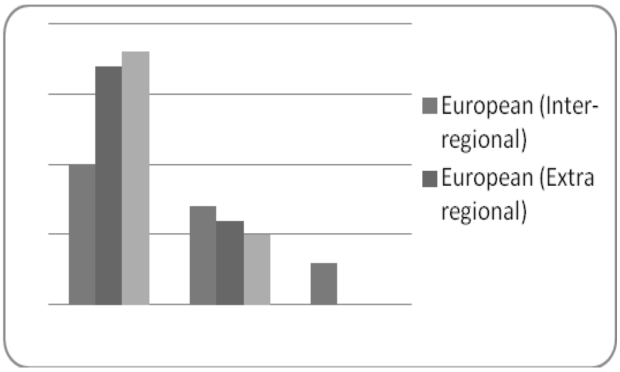

Figure 4. Geographically and technologically mediated knowledge spillovers
Source: based on the author`s interview survey

Furthermore, in the case of *computer* science R&D activities, interviewed experts considered that market and managerial knowledge had a more local character, while the technological knowledge came from elsewhere (inter- or extra-regional regional sources). One of the ways to explain it is that the computer industry's innovation activities rely more on synthetic (based on customers' views) rather than an analytic knowledge (research) therefore, the research intensive environment may not be relevant for this field.

In the opinion of the field experts technical knowledge in the *semiconductor* clusters is highly localised, mostly around the universities, whereas the market and managerial knowledge has a more global character. This is because the semiconductor industry requires highly technical knowledge covering range of disciplines, including physics, chemistry, material science, etc. Meanwhile, the interviews showed that the extra-regional (European) and global knowledge flows were the major knowledge sourcing for the R&D unit focusing on laser technologies. This is because the rapid development of the science-based field of laser technology and its applications, have an impact on a vast number of other industries worldwide and on medicine in particular[3].

The R&D networks and knowledge sharing

In terms of knowledge networking all the Heads of R&D departments emphasised their local character (with some exceptions to *space engineering* and *aviation fields)*. For these respondents home university and home region R&D institutions were the major sources of R&D networks. The importance of home regions for the knowledge spillovers in high-tech fields was also emphasized in the studies of Greunz (2003) and Fischer *et al.,* (2009). Since the demand for R&D services in *space engineering* and *aviation* comes primarily from public bodies the presence of the other national and EU based R&D institutions is more common in the R&D and knowledge networks (Figure 5). The interviewed R&D units have started only recently their precipitation in the EU funded R&D projects, resulting from 6 and 7 FP (2002–2006 and 2003 and 2007 respectively), e.g. such as AERA-Pro Project, ECARE and ECARE+.

In terms of R&D collaborations and knowledge networking in the *biotechnology* and *communications* fields, home region and nationally based R&D institutions and business entities seem to play a more significant role than EU institutions. The latter confirms the general features of a strong spatial concentration of the *biotechnology* industry. The EU ERA-NET based R&D funding only played a secondary role. In contrary, the R&D units conducting research in *computer* science related field considered other non-national EU R&D institutions to be the major partners in R&D collaboration and networking.

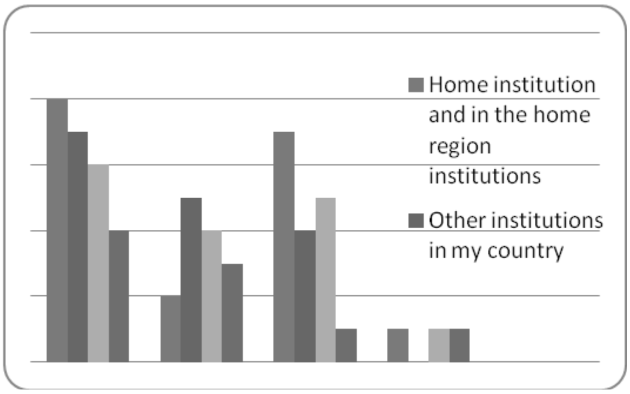

Figure 5. Significance of knowledge and R&D networks (scale of significance from 1 to 5, where 1 - very significant and 5 - least significant)
Source: based on the author`s interview survey

While the home university is clearly an important source of knowledge spillovers in the *semiconductor* field, collaboratively aligning with other universities in the country and research networks with the EU was also critical. Finally, the huge capital investments that are necessary for *laser* technologies R&D activities, make European-funded projects some of the major technological platforms and mechanisms for knowledge networking.

The last question in the interview survey concerned the secrecy in university research. When asked if they have requested from or denied other scientists any research results or materials most of respondents said no. It is only in the field of *biotechnology* where Heads of R&D units emphasised the importance of IP protection and secrecy in the undergoing R&D projects and suggested, that all the results are to be published, prior to be discussed in public or in an informal way.

Conclusions

The university-industry R&D collaboration in CEE universities is rather limited. It suggests that despite almost two decades of the transition of their innovation systems CEE regions have not yet developed the endogenous power to generate business-university-industry interactions. As a result their knowledge flows within their innovation systems are conditional on public R&D support. Therefore, the government is expected to play a more important role in coordinating innovation processes within their RISs, e.g. by establishing innovation centres, business incubators, S&T parks, etc. The importance of these mechanisms is likely to vary with the industry and each S&T field.

The geographical dimension plays an important role in the process of creation and diffusion of technological knowledge. The process of innovation requires interaction and complementarity between local and distant sources of knowledge. Universities act as platforms for local knowledge network creation; however, in more complex technologies and rapid technological advances, it is essential to promote access to complementary resources of knowledge through technology collaboration networks. The success of the integration of technological knowledge inflowing from elsewhere depends on the network structure among socio-economic agents within the home regions and locations. It spreads more rapidly in major cities and large agglomerations.

Furthermore, the interview results suggest that the role of local knowledge sourcing (home universities and other R&D institutions within the region) seems to be determined by the type of knowledge itself and may vary from one scientific field to another. The local knowledge sourcing is particularly important in the scientific fields relying on the R&D related activities in other related industries, such as for example IT and chemistry for space engineering research; electronics, telecommunications, computer hardware and software for communication research; biochemistry, pharmacology, agriculture and IT for biotechnology research. The need for sharing the experience of scientists in these multiple scientific areas partially explains the importance of formal and informal (face to face) contacts in the knowledge networks of the home region. This is not, however, universally true, since in the case of laser science, technological knowledge sourcing was embedded mostly in the international knowledge networks. One could generalise that for technological advancement in the home region not only local, national or the EU, but knowledge linkages at

[3] *Bertolotti (2005) refers to lasers as one of the most important scientific inventions of the 20th century, with a great variety of applications that include range finding and transmission and storage of information, material processing, printing, medical technology*

multiple spatial scales are important and appear to be of simultaneous. While these results may be accused of generalisation and of being limited by the boundaries of the researchers' personal experience, they reflect the nature of the knowledge spillovers in CEE universities.

List of interviewees

Prof. Jozsef Rohacs (Budapest University of Technology and Economics), Dr. Daniel Hanus, (Czech Technical University in Prague), Prof. Romana Sliwa (Rzeszow University of Technology), Prof. Vladimir Marik (Czech Technical University), Prof. Juri Vain (Talin Technical University), Dr. Janos Levendovszky (Budapest University of Technology and Economics), Prof. Indrikis Muiznieks (University of Latvia), Prof. Mr. Karoly Marialigeti (Eotvos Lorand University), Prof. George Szekeres (Pecs Industrial Park), Prof. dr hab. Wanda Dobryszycka (Wroclaw Medical University), prof. dr hab. Grażyna Lewandowicz (Poznan University of Life Science), Prof. dr hab. Krzysztof Staron (Warsaw University), Prof. Eerik Lossmann (Tallin University of Technology), prof. Jozef Lubacz (Warsaw Technical University), Prof. Szczepanski Stanislaw (Gdansk Technical University), Prof. Enn Mellikov (Tallinn University of Technology), Prof. Desire Dauphin Rasolomampionona (Warsaw University of technology), Prof Zbigniew Lisik (Lodz technology University), Prof. Krzysztof Kubiak (Rzeszow University of Technology), Prof. Rimantas Kanapenas (Vilnius Laser Technology Center).

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