IMPROVING TECHNOLOGY TRANSFER EFFECTIVENESS OF UNIVERSITY RESEARCH RESULTS

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Abstract. Research universities worldwide play a leading role in the development of socio-economic dynamic and competitive. The paper aims at establishing priority shift to increase the technology transfer effectiveness of university research results in Romania. Technology transfer materializes the relationship between science and industry and is primarily concerned with the application of research results in economics. The study examines the progress made in USA and European countries towards more effective relations between universities and industries in the field of scientific and technological research and pays particular attention to the technology transfer offices, as an essential node in the transfer network of the research results from university to industry. The study also presents the effectiveness of university research in Romania and proposes a list of measures to improve it. The methodology of the study consists on a systematic analysis of the results and approaching ways of technology transfer from university to economy, based on scientific studies, official reports and universities' sites. The paper results can be a reference for university in order to improve the process of technology transfer through a policy-driven approach and systematic actions.

Keywords: university research, research results, technology transfer, technology transfer office

1. Introduction

All over the world research universities play a leading role in the development of socio-economic dynamic and competitive environment. The impact of university research on society is linked to exploitation of research results, which is realized in multiple forms and can be grouped into two categories: 1) traditional way of recovery through scientific publications and the skills of graduates; 2) direct transfer of research results to the economy and society, known as technology transfer [1].

The trend in recent decades is the emphasis on direct participation of universities in solving society problems through technology transfer, and the paper refers to this topic.

Technology transfer materializes the relationship between science and industry and is primarily concerned with the application of research in economics. Applications can be diverse, technical, social, organizational, but most studies aimed at technical innovation, completed by making new and improved products and technologies. The collocation "technology transfer" (TT) defines the process of transfer of knowledge, rules and methods by which results of the technical and scientific activities are available of users, to develop new products and services, processes, applications and materials. In recent years the collocation „Knowledge transfer" (KT) is increasingly used: it is a wider concept than "technology transfer", which includes other transfer channels, such as mobility of staff or publications [2].

TT process is complex and includes design activities and experimentation of new products and technologies, intellectual property protection, market research and commercialization of the new solutions. The commercialization can be done through contract research or transfer of the exploitation rights (licensing of patents and know-how) to existing businesses, and the creation of new companies (start-ups and spin-offs).

Universities are under increasing pressure to improve their impact on national wellbeing, with attention primarily to economic growth, job creation, and competitiveness. This paper aims at establishing priority shift to increase the TT effectiveness of university research results in Romania. The study examines the progress made in USA and European countries towards more effective relations between universities and industry in the field of scientific and technological research and pays particular attention to the TT offices as an essential node in the transfer network of the research results from university to industry. The study also presents the situation in Romania and proposes a list of measures to improve the connections university research-society, from the perspective of the university.

The methodology of the study consists on a systematic analysis of the results and approaching ways of TT from university to economy, based on scientific studies, official reports and universities' sites.

2. Current state of exploitation of university research results in the U.S. and European Union

Recent studies, using various indicators, suggest an intensification of the knowledge transfer

or technology transfer interactions between universities and industry over time. The manner of making technological transfer and results vary from one country to another and from one university to another. Some aspects of TT in the United States of America (USA) and Europe are presented below.

Although the inclusion of research within universities' mission has its genesis in Europe [3], the first significant results in exploitation of university research results were recorded in the USA. During recent decades, American research universities have become increasingly involved in various TT activities by establishing technology business incubators, technology parks and venture capital funds for start-up companies, university research foundations, and technology licensing offices. This trend toward what is called "academic capitalism" is also illustrated by an increase in the number of university-based research centres, and by the tendency for some universities to retain partial ownership in the start-up companies spinning out of university research [4].

Regulatory reforms in the US in the early 1980s, such as the Bayh-Dole Act, have significantly increased the contribution of scientific institutions to innovation. After Bayh-Dole, universities increased their involvement in managing patenting and licensing, setting up internal TT offices to manage licensure of university patents. Organizations have been established to monitor the results of research, for example the Association of University Technology Managers (AUTM), which has surveyed American universities on their formal knowledge transfer activities since 1993 and published annual data. The analysis report in 2012 indicates that universities and research institute licensing and start-up activity remain very strong: institutions responding to the survey reported $36.8 billion in net product sales from licensed technologies in fiscal year 2012, 14,224 new patent applications filed, 5,145 issued U.S. patents; 5,130 licenses executed, 705 start-up companies formed, 15,741 full-time employees in the start-up companies etc. [5].

The previous presentation illustrates the emphasis in the USA on indicators that measure the impact of academic research on society: the number of licenses applied, licensing incomes, and the number of new jobs created by the application of research results. The AUTM studies also points an interesting aspect of research in the public sector: it is highly concentrated, so, in the USA, approximately 100 leading universities, out of a total of over 2,500 tertiary education establishments, accounted for 90% of all Federal Government funding of research for the tertiary education sector. Most of these leading universities were also regular participants in the annual AUTM surveys [6, p.75].

Based on Bayh-Dole Act model, other OECD governments, of Western Europe and Japan, have promoted policies that stimulate the exploitation of the results of university research through technology transfer. In order to support and develop the links between the worlds of science and industry, professional Technology Transfer Organizations (TTOs) have been created at universities around the globe, and they have received particular attention in Europe. Although some public research organisations have had TT offices for decades, the majority of European TTOs have been established since 1990 [6, p.74].

This trend in new structures development is accompanied by a change in the institutional research policies, designed to encourage the exploitation and subsequent commercialization of scientific discoveries. European universities (and other public research institutes) are now expected not only to be producers of basic knowledge, but the know-how they generate should be better and more quickly transferred into commercial activities.

The need to stimulate technology transfer among universities and industries is recognized by European funding programs, either by explicitly including the joint presence of universities and industries as one of the eligibility criteria for obtaining the funds, or through specific funding schemes aimed at creating long-term partnership between industries and universities. Increasing number of university patents in European countries shows the change in the thinking of scientists and universities behaviour about advanced forms of transfer.

This trend in new structures development is accompanied by a change in the institutional research policies, designed to encourage the exploitation and subsequent commercialization of scientific discoveries. Adopting „Recommendation on the management of intellectual property in knowledge transfer activities and Code of Practice for universities and other public research organisations" [7], in 2008, had an important role in supporting changes in European Union (EU) countries. The results of the recommendations are reviewed every two years.

In accordance with the European KT Policy Surveys in 2010 and 2012 [6], taking all countries, all Recommendation' themes, and considering also

plans for future KT policies, the overall level of implementation in 2012 was on average 53%. There are strong differences between European countries not only in the overall level of the Recommendation implementation; each country has its profile of KT policy. A comparison of European performance with USA public research organizations shows that the latter report significantly more absolute numbers for all indicators, except for start-ups. American public research organizations are more efficient producers of invention disclosures, patent applications and license income: while European public research organizations spend on average € 81.1 million to generate € 1 million in license income, American public research organizations spend only € 24.4 million to generate € 1 million in license income. This indicator shows that American public research organizations are more effective than the European ones, when it comes to commercializing research results. At present, license income provides only a small financial gain to research public organisation in Europe: limited to respondents that reported license income and research expenditures, total license income only accounted for 0.9% of research expenditures by universities.

The functioning of the TT Offices (TTOs) is an important analysed issue at EU level. In this regard a recent Report of the League of European Research Universities (LERU) [8] describes how the functioning of the TTOs from European universities can be successfully embedded, in order to have a significant impact on effective TT operations. The most important proposals refer to: the necessary level of governance autonomy, strategic flexibility and financial autonomy within the TT university structures; appropriate incentive and code-of-conduct schemes for the academic community, stimulating the TT activities and behaviours of the researchers; continuous benchmarking, positioning and comparing its own approaches against the "best available practices" in TT or knowledge transfer etc. In terms of processes, LERU sees potential benefits when the TTO function integrates the front and back-office activities related to the industry-science links. The three TTO core processes - contract and consortium research, patenting and licensing, and spin-off creation - are closely interrelated and therefore deserve to be managed in a coupled manner. Moreover, in the emergent Triple Helix environment (considering the contribution to the innovation of the three institutional spheres - the scientific community, the private sector and public administration) [9], industry-science links often take on the format of joint research activities, thus further stressing the need for explicit transversal arrangements linking TTO staff to local research groups and departments.

3. Technological transfer of university research in Romania

Changes in academic research have been conducted in Romania, especially after becoming EU member. Objectives and change axes were based on the Research & Development and Innovation (RD&I) strategy for 2007-2013 [10], harmonized with European ones. Regarding the TT, the strategy stipulates that universities and public research institutes develop their own structures for capitalizing knowledge and ensuring its transfer in innovative products and services. TT centres and incubators for high-tech companies stimulate knowledge transfer and entrepreneurship. Evaluation of the commercial potential of an idea, protection and licensing of intellectual property rights will be common elements of TT processes.

A brief characterization of the current situation of academic research in Romania is included in the National Strategy for RD&I 2014-2020 (preliminary version) [11], from which we quote: the system of public research&development organizations is highly fragmented, comprising approximately 250 public entities on R&D (universities and other organizations) that cover many sub-domains and scientific niches and generate sometimes redundancy and duplication in the system; institutional assessment processes are not satisfactory, tending to preserve the status quo, including underfunding by dispersing public resources. Romanian articles percentage among the most cited papers internationally has increased, but is below the European average.

Several assessments of the valorisation of research results are presented in the World Bank report on Romania's RD&I sector [12]. The Review suggests that Romania's RD&I sector is in a silent crisis, with seriously negative implications for the country's longer term competitiveness and growth prospects. As a general note, the situation is negative, Romanian level is below the EU average in all indicators. Regarding the TT, report says that several efforts have been made to promote patenting and licensing, emergence of spin-off companies, and the expansion of joint or contract research. Nonetheless, the results of public research remain essentially in academic domains, with little impact on economic development.

Studies on university research, institutional reports and information on university websites reveal a number of causes of TT low efficiency, namely:

- Developing partnerships between the private sector and universities is an overflowing process, and the limited funds are one of barriers, according to experts.
- A relatively small number of universities have developed specialized structures to support the exploitation of research results: intellectual property offices, business incubators, technology transfer centres. The organization and functions assigned to these structures are not in the templates, but generally the created university structures not cover all the activities of the TT process.
- Research universities have made inventions and obtained patents within the research programs public research funded and doctoral projects, but few of them have been completed by real applications (products and services). Increasing the number of patents is considered a positive aspect, but if patents are not enforced, they do not produce economic benefits, but additional charges.

The expenses that Romanian organizations must do to support a patent for a period of five years are shown in Table 1 (in accordance with the current Romanian lows) [13].

Table 1. Costs of issuing and maintaining patents in Romania, in RON

Nr. crt.	Procedure	Fees in normal examination*	
		100%	20%
1	Registration	108.00	21.60
2	Publication-after 18 months	180.00	36.00
3	Substantive examination within 18 months of the payment of the examination fee	108.00	216.00
4	Issuance of the patent	360.00	72.00
5	Subtotal (1+2+3+4)	1728.00	345.60
6	Maintaining within 5 years	1764.00	352.80
7	TOTAL Expenses (5+6)	3492.00	698.40

*"Normal examination" - allows the patent within maximum four years from the filing; for this procedure reduced rates to 20% are applied (Article 10 of Law 381/2005)

An evaluation strategy and market-oriented licensing is essential to avoid a sterile patent process with the high costs that it involves. In this respect, setting the period of patent protection is important: this decision involve a regular analysis of patents' portfolio and gains generated by waiving annuity payments for the patents that can not be commercialized. Du Pont Company, which in 1999 saved $ 64 million by inactive patents cancellation, is only one example [14].

These aspects are related to intellectual property management, but the approach to improve the TT is broader, considering all key processes of the innovation, namely: management and negotiation of contracts, management of intellectual property, new business development and spin-off, assistance in managing business projects, financial management of contracts and licenses, specific human resource management issues related to TT. A synthetic image of these processes and the links between them is shown in Figure 1.

Professional and efficient achievement of these processes requires creating in university an adequate TT management system, which involves:

- Improving TT planning and controlling, which primarily involves the introduction of relevant indicators to measure the impact of research on society (number of patents applied, number of start-up or spin-off, new jobs, economic benefits generated by new products and technologies);
- Establishing clear procedures for staff an students regarding the disclosure of new ideas with potential commercial interest and the sharing of financial returns from TT revenues;
- Enlargement of the autonomy and roles of TT structures, while strengthening links with research centres and the creators involvement in the TT processes;
- Developing TT skills of the researchers and implementing appropriate incentives and assessment tools in order to encourage their involvement in the exploitation of research results;
- Developing contacts with other structures, increasing the visibility and flow of ideas in order to optimize the chances of the two potential partners to identify and develop collaborations. In this regard, a way to improve the promotion of research results is the patents publication on websites of universities.

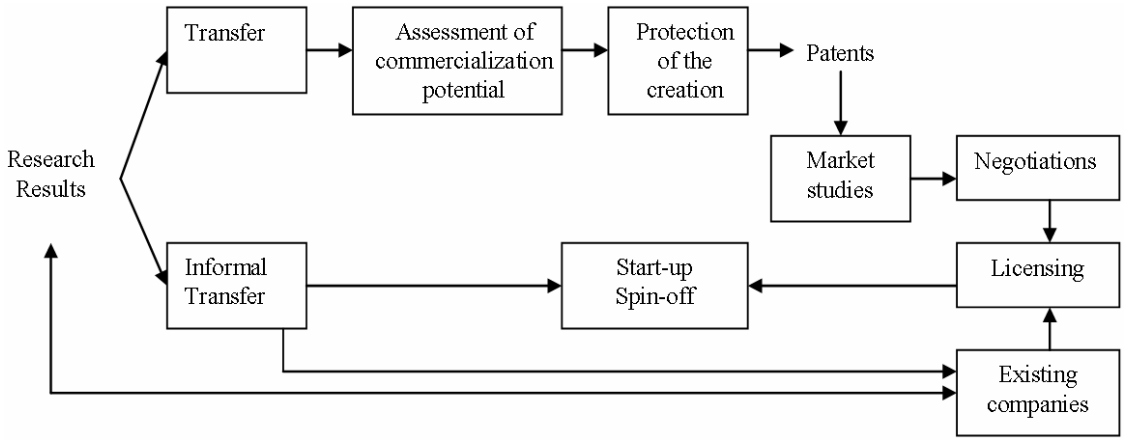

Figure 1. Process of Technology Transfer

The promotion actions at the institutional level are supported by the researchforindustry.ro platform, created within a partnership project, which has two essential components: databases with research laboratories and technology companies from Romania, on the one hand, and on the other hand, examples of success stories are posted, which can be a source of inspiration to motivate researchers to open up to this new world, characterized by dialogue with business partners and technology market capitalization [15].

Finally, it must be said that universities and other public research institutions are a key component of the innovation network, including administration, research organisations and industry, in a "triple helix" concept. The change should be extended on others components of the innovation system. In this respect, the legal framework has an important role, particularly in the field of intellectual property, in the field of tax incentives for research, entrepreneurship and technology investors.

4. Conclusion

Universities have a key role in the economic recovery concerns and competitiveness, both through training processes and scientific research. From the perspective of academic research, an important issue is the best use of the research results through technology transfer.

The paper highlights the complexity of TT concerns to improve the link between university research and industry and the diversity of the solutions adopted in USA and EU on the TT management. It stresses the importance of university TT structures as network nodes of innovation and the principal action axes for improving their effectiveness.

The analysis of the situation from Romania concerning the capitalization of results of university research through TT illustrates the weaknesses in the R&D and innovation system, both at institutional and national levels. In order to improve the effectiveness of the university TT, a set of actions are presented, relating to: TT planning and controlling, regulations on the propriety rights of researchers, the autonomy of the TT structures, skills and staff involvement, collaboration with other institutions and promotion actions. All these processes are interrelated and should be embedded within the university taking into account best practices adapted to the internal context of the university.

The paper can be a reference for universities in improving TT processes through a policy-driven approach and systematic actions. It also indicates the need to introduce relevant indicators for measuring the results of academic research, and regulations to support the implementation of necessary changes in the management system of university research. These themes must be included within national strategies and policies for R&D and Innovation.

The novelty of the study consists in approaching TT in terms of management and defining components of TT management system on process-based approach. The TT processes define the TT management system and its development should be integrated to quality and excellence in university research.

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