

Aspects Regarding the Efficiency of Technology Transfer from the National Research Institutes towards the Industry in order to Accelerate the Development of Romanian Economy

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Abstract: Currently, Romania is faced with problems regarding closing the deep economic gap between it and the rest of the EU members. In addition, Romania is concerned with overcoming the difficulties generated by the current economic crisis. The technology transfer of the research results from the scientific field towards the industry is one of the main leverages for the economic development, the innovation development and the competitiveness of the companies. At this point, Romania marks a very low transfer rate of technology between the research institutions and the economy. This is why, increasing and accelerating this rate becomes a vital element for the Romanian economy. The national research institutes are one of the most representative institutions of the national research and development system. With a high capacity of generating scientific results specific to certain national areas of expertise, their potential of transferring technology should be exploited and made more efficient. This paper presents a synthesis of the written works regarding the technology transfer, its role in the economic growth and the factors influencing its efficiency. The paper performs an analysis the current state of the national research institutes and formulates hypotheses regarding the causes leading to the low technology transfer rate, making suggestions on further research studies on how to turn this important process into a more efficient one.

Keywords: economic growth; innovation; research and development; organizational processes;

JEL Classification: O32, L20, M10

1 Introduction

There is a strong relationship between scientific research and economic growth. The economic development due to the research and innovation activities consists mainly of three stages: (1) performing scientific research in order to produce new

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knowledge that can be transferred in the economy, (2) adapting and transferring these results in the economy market in the form of innovative products and services, (3) disseminating such research and changing the economy behavior of the companies and consumers – who end up accepting and using them when noticing their significant advantage (ANCS, 2009). Thus, the concept of *technology transfer of scientific results* defines a creative concept that generates economic and social value. According to the trends established by the Lisbon Strategy at the EU level, science and technology are seen as key instruments for the economic and social further development. The technology transfer is essential for the increase of company innovation and technological enrichment and it is one of the main economic growth factors at the regional, national and international levels. The efficient deployment of technology transfer brings major benefits to all stakeholders (European Commission, 2007).

The companies that capitalize the values of the research, increase their competitiveness and their competitive advantage. The research entities, as knowledge suppliers, can increase their income and can obtain a higher financial autonomy in order to run their entrepreneurial and research activities. They can also enjoy other collateral advantages, such as attracting sponsored research contracts from certain companies, the possibility to hire and maintain high specialized and top researchers in their staff (Phan and Siegel, 2006).

Yet, turning scientific research results into new products and technologies is a complex, large-scale process, which involves the participation of a high number of stakeholders from the scientific and industrial fields. This process presents several risks and uncertainties with respect to success, it involves many resources and the results are not easily quantifiable. The European Commission Bulletin (2007) regarding the improvement of knowledge from the research institutes towards the industry within the European Union, highlights that it is imperative that an efficient collaboration between the industry and the scientific research must be achieved so that their common goal is the maximizing of the economic and social benefits that an innovative idea could bring (European Commission, 2007).

2 The Role And Importance of Technology Transfer in the National And International Context

The current globalization market trends at the worldwide level, economic crises, the limitation of certain natural resources, creating economic alliances such as the European Union; all these demand the stakeholders to find efficient solutions. Innovative ideas, with a high degree of novelty become in this way essential so that the companies secure a competitive advantage against the competition and maximize their performances.

There are certain theories that explain why the innovation capabilities and technology transfer of a country, region or economic entity heighten the economic growth in general and trade (economic exchange) in particular. Thus, the theory of the product life cycle developed by Raymond Vernon, shows that the main reason for international trades is the technological advantage incorporated in innovations. Because the access to a certain innovative technology incorporated in a product is limited, innovation is spread gradually along the product life cycle, from the innovative country to the imitating one (Hill, 2007).

The theory of technology gap states that international exchange is possible due to the technology gaps between countries, which make certain countries capable of securing a competitive advantage thanks to their high capacity of research and development, technology transfer, assimilation of innovative technologies and innovation. The theory of scale production claims that winning (and implicitly the competitive advantage) is due to the country's high specialization and its capacity to reduce costs per unit (Gurbiel, 2002).

The process of technology transfer disseminates innovative technologies and it is influenced by the stage of economic development and the absorption and innovation capacity of a country. Currently, at a worldwide level there is a significant difference between countries with respect to the economic strength, their innovation capacity and the growth potential provided by the technology transfer process (Nicolescu and Nicolescu, 2011).

To illustrate the strong connection between the technology transfer and the economic growth, one powerful example is the developing method of some of the Asian countries, which, within a relatively short period, have managed to move from technology importing countries to technology developing and exporting ones. Korea, Taiwan, Hong Kong and Singapore have evolved in just three decades, ending up being high economy powers based on technology production. The massive acquisition of technology by means of an efficient economy transfer and using efficiently this technology in production processes, all have played a key role in their long-term development and in gaining an international competitive advantage. Strict policies regarding imports have allowed these countries the gain of technology by various technology transfer means. This in turn has been developed by means of inner research and development abilities in collaboration between the industry and public and private research centers (Gurbiel, 2002).

Another relevant example is Finland, which in just 10 years became the most innovative country within the EU and this led to a strong increase of its GDP. Owning and accessing state of the art technology affects the position of a country in the international classification according to competitiveness. Without having its own innovative technologies, long-term competitiveness can generally rely on technologies at hand and on efficiently using major technologies. This is the

special case of several central and East European countries, which have a major gap from the developed countries in terms of competitiveness.

Generally, the transfer of scientific results in the economy amplifies innovation within companies, and this attracts an increase in their competitiveness. The competitive advantage of a company or an economy depends on its capacity to innovate and to improve the quality of its products and services offered in a market in a state of efficiency and effectiveness (Groumpos, 2009).

3 Technology Transfer – Concept and Entities Involved

In the absence of a standard, universally accepted definition for the technology transfer, several definitions try to capture a very complex reality. The economists and management specialists tend to define technology transfer based on the knowledge that is at the foundation of the transfer, emphasizing the stages of this process and its influencing factors. Sociology tends to focus on the connection between technology transfer and innovation, while anthropology look at the technology transfer from the point of view of the climate and the cultural changes it determines (Bozeman, 2000; Oliveira și Teixeira, 2010).

The technology transfer is a process run by universities and research institutes or by any socio-economic entity by which a knowledge system (patented or not) is transferred towards socio-economic entities that are capable to materialize such knowledge in their benefit or for the benefit of the society (Brad, 2010). The Federal Laboratory Consortium for Technology Transfer defines technology transfer as “the process by which knowledge, facilities or existing capacities, financed from public research and development funds are used to satisfy public and private needs” (***, 2011).

Thus, the technology transfer is viewed (in its most general terms) as the transfer of research results from the research units (universities, research institutes) towards companies or other social components. The entities participating at this technology transfer aim to accelerate the usage of the research results in the economy, involving the transition from invention to innovation and its successful spread on the market, thus creating added value (Badea C., Radu M., Mocuța Gh., 2008).

Taking into account the fact that the process of technology transfer is based not only on technology in itself, but it can also involve silent knowledge that the entity transfers and holds thanks to its experts and specialists, the literature often uses the term knowledge transfer, which depicts a comprehensive form of technology transfer. The modern period is called the age of knowledge and intellectual value and highly appreciates knowledge and its usage in order to obtain economic value.

Basically, the technology transfer process implies having two or more entities in a state of cooperation (OECD, 2004; Foray and Lissoni, 2009):

1. The public or private research and development unit that is the knowledge source and holds the transfer object;
2. The transfer agent that intermediates the process and that can or cannot be related to the unit that transfers technology;
3. The unit that receives and adopts the scientific result (the object of the technology transfer).

Apart from the research and development institutions, companies from the industry and the entities mediating the process, another especially important stakeholder that will decisively influence this process also enters this process: the state and its representative authorities. The state can use its policies, strategies and resources to influence and stimulate technology transfer. Public and private finances can also provide essential support for this process (Brad, 2010).

These three entities that work together to accomplish the technology transfer aim at the acceleration of economic use of research results, with the transition from invention to innovation and its diffusion on the market, thus creating added value.

4 The Efficiency of the Technology Transfer Process and its main Influencing Factors

The efficiency of technology transfer is given by the optimal function of input and output by involving several entities and under the influence of several factors. The inputs for the technology transfer are: research results and financial resources. The outputs, according to several authors, are: income from patent licenses, the number and income from the contracts with the industry, the number of patents sold, the number of spin-offs created, the economy growth indicators or workforce employment (Oliveira and Texteira, 2010; Bercovitz and Feldman, 2006).

The efficiency of the conversion process into results is influenced by several factors. The classification of these factors in the literature is different according to the authors. Thus, Oliveira and Texteira (2010), in a study based on the literary on technology transfer written for the 2001-2007 period, classify the influencing factors in two main categories: internal factors and external ones. The internal factors are: the age of the entities involved their size and structure, the rewards offered, the nature and the stage of the technology that is being transferred, culture and norms, the links with the industry. The external factors are: location, laws and other legal rules and regulations, the regional economy context, public policies (Oliveira and Texteira, 2010)

Bozeman (2000) elaborated a model called “The contingency model for efficiency of technology transfer”. This model includes five broad dimensions determining the efficiency of the technology transfer, (Bozeman, 2000):

1. *The characteristics of the agent that wishes to transfer technology*: the technology niche, the mission, the economy sector, the resources, geographic location, organizational structure, managerial style, internal policies;

2. *The characteristics of the channel performing the transfer*: the literature, patents, licenses, informal channels, staff exchange, demonstrations, spin-off formation;

3. *The characteristics of the research results that make the object of technology transfer*: scientific knowledge, technologies, drawings and technical drawing, processes, know-how;

4. *The characteristics of the entity that receives the technology*: the resources, production experience, marketing capabilities and abilities, geographic location, business strategies;

5. *The demand of the economic and social environment* in relation to the technology transfer: the existence of the demand for the object of technology transfer, its commercial and economical character, its potential demand.

Phan (2006) suggests that the efficiency of the technology transfer should be analyzed in three contexts: the institutional context, the organizational context of the research institution and the individual context. The institutional context refers to the internal policies, such as reward policy, the development strategy, the mission of the institution. The organizational context refers to the organizational structure, the document and information flow, hierarchical structure, decision-making policies, etc. The individual context refers to the aspects related to the professional ethics, individual objectives, professional and entrepreneurial skills of the researchers. In order for the technology transfer to be successful, all these three elements must be consistent (Phan and Siegel, 2006).

The main barriers encountered in the technology transfer activity that can negatively influence its efficiency are: company deficiencies, cost, risk and uncertainty, research institution deficiencies, institutional and organizational barriers and lack of information. The ability of the company to absorb transferred knowledge, measured in the quality and the expertise of the human resource and the existence of research activities are the pre-conditions for a company to become involved in technology transfer activities (Arvantis și alții, 2005).

Landry et al (2007) also presents a study on a group of 4000 Canadian researchers from 25 areas of expertise grouped in six major categories: chemistry, physics, mathematics, informatics, earth sciences and engineering. The study shows that the

main factors influencing the knowledge transfer for all six areas are (1) the connections between the researchers and the users of the knowledge resulting from the research activity and (2) the focus of the research projects on the specific needs of the users (Landry et al , 2007).

Analyzing the factors influencing the relevant efficiency of the technology transfer process, the literature notices that they are very complex and dependable on each other. All interested entities can have significant influences, both positive and negative, on the efficiency of the process.

5 Romanian National Research Institutes – Important Sources For Innovation And Technology Transfer

The technology transfer process depends essentially on the dependence of all entities performing research and development activities and the companies on each other. In Romania, the entities performing research and development activities are included in the national system for research and development. A distinctive part of this system is the research and development system of a national interest, which contains the national institutes for research and development. The national institutes for research and development represent a form of institutional organization that is specific for the activities of research and development, established for the consolidation of the science and technology in the areas of national interest (which have been established according to Romania's development strategy) (***, 2002)

At present, the national system for research and development contains 45 national institutes subordinated to nine ministries. All these national institutes perform research activities targeted towards specific areas of expertise: physics, chemistry, engineering, biology, medical studies, micro technology, geology, energy, environment, electrical science, electronics, communications, IT, tourism, food and agriculture (ANCS, 2010).

Unlike other research entities, they are financially independent and they find their own finance sources. Their funds come mainly from research projects won during national competitions financed from the state budget, according to the National Plan for Research and Development 2007-2013. Other income sources are the funds resulted from the international programs and cooperation and the ones attracted from collaborations with the companies. What is most important is the fact that the research results – documentations, studies, papers, designs, schematics, invention patents, licenses for designs and industrial drawings, technologies, procedures, informational products, networks, formulas, methods, prototypes – belong to the institutes that generated them. These can be managed by the owners and they enjoy all the ownership rights deriving from them (***, 2002).

One of the major objectives of these institutes is using the applicative results by transferring them to the companies. The collaboration with companies plays a very important part in the process of generating and diffusing knowledge and the acceleration of the innovative process inside companies.

Due to their areas of expertise in various key fields of the Romanian economy, the national institutes must become promoters of technology transfer towards the industrial fields compatible with their technical and scientific competences. Taking into account the fact that these institutes are free to manage and harness their knowledge portfolio to produce extra income, it is important that they above all should have the skills and capabilities of supporting the technology transfer.

6 Critical Analysis of the Current Trend of the Romanian Technology Transfer

At this point, Romania is faced with an acute lack of innovation in the case of companies. This represents a negative influence on their competitiveness on national and international markets.

According to the Community Innovation Survey from 2008, between 2006 and 2008, more than half of the industrial and service companies in the 27 EU membership states performed innovative activities (51,6%). In Romania the innovative companies represent only 33,3% (European Commission 2011).

Another evaluation instrument, the European Innovation Scoreboard (EIS), developed by the European Commission to evaluate and compare the performance of the membership countries in the field of innovation, places Romania in the category of the catching-up countries. Thus, the summary innovation index for Romania in 2009 is at 0,256 – relatively far from the UE27 average (0,481), which means that our country is on the second before last position (***) 2009). In 2010 (fig.1.1), the aggregate score for innovation declined in comparison to 2009, from 0,256 to 0,237, representing less than half the UE 27 average (0,516) (ANCS,2010).

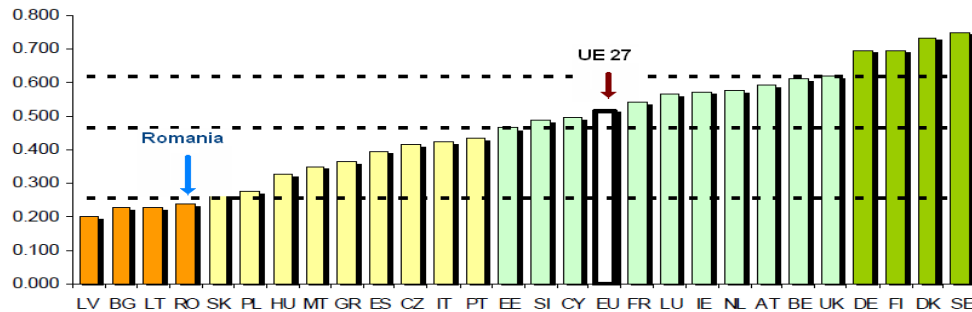


Figure 1.1 Cumulative innovation indicator for the EU members 2010 (ANCS, 2010)

- Inovatori de frunte ("innovation leaders")
- Inovatori in urmarire ("innovation followers")
- Inovatori medii ("moderate innovators")
- Tari in recuperare ("catching-up countries")

The current trend of Romania, although positive for the number and quality of the research results, its impact is barely felt in companies, as confirmed by the summary innovation index. Romania is part of the group that shows positive economic growth based mainly on the reduced workforce costs and low value added exports. On the other hand, the economic growth is based on a low level of infrastructure and innovation mechanisms, which are still in an incipient developing stage and cannot contribute significantly to this growth. The lowest indicators are registered for the “willingness, excellence and attractiveness of the CDI system”, “entrepreneurial connections”, “intellectual capital” and “innovators” (ANCS, 2010; ANCS, 2009).

The competitiveness of our country is no different. Table 1.1 presents the scoreboard of countries according to competitiveness, in comparison with representative countries such as USA, Hong Kong, Sweden, Germany, etc. The indicators show that Romania is situated at the end of this list.

Table. 1.1 Ranking changes in the international competitiveness scoreboard 2008-2011

	2008	2009	2010	2011
USA	1	1	3	2
Hong Kong	3	2	2	1
Singapore	2	3	1	3
Switzerland	4	4	4	5
Sweden	9	6	6	4
Finland	15	9	19	15
The Netherlands	10	10	12	14
Germany	16	13	16	10
Japan	22	17	27	26

UK	21	21	22	20
Bulgaria	39	38	53	55
Poland	44	44	32	34
Hungary	38	45	42	47
Italy	46	50	40	42
România	45	54	54	50
Venezuela	55	57	58	59

Source: IMD, World Competitiveness Scoreboard, 2009-2011

Another significant aspect revealed by the community innovation survey (CIS 2008) is the cooperation between the companies and the research institutes in the case of innovative activities. One third of the innovative enterprises in the EU (34,2%) have cooperated with other enterprises, universities, public or private research institutes between 2006-2008 in order to perform innovative activities, while the rest of them (65,8%) have innovated using only internal resources.

In Romania the rate of innovative enterprises that have cooperated in order to perform innovative activities was only 13,8%. This is the lowest rate among the EU member countries. The cooperation with other partners for this kind of activity refers to the partnerships with other enterprises, universities or public national or international research institutes (European Commission 2011).

The low rate of these indicators has many causes. One of them obviously is the low technology transfer rate from the national research and development system towards companies and the low efficiency of the relationships between these entities.

The national research institutes, key components of the national research system, occupy a determining role in the technology transfer process in the case of Romania. They play a decisive role in the creation of knowledge and the generation and distribution of the technical and scientific results. The success of this process depends decisively by their degree of involvement in the technology transfer.

There are major differences between these research institutes in the way they perceive the vital and real importance of the process of technology transfer for the Romanian economy. From a judicial point of view, their functioning is regulated in a unitary manner by the current laws. However, the institutional and managerial contexts vary according to the strategic vision of the top management.

The successful process and the creation of a bond with the economy depend on how much the institute chooses to adopt a strategic vision with respect to the technology transfer.

The result of the technology transfer process resides in not only selling a patent, giving out a license or initiating a collaboration project with the industry. The

success of this process is also represented by the selling and acknowledging of an innovation or an innovative product on the market. This is why the vision of the national research institutes must be a strategic one, oriented towards ensuring a set of complex research and consulting services for the companies – meant to support innovation. The approach must be proactive and should aim at meeting the specific needs of companies – especially the productive ones – and should aim at a timeframe that would correspond to the lifecycle of a product or innovative technology.

From a managerial point of view, supporting the technology transfer at a research institutional level implies establishing strategic objectives, process, decision-making and information organization of the structure that will serve this purpose.

Thus, taking into account the organizational processes taking place inside national institutes, certain deficiencies could explain the low rate of technology transfer. The main hypotheses are:

1. The lack of a proper management of technology transfer in the case of national research institutes;
2. The lack of an integrated institutionalized vision regarding technology transfer;
3. The improper management of intellectual property rights within national research institutes;
4. The poor quality of organizational processes within institutes and the lack of interest of the administration to involve in technology transfer activities, as well as the lack of an entrepreneurial approach in relation to using the research results;
5. The lack of technical, judicial or administrative support, which should be able to manage the relations with the industry and the lack of experience in this matter;
6. The lack of an incentive system for researcher for patenting and involvement in technology transfer activities;
7. The tendency of researchers to develop personal relationships with the companies, rather than institutional relations;
8. The inconsistency between the research fields with applicable results and the fields of the Romanian economy trends with innovation potential;
9. The predominant orientation towards the fundamental research and overlooking the applicative one;
10. The lack of a constant tie between the national institutes with the economy, the industry and the companies, with the entrepreneurs and the potential investors;

11. The lack of consensus between the needs and the expectations of the economy, the offer of the national research institutes, the intermediary agencies, governmental policies and financial policies.

All these aspects can become investigation matters for finding causes and solutions for the improvement of organizational processes within national research institutes in order to increase the efficiency of technology transfer activities.

7 Conclusions

The efficient process of technology transfer brings major benefits to all the stakeholders. The increase of the technology endowment by means of technology transfer from the research institutes towards the industry contributes significantly to the economy growth rate at a national and regional level. At the same time, the research institutes, as knowledge suppliers, can increase their income and can become financially independent in running entrepreneurial and research activities. Also, they can obtain other collateral advantages, such as research contracts sponsored by certain companies, employing and maintaining specialized staff and top researchers (Phan 2006).

Given all these positive effects that appear due to technology transfer, the national research institutes and all those involved in creating and implementing governmental policies for the stimulation of technology transfer must study, evaluate and improve the efficiency of this process.

Successful technology transfers depend on the ability of the top management of the research institutes to think this process strategically. It must eliminate the danger of not taking into account the importance of creating a performing and proper organizational context so that the process can take place.

8 Acknowledgement

This paper was supported by the project "Improvement of the doctoral studies quality in engineering science for development of the knowledge based society – Q_DOC", ID: POSDRU/107/ 1.5/S/78534, project co-funded by the European Social Fund through the Sectorial Operational Program Human Resources 2007-2013.

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