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Research of Commercialization Models of Scientific Developments in Projects of Technological Entrepreneurship

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Abstract
The article is devoted to the development a system of training future entrepreneurs for commercialization of scientific developments, which come from the Institute of Applied Physics the Russian Academy of Sciences (IAF RAS). In the thorough analysis of the existing models of commercialization of scientific research was carried out, which are used in Russia and abroad. It was noted that at the moment there are 7 basic models of commercialization, which are the most successful. The most successful projects in the commercialization of scientific research IAF RAS were studied in the article. They are ZAO NPP "boom", NTK OOO "Medusa" and "Center of scientific and technological development". As a result of this study it was proposed to implement the developed commercialization model it was asked to create a separate structural unit within the IAF RAS - the Center for Technology Transfer.

Keywords: technological entrepreneurship, scientific developments, commercialization model.

JEL classification: O320

1. Introduction

Today, market conditions are varying rapidly, and companies also need to respond quickly to these changes to remain competitive. Creation and introduction of innovative products and technologies on the market allow many firms to remain leaders of their industry.

Currently during the formation and establishment of national innovation system, there is a need to develop specific mechanisms to optimize the process of commercialization of scientific breakthroughs. The problem is the absence of an interactive effective mechanism between research institutions and business, which does not allow realizing the majority of Russian scientific research.

If we consider scientific organizations that are primarily engaged in science and discoveries, now more and more of them are forced to provide them financing. Commercialization of the acquired knowledge and technologies in scientific organizations will allow them to receive financial benefits from their activities.

Today, the role of universities and scientific organizations primarily in the innovation economy is reduced not only to educational activities, but also to the creation of scientific knowledge, new technologies and scientific developments that are the centers of innovation breakthroughs. The purpose of creating scientific discoveries and technologies is to introduce them into the real sector of the economy. As organizations need new technologies to preserve and acquire new competitive advantages, it is necessary to build close relationships with other companies and with universities (Aarikka-Stenroos, 2014). In order to profitably realize the development, it is necessary to understand who is experiencing the need for it and how to sell it to it. It is the model of commercialization that describes through which channels one can reach a buyer, how to present a new product or discovery, how to deal in the best way, and what resources are needed in the process.

It should be noted that the success of the commercialization of scientific breakthroughs directly depends on the chosen form of technology transfer. Also, the model used influences of how

indirect benefits, profits and risks will be distributed among the participants in the innovation process.

The chosen commercialization model of scientific technology plays an almost a vital role in the development of technological entrepreneurship.

In connection with the entry into force of the law on reforming the RAS system, the situation there has changed radically. Funding for the structures of the Russian Academy of Sciences has significantly decreased. Therefore, in the current conditions, the most effective way of obtaining funding for institutes is the commercialization of their scientific breakthroughs.

In this paper, mechanisms for interaction between participants in the process of commercialization of scientific discoveries for the Federal State Budget Scientific Institution "Federal Research Center of the Institute of Applied Physics of the Russian Academy of Sciences" have been developed.

2. Literature review

In order to study in detail the commercialization models used by the Institute of Applied Physics the Russian Academy of Sciences (IPF RAS) projects, it is necessary to determine what a technology transfer is.

There are several approaches to the definition of the concept of technological entrepreneurship:

• Creation of a new technological enterprise (Jones-Evans, 1995);

• Joint efforts to interpret ambiguous data, shared understanding to maintain technology designation and a constant, coordinated effort to achieve scientific and technological progress (Necoechea-Mondragon, 2013);

• A set of different actors, each involved in engaging with technology and, in the course of its activities, creates a contribution that leads to the transformation of evolving technological progress (Garud, 2003);

• Ways of employing resources by entrepreneurs to take advantage of the opportunities of emerging technologies (Liu et al., 2005).

Analyzing the existing definitions of technological entrepreneurship, we can conclude that it includes a number of characteristic features:

- Leadership of a small company, which is owned by inventors and scientists;
- Finding problems or applying a separate technology;
- Launching a new risky business, implementing a new application or using opportunities that rely on scientific and technical knowledge;
- Implementation of technological changes.

Over the past few years, scientific literature has seen an increased interest in technological entrepreneurship as an important global phenomenon. It allows ensuring a stable growth of the company, differentiation of products, as well as acquisition of important competitive advantages, not only at the level of a separate economic entity, but also at the level of the region and the country as a whole.

In this paper, the following definition was used: technology transfer is a rather multidimensional process that intentionally promotes the use of scientific breakthroughs and technologies. The transfer of scientific developments begins in the process of creating technologies and ends in the process of implementing scientific breakthroughs. This process involves several stakeholders and certain resources, and includes activities related to the transfer and implementation of new technologies (Aidis, 2008).

The most important aspect of the activity for a technology entrepreneur is the commercialization of technology. In this paper, models and forms of commercialization of scientific discoveries of technological projects will be studied; therefore, it is necessary to consider the conceptual apparatus of the "commercialization model".

The term "technology" is a fairly broad concept and, depending on the field of application, it has a different meaning.

For example, Webster in his work gives three definitions to the word "technology": 1) science or teaching about practical experience in the field of industry; 2) the term used in science in technical terminology; 3) applied science (Bozeman, 2000).

Speaking about the term "technology transfer", he also has a number of different interpretations. Rosesner gives the following definition: technology transfer is the movement of know-how, technical knowledge or technology from one organization to another (Bozeman, 2000).

At present, the role of universities and scientific organizations in the innovation economy boils down not only to educational activities, but also to the creation of scientific knowledge, new technologies and scientific breakthroughs that are the centers of innovation development. The purpose of creating scientific breakthroughs and technologies is their transfer to industry, introduction to the real sector of the economy. As companies need new technologies to retain and acquire new competitive advantages, it is necessary to build close relationships with other companies and with universities (Audretsch et al., 2012). In order to profitably implement the discovery, it is necessary to understand who needs it and how to sell it to this person or organization. It is the model of commercialization that describes through which channels one can reach a buyer, how to present a new product or development, how to deal in the best way, and what resources are needed in the process.

The payback and profitability of new products or services in the company largely depends on the chosen model of commercialization of scientific breakthroughs. Also, the model used influences how indirect benefits, profits and risks will be distributed among the participants in the innovation process.

The role of universities in this process is recognized as critically important, and therefore they seek to formalize the processes of commercialization of results of intellectual activity (RID) and technology transfer (Rolfo and Finardi, 2012). Transfer of technology can bring significant benefits to the organization in the form of revenues, established links with industry and increased economic development of the region and the country as a whole. For this purpose, universities and scientific organizations build internal processes for the commercialization of the results of intellectual activity by creating technology transfer centers, centers for evaluating commercial prospects (Gulbranson and Audretsch, 2008), whose responsibility is to build and apply various models of RID commercialization.

Bozeman proposes in his work a model describing some performance indicators, including various characteristics of the technology, the transfer agent and the recipient of the technology. The most important characteristics of this model is that there are a number of factors that affect the efficiency of technology transfer, such as market influence, political pressure, the impact of people involved in this process. Also, resources available for other purposes and for other scientific and technical objects have a significant impact on the efficiency of technology transfer.

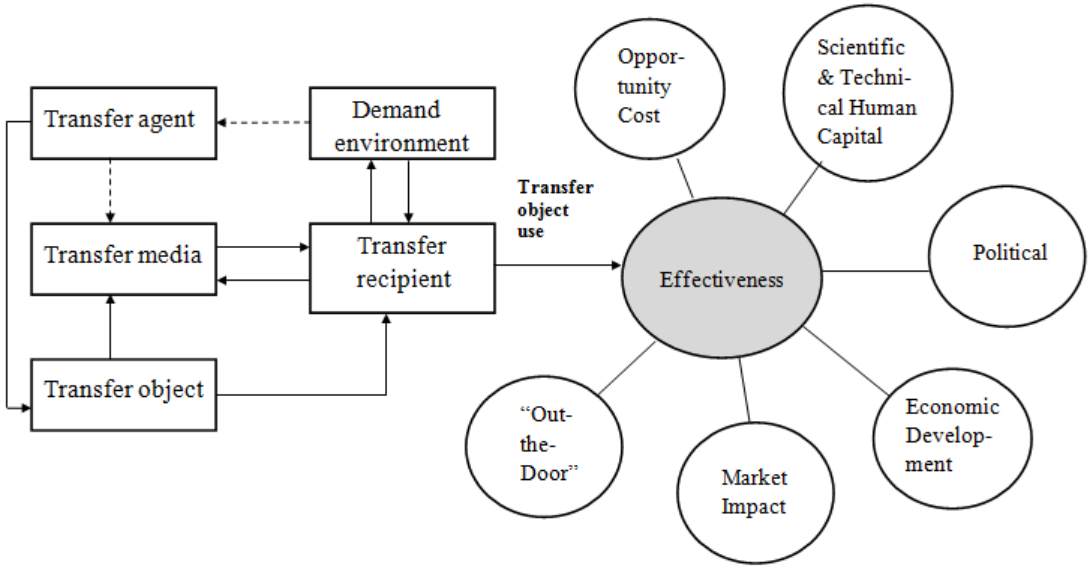

Fig. 1. A successful model of technology transfer (Bozeman, 2000)

Transfer agent. The author of this model implies an agent under the transfer agent, which has its own history, culture.

The technology carrier is open literature, patents, licenses, acquisitions, informal sources of information, personal communication, demonstration of goods on Internet sites, spin-offs of the company.

Object of transfer. Its tasks are to determine the technological niche of a new product, designate a mission, the sector of the economy, and the necessary resources. In addition, it is important to understand the geography of the application of the new product, as well as the political restrictions that may hinder the spread of a new product in the territory under consideration. Objects of transfer are: scientific knowledge, physical technologies, technological design, processes, know-how, skill.

Technologies can be used to use them as resources for other processes, in the form of production experience, market opportunities, distribution geography, product diversification or production, and as a business strategy.

In the thorough analysis of the existing models of commercialization, which are used in Russia and abroad, a scientific research was carried out,. It was noted that at the moment there are 7 basic models of commercialization, which are the most successful. Each of these models has been discussed in detail, described as a graph and test format. They are (Audretsch, 2012; Bauer, 2010):

- Licensing;
- Creation of spin-off companies;
- Opening of joint university laboratories with industrial companies;
- Implementation of R & D at the request of an industrial company;
- Sale of all intellectual property;
- Creation of joint ventures;
- Strategic alliances.

Analyzing the use of models in Russia and abroad, it is worth noting that in most other countries the licensing model is most often used. One of the reasons for the frequent use of this model is the quality of scientific discoveries and their relevance to the market. From the literature review of abroad scientist, research organizations often fully sell their intellectual property, and begin to engage in research in another industry or make new developments in the current. In Russia,

the situation is reversed; the model of creation of spin-off companies is most often used. This trend is regulated by the requirements of the state to establish small innovative enterprises by universities and scientific organizations.

In addition, it is worthwhile to consider other models for the commercialization of scientific breakthroughs at the Institute, which are also used by many scientific organizations.

The list of models of commercialization of scientific developments considered above is not exhaustive. The work presented models that are applied both by scientific organizations and institutions, and by companies.

It is worth noting that there is no correct or universal innovation model of commercialization. The choice of this or that model depends on the situation in the scientific organization, and on the discovery itself. In general, many institutions use several models, but at different times and in different conditions, which, above all, depend on a changing market. The choice of a certain model of commercialization should be carried out consciously, weighing all the pros and cons, and regularly reviewed.

Researchers study these models from the point of view of efficiency and features of their application, paying attention to time costs, potential profit or benefit for the university, as well as the complexity of the commercialization procedure. Among the factors that influence the process of commercialization of intellectual activity, researchers identify the structure of funding, research activities, the legal environment in the university, the institutional environment; among the factors that increase the activity of commercialization, reward the employees of the university for their active participation in the process of commercialization of the results of intellectual activity, proximity to regions with a high concentration of high-tech companies, experience of the structures responsible for transfer of technology (Heinzl, 2008).

In order to compare the different models of commercialization of scientific breakthroughs of the scientific organizations, it is necessary to develop criteria for their evaluation. To do this, we turn once again to the notion of "technology commercialization". Commercialization is the process of developing and implementing a series of activities through which the results of research and development can be offered in the markets of goods and services for commercial purposes.

All models of commercialization of scientific breakthroughs of the University can be compared by the following criteria:

• Intellectual property rights;
• Readiness of development;
• Demand for scientific discovery or research;
• The magnitude of the financial impact of the commercialization of development.

Summing up a small result to the considered models of commercialization of scientific breakthroughs of the Institute, it is worth noting that in this process there are always two sides: the institute and the company. And it is very important to take into account the interests of both sides when choosing a model. Only in this case, such cooperation will be mutually beneficial and profitable.

3. Methodology

A large number of technological enterprises are concentrated in the Nizhny Novgorod region, which were created during the last several decades. The region has a great scientific potential and quite good conditions for the development of innovative entrepreneurship, but there are a number of significant problems that sometimes hamper the activities of such companies.

Official statistics indicates a large number of technology projects, but only about 10% of them carry out their activities in the market. Institute of Applied Physics of the Russian Academy of

Sciences is one of the leading research organizations in the region, which creates technological projects. These projects show good results, including financial ones, to start a business, but there is no further development of the projects.

IAF RAS is one of the most powerful scientific organizations in the region. It conducts fundamental and applied research in the field of plasma physics, high power electronics, atmospheric physics, hydrophysics and quantum electronics.

Despite the absence of a system for the commercialization of scientific breakthroughs, several companies have been created around IAF RAS since 1990 on the basis of the intellectual property belonging to the Institute. Also IAF RAS successfully transfers its technologies.

At present, about 30 patents of the Russian Federation for inventions, 5 certificates for computer programs, 2 secretions of know-how are supported in the IPF RAS, as well as 6 foreign patents for inventions registered in China, South Africa, South Korea, Hong Kong, Japan, USA. But at the current time the institute does not have a system for the commercialization of its discoveries, which makes this process difficult and causes a number of difficulties. Despite the absence of a system for the commercialization of scientific breakthroughs, several companies have been created around IPF RAS since 1990 on the basis of the intellectual property belonging to the Institute. Also IAF RAS successfully transfers its technologies.

The Institute of Applied Physics of the Russian Academy of Sciences does not stop there. The Institute constantly develops new products or substances that will be commercialized in the future. Accordingly, the issue of commercialization of scientific developments in this institute is considered quite important.

The unit of analysis is one company from the IAF RAS. The selected companies are the most successful and have achieved great results during their existence. In this research, 3 companies were studied, they are: CST NPP «Gikom», NTK LLC «Meduza» and LLC «Center for Scientific and Technical Development».

The data was collected in 2016 from the Internet, the official company's sites, the company's internal documentation, and in this study interviews with the company's managers were conducted. The conversation with company representatives was recorded on the recorder, and written notes were taken during the interview. The total time of the interview was not more than 50 minutes. The guide for the interview was compiled on the basis of an analysis of information from foreign and Russian authors on existing models of the commercialization of scientific discoveries of the Institute, on the possible problems of this process.

For each company, information was obtained on the following parameters:

- a brief description of the company;
- available intellectual property;
- commercialization model;
- participation of the developer in commercialization;
- Achievement of the project.

Such data allow us to draw conclusions about what prevents the commercialization of scientific developments in companies, as well as to offer a new model of commercialization.

Speaking about the model of commercialization of scientific breakthroughs of the companies examined, it should be noted that all of them currently maintain close ties with the institute. The 1990s were a difficult period, including for small innovative enterprises. There was no official transfer of technology, so all companies protected their intellectual property in a know-how mode. Since the beginning of the 2000s, the country's leadership has increasingly started talking about innovations and scientific developments, and legislative acts have begun to appear that officially consolidate and protect the transfer of technology. LLC "Center for

Scientific and Technical Development" has already been established for 217 Federal law with the participation of the Institute, which also consolidated its status.

The basic principle that must be observed when developing recommendations for the successful commercialization of discoveries in the IAF RAS is to observe the interests of all parties involved in this process.

None of the above models of commercialization of scientific breakthroughs in a scientific organization is found in its pure form, which is due to the market and the economic situation. In this case, it is necessary to carry out a complex work both inside the research organization for the training of researchers, and work with spin-off companies, helping them to develop independently.

4. Results

In the course of the analysis of the activities of the three companies that come from the IAF RAS, it is worth noting that all have similar difficulties, such as a lack of qualified personnel, knowledge lack and experience in doing business at the time of the company's creation, lack of demand for innovative products in the country or from the industry, and also that companies do not know in which direction they should develop further, improve their products or come up with new ones, enter new markets, or look for new niches in Russia.

In order to prepare scientists more carefully to create their own business using the created intellectual property, it is necessary to develop a system of training future entrepreneurs within the institute. The most effective way is to break the whole process into 3 stages: training, preparation for commercialization and the creation of SME. Let's consider each stage separately.

1. Training. This stage involves familiarizing students and employees with the entrepreneurial sphere, with business.
2. Preparing for commercialization. At this stage, young researchers need to listen to a number of courses on the notion of intellectual property, models of its commercialization, the forms of technology transfer abroad, legal and financial aspects of the commercialization of scientific development.
3. Creation of small and medium-sized enterprises (SME). This stage involves the registration of the spin-off of the company, escort on issues related to the activities of SME.

Undoubtedly, there should be organizational structures responsible for these stages and accompanying scientific personnel in this process.

The initial stage of training should be carried out under the leadership of the sector of innovative programs directly, which exists at the Institute of Applied Physics of the Russian Academy of Sciences today. The main tasks of this structural unit are to ensure mutually beneficial cooperation with laboratories and departments of universities of the Nizhny Novgorod region, which are associated with new technologies and discoveries. This is necessary in order to conduct courses of introduction to the specialty for real university students on the basis of them, in order to show young people the possibility of a scientific career and further prospects.

If we talk about the stage of preparing the scientific breakthrough for commercialization, then the presence of the Sector-Innovative Programs of the IAF RAS is important, and it is also advisable to create an Association of spin-off companies whose members would share their personal experience with young scientists in the issues of technology commercialization.

The objectives of the structure of the institute are the initial evaluation of technology, their selection, recommendations for finalization, advice on the legal design of intellectual property, market research of the market and consumers of this technology.

The Association of spin-off companies is the association of several of the most successful spin-off companies that are ready to share a recipe for success with the younger generation and give practical recommendations at the stage of creating and developing a technology business. They can act as coaches or mentors. The creation of such a structure is extremely important, because when about technological entrepreneurs write in books - this is one thing, and when you can personally get to know them and ask all the questions or get professional advice, this gives more confidence to young scientists in their abilities.

The main objectives of such an association should be the following:

• Advising and assisting young scientists in the commercialization of their developments;
• Act as partners in the most promising technological projects;
• To develop the market of technological entrepreneurship in the region.

The last stage is the creation of a small innovative enterprise. An important role is played by external partners, such as HSE, Business Incubator, Technopark Ankudinovka and others. Here, the creation of a business incubator based on the IAF RAS together with the Higher School of Economics - Nizhny Novgorod would be most appropriate. Such an association will allow the preparation of projects only by the IAF RAS for commercialization proceeding from the peculiarities of the technologies of this institute. At this stage, they act as consultants, mentors, assist in organizing meetings with investors, train young scientists for high-level talks, and provide assistance as a technology broker. Such assistance is extremely important for MIPs, because Leaving the university walls, they fall into a tough competitive market, where it is difficult to survive, especially a young start-up company. Such structures help the company spin-off to enter the market, advise how to act in different situations and give clues.

The most effective way will be to develop a new model of commercialization, which would include the creation of spin-off companies from the institute and the creation of joint ventures. It suggests that the institute will develop a new technology or product within the laboratory or department. Further, the institute together with another company (commercial or other scientific institute) creates a separate enterprise in which employees of both sides will work. The Institute invests in the authorized capital of intellectual property and equipment (if any), and another company - finances, and provides the young company with human resources for conducting activities. As a result of this interaction, the newly established enterprise has all the necessary resources for a successful start of its business.

With the implementation of this model, the institute's employees would have the opportunity to earn additional income and realize their knowledge in a separate company in a time free from their main work, which would be an additional motivation for continuing to engage in scientific activity.

Speaking about the interests of a third-party partner company, it is also an additional income for its employees, as well as additional earnings for the company itself as a result of the successful promotion of a new product or technology to the market.

To make this model work well enough and make a profit, the Institute of IAF RAS needs to make some changes. First of all, it is necessary to create a structure inside the institute that would be engaged in the commercialization of scientific breakthroughs, the search for partners, choosing the most successful way of implementing new products or technology. An example of such a structure is the Center for Technology Transfer of the IAF RAS. In addition, you need to think in more detail about the interaction with partners who will invest in the creation of a new enterprise, how many will invest in the creation of a new enterprise, who will make important decisions, who will have the final say, how the intellectual property will be formalized and who it will belong to and many other nuances, which will arise in the process of interaction with each other. All this information is described in more details in the

concept of creating the Center for Technology Transfer of the IAF RAS, which is presented in the next section of this chapter.

No less important is the development of a program involving employees in the process of creating an innovative product and its subsequent commercialization in conjunction with another company. Here it is necessary to differentiate the functional duties of employees in the work at the institute and also evolve a program for motivating specialists.

In the process of implementing any model of commercialization of scientific discoveries of the institute, it is worth remembering that this process will be successful if the interests of all involved parties are taken into account. Only in this case, each company will be satisfied with the whole process of commercialization.

As a result of this study the commercialization model of scientific research IAF RAS has been developed, which will not only commercialize existing and future breakthroughs of the Institute, as well as elaborate these developments as a part of the new company. To implement the developed commercialization model it was asked to create a separate structural unit within the Institute of Applied Physics Academy of Sciences - the Center for Technology Transfer, for which the work has been spelled out the concept of creation, as well as an action plan for 2016-2018.

The results can be used for further research models commercialization of scientific research technological entrepreneurship projects in other regions.

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