

Methodological aspects of universities' R&D commercialization in Ukraine in the context of the Quadruple Helix Model

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Abstract

The necessity of the formation and development of the mechanism of commercialization of the researches results of HEIs in Ukraine has been substantiated. The present state of the process of commercialization of the researches results of HEIs in Ukraine has been analyzed. The problems and strategic guidelines for improving the mechanism of commercialization of the researches results of HEIs in Ukraine have been identified. The components of the mechanism of commercialization of the researches results of the HEIs in Ukraine in the context of implementation of the "Quadruple Helix" model (HEIs - business - government - civil society) have been determined, which is focused on the integrated management of innovation activity, in particular, on the process of formation, transfer and realization of scientific developments, the creation of high-tech technologies on their basis. The classification of the researches results of HEIs, which are the objects of commercialization, has been offered.

Keywords: *Commercialization, HEIs, Organizational and economic mechanism, Quadruple Helix Model*

JEL Classification: L21, L31, L32, M14

INTRODUCTION

The current global trend of development of the world's leading countries is the formation of a new type of economic system - the information economy. The characteristic features of information economy are: the transformation of knowledge and information into productive power; the growth of the role of intellectual and information resources in the economy development; the expansion of the knowledge-intensive sector of economy; the increase in the share of workers employed in the science-intensive sector of economy; active implementation of information and communication technologies; raising the level of innovation activity of business entities; the development of innovative consciousness; the increase in the share of high-tech products in the gross domestic product of the country; the expansion of the information services; the modernization of approaches to the organization of entrepreneurial activity; the formation of a global information space, etc. The development of entrepreneurship in such conditions faces a number of challenges, first of all, changing the factors of competitiveness of economic entities. The high competitive positions require innovation activity, flexibility and adaptability of enterprises to the changes of dynamical economic environment. The economic entities' innovation activity is largely based on the efficiency and intensity of research activities

of higher education and research institutions of the country. The gaps between the elements of the Quadruple Helix model (higher education sector – business enterprise sector – government sector – private non-profit sector) reduces the processes of research results commercialization in the real sector of the national economy.

LITERATURE REVIEW

Today, one of the tasks of the Ukrainian economy is the development of industrial knowledge-intensive production and the formation of stable market relations for obtaining domestic competitive products. Due to the rapid growth of the market of scientific and technical products and the high level of competition in this market, the search for the ways to commercialize the researches results of HEIs becomes an expedient solution. The commercialization of the researches results is an important source of the formation of the revenue part of the university budget, as well as the factor of attraction of investments in its research and teaching activity.

The gaps between the elements of the Quadruple Helix model (higher education sector – business enterprise sector – government sector – private non-profit sector) reduces the processes of R&D results commercialization in the real sector of the national economy. The Quadruple Helix model is the development of Henry Etzkowitz's Triple Helix model (universities – firms – public organizations). We agree with scientists who propose to widen Triple Helix adding the civil society (or private non-profit sector – Eurostat, Eurocommision) as one of its important elements (for example R.Arnikil, A. Jarvensivu, P.Koski, T.Piirainen from Institute for Social Research at University of Tampere, Final Report on Quadruple Helix Research for the CLIQ project, 2010).

The theoretical and applied principles of the study of the Quadruple Helix model are laid down by E. Carayannis and D. Campbell (2009-2016). Yawson R. (2009) substantiates the importance of including of public to the Helix. Park H. Woo (2014) proves the lack of sensitivity of the Triple Helix model to the challenges of XXI century; therefore the scientist justifies the extending of the Triple Helix model to the Quadruple Helix.

Issues of commercialization in the spheres of higher education and science are gaining increasing scientific interest not only in Ukraine but also abroad. In 2016 a group of scientists (McAdam, M., Miller, K., & McAdam, R.) published the article devoted to the study of Quadruple Helix relationships of university technology commercialization. On the bases of empirical studies the researchers concluded that at the micro-level the influence on the commercialization processes is made by the set of specific interrelationships between the Model's subjects. Also, the authors put the attention on the variation of the interaction depending on the type and profile of the university and on the phases of the innovation cycle; stressed the complexity of organization of effective cooperation of stakeholders in the realization of commercialization processes ((McAdam, M., Miller, K., & McAdam, R., 2016).

Ukrainian scientists (Samilo, A.V., Rostin, O.V. & Kupchak, M.Ya.) propose to consider the commercialization of the researches results as a return of costs for the creation of scientific researches results, obtaining additional revenues to the special fund of estimates in order to accelerate the introduction of positive results of the science in to practice, the formation of favorable economic conditions for development (Samilo, A.V., Rostin, O.V. & Kupchak, M.Ya., 2013). I. Mazur defines the commercialization of scientific developments as a way of transforming the object of intellectual property

(innovative product, innovative technologies) into commodity, its embodiment in production and obtaining from this commercial result (Mazur, 2013).

We support the position of the scientist T.M. Bogolyb, who, under the commercialization of the researches results, considers the process of transformation of research results that retain their market relevance and demand into products and services on the market in order to generate revenue from their sale, licensing or independent use. In its turn, the process of commercialization involves the search, evaluation and selection of innovations for financing, raising funds, legal consolidation of rights to a future intellectual property, the introduction of innovations in production, as well as the subsequent modification and maintenance of the object of commercialization (Bogolib, 2014).

The results of the analysis of scientific researches and the practice of activity of domestic HEIs confirm the existence of a number of problematic aspects in the implementation of the process of the commercialization of scientific researches results, which sets us the task of developing scientific and methodological foundations and the mechanism of the commercialization of the researches results of HEIs in Ukraine. The main problem of the implementation of scientific developments is the lack of links between scientific and educational organizations, business, the state and public institutions. According to the scientists, in particular M.V. Fedorova and E.V. Peshina, a promising form of production of knowledge and scientific developments should become "pentaspiral" (science-education-business-government- civil society), an important task of which is the integrated management of the processes of innovation (production, transfer and use of scientific knowledge, the formation of the science-intensive technologies on their basis) (Fedorov, Peshina, 2012).

MATERIALS AND METHODS

The key issues of the commercialization of the researches results of HEIs in Ukraine include: non-regulation of provisions of the regulatory framework on the commercialization of scientific researches results; organizational and economic collisions in the functioning of the mechanism of using the researches results in economic circulation; the absence of a system for assessing the market value of the researches results; insufficient level of qualification of specialists on the issues of commercialization of scientific researches results; the lack of well-established infrastructure, which should provide solutions to the issues of the commercialization of researches results of HEIs, and others.

The research methodology included the collection of statistical and reporting data on the commercialization of HEIs' R&D results from official sources. In the process of research, general scientific and special research methods have been used, in particular: 1) theoretical generalization, comparison and morphological analysis - in the process of formation of the conceptual-categorical apparatus of the research; 2) system analysis - to formulate the conceptual foundations for constructing the components of the mechanism of the commercialization of the researches results of HEIs in the context of the implementation of the model "Quadruple Helix"; 3) regulatory and legal monitoring - to assess the compliance of the institutional environment with the conditions of implementing the organizational and economic mechanism of commercializing the researches results in Ukraine.

The purpose of the article is to justify the problems of the commercialization of the researches results of HEIs and the development of methodological approaches to the

formation of an effective mechanism for the commercialization of the researches results of HEIs in Ukraine using a model «Quadruple Helix».

RESULTS AND DISCUSSION

The economic essence of the researches results implies that commercially-attractive knowledge can acquire a commodity form, because an intellectual property protected by law can bring significant profits to its owners. In today's market conditions, the knowledge economy, based on the researches results, has become a key factor in the evolution of production processes, a key to the success and stability of the country's economic development. Taking into account such aspects, the European countries are working to create a transnational powerful economy, based on modern technologies. Therefore, taking into account the orientation of the domestic economy to the deepening of constructive socio-economic, normative-legal, and scientific-technological relations with the European Union, the issue of formation and development of the national market of knowledge becomes of special urgency. Ukraine is rich in its scientific and technical potential, which needs to be effectively used through the formation, popularization and commercialization of researches results of HEIs, which will contribute to a significant increase of the state's competitiveness on the world market of goods and services. In its turn, Ukraine's leadership on the global market is hampered by a socio-economic instability, chronic underfunding and brain drain. Under conditions of market economy, Ukraine did not pay sufficient attention to the development of scientific researches.

Having formally established new economic rules with the proclamation of independence, Ukraine continued its way for a long time on the basis of the mental approaches established in the Soviet period. Usually the customer and the owner of the researches results was the state, in its turn, the work of scientists was marked only by moral rewards. Therefore, the researchers did not have the necessity, and often the opportunity, to set themselves the goal of commercializing the results of their scientific achievements and present them on the market. As a result of this situation, modern scholars of HEIs, do not know how to market their own product. The result of such tendencies was a significant decline in the scientific and technical potential of the domestic industry.

The question of determining the owner of the researches results deserves particular attention since the domestic legislation contains a number of differences in this direction. At present, two entities applying for their commercialization (directly the inventor and his employer) are involved in the formation of the researches results of HEIs. Such circumstances affect the important issues of the legal regulation of material incentives of the scientists in the process of creating scientific products and inventions, as well as the peculiarities of evaluating the results of such activities. Scientific goods are generally understood to mean any scientific, educational, etc. products in the form of scientific monographs, dissertations, articles, reports, textbooks, teaching aids, deposited manuscripts, etc. The situation with scientific and technical inventions remains unclear.

The Law of Ukraine "On Copyright and Related Rights" defines the notion of the official work, which is considered as the work created by the author during performance of official duties, in accordance with his official duties or in accordance with an employment contract (contract) between him and the employer (The Law of Ukraine «About copyright and related rights», 1993) But one should pay attention to the

fact that labor agreements between the HEIs and scientific and pedagogical workers, as a rule, do not specify the scope and criteria of the scientific works to be created by a scientist. In addition, HEIs actively use the scientific assets of their own team for free. Taking into account the provisions of Article 429 of the Civil Code of Ukraine, according to which non-proprietary intellectual property rights belong to the author's work, and property ones besides him also belong to a legal entity or individual, the employer, unless it is otherwise established by the contract, it is obvious that in the legal plane this question is not clearly resolved, and hence the problem still remains open. In accordance with Part 1, Article 9 of the Law of Ukraine "On the Protection of the Rights to Inventions and Utility Models", the employer of the inventor has the right to obtain a patent for a service invention. There is a general competition (Part 2 of Article 429 of the Civil Code of Ukraine) and a special one (Part 1, Article 9 of the Law of Ukraine "On the Protection of the Rights to Inventions and Utility Models") of the norm, which according to the rules should be overcome in favor of a special rule. However, in this case, this rule does not work in the light of Article 4 of the Civil Code of Ukraine, which states that the Civil Code of Ukraine is the main act of the civil law, that is, the priority has Article 429 of the Civil Code of Ukraine (The Civil Code of Ukraine, 2003).

A similar situation exists with regard to the registration of the intellectual property treaties. In accordance with Part 2 of Article 1114 of the Civil Code of Ukraine there is a law to transfer the exclusive proprietary rights of intellectual property, which, in accordance with the Civil Code or other law, are in force after their state registration. That is, the rights to the objects of patent law come into force from the moment of their registration. In its turn, the patent legislation establishes the faculty of such registration (part 8 of Article 28 of the Law of Ukraine "On Protection of the Rights to Inventions and Utility Models"), therefore it is also necessary to apply the provisions of the Civil Code, which requires the regulation of the current legislation.

Such circumstances cause the remoteness of the national science from the real sector of the economy. That is, between the researches results and business, it is necessary to radically change relations, first of all, through the formation of a new style of organization of production, in which science will be integrated with it, namely, production will acquire a knowledge-intensive nature. To resolve this issue, it is necessary to establish an effective organizational and economic mechanism for the commercialization of the researches results of HEIs in Ukraine, first of all, due to the formation and efficient operation of the system of transfer of knowledge and technologies. From the position of the current national legislation, technology transfer is defined as the transfer of scientific researches results, which is drawn up by concluding between the natural or legal persons of the relevant agreement, which establishes, changes or terminates property rights and obligations regarding the researches results or their constituents (The Law of Ukraine «On state regulation of activities in the field of technology transfer», 2006).

Today, the organizational and economic mechanism of commercialization of research results in Ukraine includes the system of the Network of Regional Innovation Development Centers of the State Agency of Ukraine for Investments and Innovations (STT INDEV). This network is a part of the nationwide innovation infrastructure of Ukraine, which is a set of information and communication networks, hardware and software, which provides a non-profit basis for the activities of enterprises, institutions, organizations of all forms of ownership, in all regions of Ukraine regarding technology

transfer, based on a single normative and methodological basis. The purpose of the activity of the STT INDEV is to develop the innovation infrastructure of the national economy and to facilitate the commercialization of the researches results , which provides for their transfer from the HEIs to the business sector.

The Ukrainian integrated system of technology transfer, which is intended to accumulate and provide operational information exchange of the researches results between the HEIs and consumers, plays an important role in ensuring the organizational and economic mechanism of commercialization of the scientific research results in Ukraine. The purpose of creating such a system is to ensure the openness of access to the information on the researches results that is of commercial value in the context of the development of information resources and services that facilitate the objective perception of Ukraine in the world community as well as the strengthening of trust in various areas of the international cooperation.

In Ukraine, in 2009, under the State Research Institute "Ukrainian Institute of Scientific and Technical Expertise and Information" (UkrINTE), a National Technology Transfer Network (NCTT) was established, which operates according to the methodology and model of the European network of relay-centers (Innovation Relay Senters - IRS network - since 2008 EEN) and the Ukrainian network of technologies transfer UTTN. The role of this network consists in the consolidation of information resources of state, public, private innovative structures of Ukraine, enterprises, institutions and organizations in a single technology transfer network and the further integration of NCTT into the European network of EUN. Among the main tasks of the National Technology Transfer Network is the commercialization of the results of research in HEIs (the establishment of interconnections between the HEIs and business, the search for partners and investors for the mutually beneficial commercialization of research results, and the establishment of constructive relations with the international technology transfer networks).

In the long term, it is foreseen to establish a clear organizational and economic mechanism of the commercialization of the researches results in the HEIs, as currently the process of moving to the market of research results in Ukraine is a topical issue of higher education. As the cooperation of the HEIs with business leads to the fact that all copyrights to the researches results receives business because of the lack of funding in the HEIs to protect these rights.

The study of foreign experience in commercializing the researches results has made it possible to identify the peculiarities of the functioning of the research universities that pursue an active policy of joint research with industrial corporations and state research laboratories, forming alliances and participating in public-private partnerships. An innovative infrastructure is created, around these HEIs, which is represented by such objects as research parks, technology parks, science parks, technology transfer centers, centers for the commercialization of research results, technopolises, venture funds and investment companies.

During the last few years, significant steps have been taken in Ukraine to create favorable conditions for the commercialization of research results. There are 16 technoparks in Ukraine (8 of which are permanent ones). The following industrial parks are the most successful: "Semiconductor technologies and materials, optoelectronics and sensory technology", "Institute of Electric Welding named after Ye.O. Paton", "Institute of Single Crystals", "Kyiv Polytechnic", "Institute of Technical Thermophysics", "Ukrinfotekh", "Intelligent Information Technologies". The peculiarity of the

functioning of national technology parks is that in our country, unlike other countries, there are almost no venture technoparks (Bay, Doskonala, 2012; Industrial Property in Figures: Performance Indicators of the State Intellectual Property Service of Ukraine and State Enterprise "Ukrainian Institute of Intellectual Property", 2015).

In order to stimulate innovation processes in Ukraine, 24 centers of innovation and technology transfer; 108 scientific and educational centers; 34 educational research-and-production complexes; 1 investment (innovation) venture fund; 6 non-bank financial and credit institutions; 27 research and development enterprises; 7 consulting centers on innovation activities; 10 innovation and technological clusters; 22 innovative centers; 23 innovative business incubators; 38 centers of commercialization of the objects of intellectual property rights; 17 enterprises of the STI system; 1 industrial park; 8 national contact points of the Seventh EU Framework Program for the Research and Technological Development; 9 science parks; 27 regional investment and development centers; 7 public organizations on innovation issues; 61 another innovation structure were also created (Statistical information: innovative activity, 2016).

However, due to the considerable formalism, bureaucratic, socio-economic and regulatory barriers, the functioning of the organizational and economic mechanism of commercialization of the researches results in the HEIs in Ukraine, takes place through the slightest opposition. At present, the number of registered inventions is significantly lower than the number of applications for utility models, which are simpler in design and execution, but also significantly lower in terms of commercial returns. During 2011-2016, all national HEIs received over 36 thousand patents for inventions and utility models, but inventions amount to only 5,500. The first place is taken by the National University of Food Technologies (462 inventions over the last 5 years). The second place belongs to the National University of Bioresources and Natural Resources of Ukraine (249 inventions) (Statistical information: innovative activity, 2016).

The key problem of establishing an effective organizational and economic mechanism for the commercialization of the results of researches in the HEIs is insufficient support from the state. In Ukraine, the first steps have been taken to form effective mechanisms of cooperation between the HEIs and business. Thus, the Kyiv National Taras Shevchenko University, with the aim of establishing effective work with external, first of all, European, technology markets since June 2011, has become a member of the Consortium of EEN-Ukraine. As a part of this collaboration, he represents the best Ukrainian innovation developments in the Network of the European Enterprises (EEN), which is one of the key European tools for establishing contacts between the researches results and business. By now, the university has hosted 32 proposals (21 own and 11 from other HEIs and the National Academy of Sciences of Ukraine), which represents about 50% of the projects presented on the network of UES. However, the country has yet where to strive for, because compared with other countries, these results are rather low (Table 1).

Thus, in Ukraine, there are all grounds for the development of the organizational and economic mechanism of commercializing the researches results, but it is necessary to take into account the lack of links between the scientific and educational sphere, business, government and society. We propose to consider the mechanism of commercialization of the researches results es of HEIs as a set of elements of the organizational structure and a set of economic, managerial, motivational and other methods, rules, procedures, which are provided by three functional areas: resource,

commercial and the direction of strategic planning of the process of commercialization of scientific researches results.

Table 1. Presented profiles in the EEN database (commercial offers, business inquiries, technological inquiries) in 2016

	Ukraine	Sweden	France	Germany	Poland	UK
Total in the database	52	164	607	615	770	943
Business offers	17	88	339	289	589	638

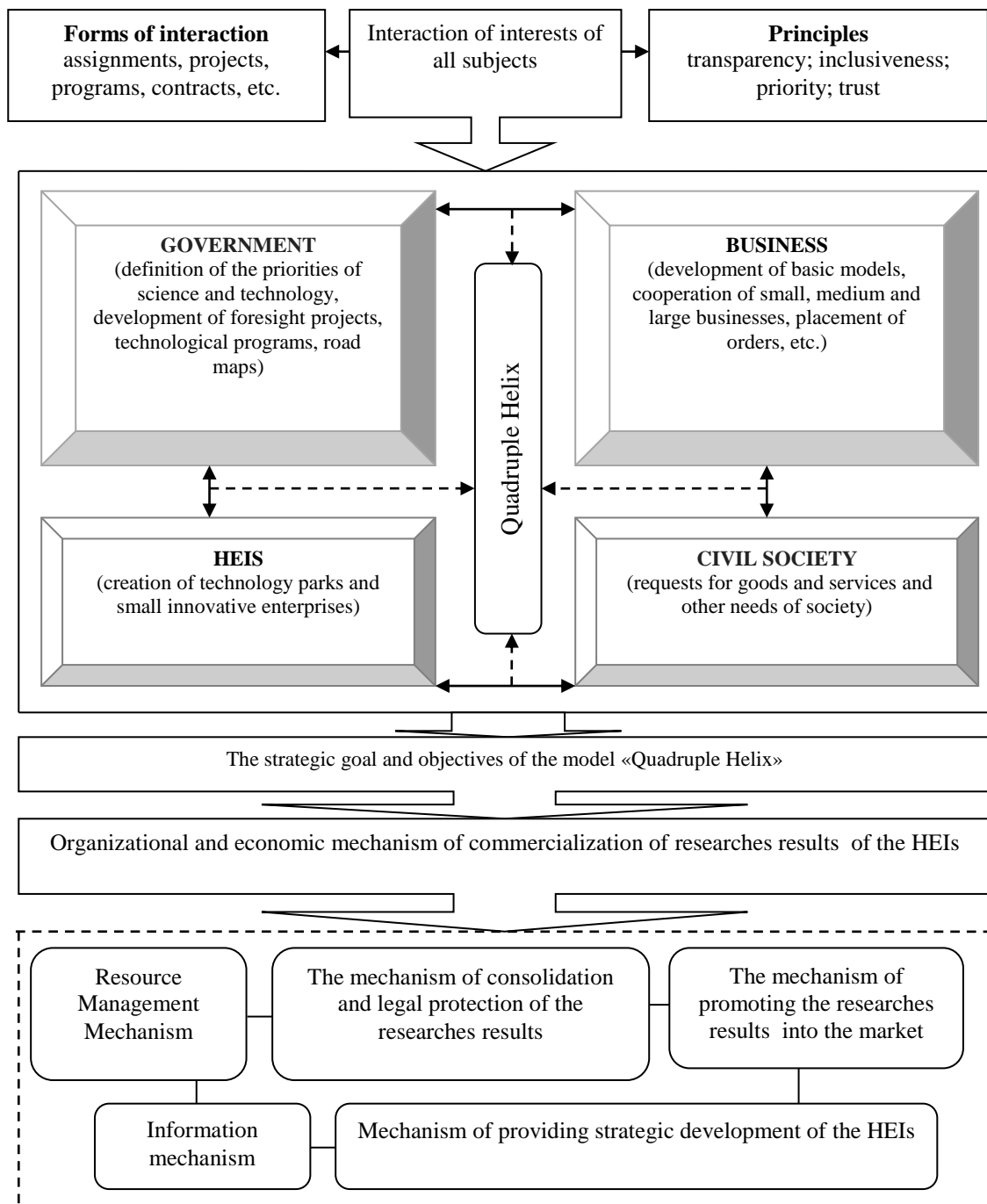
Source: *Partnering Opportunities. Enterprise Europe Network. Mode of access: [http://ein.es.eur.open.edu/tools/serrvices/SearchCenter/Search/ProfileSimpleSearch? Shid = 32db25cb-726f-43bo-8b5f-7742d0935799](http://ein.es.eur.open.edu/tools/serrvices/SearchCenter/Search/ProfileSimpleSearch?Shid=32db25cb-726f-43bo-8b5f-7742d0935799)*

That is, the first major function should be the resource management function. In our opinion, the commercial direction is provided by three functions: marketing (advancement of the results of research on the market), the function of legal protection and the function of informational support for the commercialization of the researches results in the HEIs. The third direction is provided by the function of strategic planning (strategic management). Thus, we suggest assigning to the main functional elements of the mechanism of commercialization of the researches results HEIs: 1) the mechanism of resource management; 2) the mechanism of consolidation and regulatory protection of the researches results ; 3) the mechanism of promoting the researches results into the market; 4) information mechanism; 5) the mechanism of ensuring the strategic development of the HEIs.

In the framework of the systematic work on the commercialization of the researches results, the main subject is the HEIs, which interacts with a number of other economically independent entities involved in this process. Such subjects can be both included in the HEIs, that is, included in its internal environment (researchers, scientific groups, etc.), and external to the institution of education, that is, in the composition of the environment (the state as an investor and controlling body, private investors, implementing organizations, consumers, competitors, etc.). The interaction with these subjects on the development, use, transfer of scientific researches results with a view to introducing them into commercial circulation represents the content of the activities of commercializing the researches results by the HEIs. In its turn, the number of subjects of commercialization and their composition may be different. Regarding the analysis of the interconnections in order to ensure the commercialization of the results of research in the HEIs, we consider it appropriate to propose a model of "Quadruple Helix", which involves the association of such subjects as: government, HEIs, business and civil society (Fig. 1)

At the state level, it is necessary to adopt legislative acts, to determine the priorities of science and technology, technologies, to develop foresight projects, concepts of science, scientific and technical programs, road maps, etc. At business level it is necessary: to work out the basic models of small and large business development; the implementation of cooperation between small, medium and large businesses; placement of orders; the formation of new structures, etc. At the level of HEIs, it is envisaged: the coordination of activities of the HEIs, research institutes; the formation of technology parks and small innovative enterprises; conducting fundamental scientific researches and experimental approbation of their results in technological parks. The

public forms various requests for goods and services and other needs of society up to individual orders of individuals and legal entities.



Graph 1. Schematic interpretation of the conceptual components of the Mechanism of Commercialization of the Researches Results of HEIs on the Quadruple Helix Model

The strategic guidelines of the organizational and economic mechanism of commercialization of the researches results es of the HEIs are to ensure the maximum inclusion in the commercial turnover of the researches results (potential objects of commercialization, Table 2).

Table 2. Classification of HEIs’ research results as the objects of commercialization

No	Classification group	Types
1	Affiliation to the type of activity	1) fundamental research; 2) applied research; 3) research and development (R&D); 4) educational and methodological developments
2	The term of obtaining scientific researches results	1) long-term (more than 3 years); 2) medium-term (1-3 years); 3) short-term (up to 1 year); 4) used in current activities
3	Sources of funding	1) external financing (grants from international organizations and foundations); 2) state financing (government procurement, targeted programs, state funds); 3) private financing (venture investments, joint activity, sale of rights, sale of services); 4) mixed financing; 5) creation of endowment funds (the investment funds which are funded by donations (including the HEI graduates as donors)
4	Depending on the customer	1) scientist's initiative; 2) higher education institution’s internal need; 3) state order; 4) contract with business sector
5	Depending on the way of commercialization	1) the transfer of research results (sale of rights, formation of small innovative enterprise, the transfer of researches results to the customer under the contract); 2) internal use (in educational process, in further research activities, in provision of services, etc.)

Source: Mazur I. (2013). Commercialization of scientific developments as a factor of competitive development of entrepreneurship. Bulletin of the Taras Shevchenko National University of Kyiv, 148, 245-251.

Taking into account the peculiarities of commercialization objects, it is expedient to use two approaches to commercialization, which are reflected in the structural and functional elements of the organizational and economic mechanism of commercialization of the researches results of HEIs, namely: 1) handing (transfer); 2) commercialization by obtaining the income from its own use by a higher education institution. The peculiarity of functioning of the national HEIs is that they do not have the necessary financial resources to create a ready-made innovative product based on the researches results that would have demand in the modern market. That is why the transfer of researches results to HEIs in Ukraine should be considered as a key tool for their commercialization and serve as a benchmark for improving the organizational and economic aspects of functioning of the HEIs in Ukraine.

CONCLUSIONS AND RECOMMENDATIONS

The essential condition for the formation of the domestic innovative economy is the effective mechanism of commercialization of the researches results, as well as matching the demand for innovative technologies put forward by the real sector of the economy, and proposals for their development on the part of the HEIs. Successful

commercialization of scientific achievements is possible when the higher education establishments interact with business through the innovative infrastructure. Thus, the conceptual structure of the mechanism of commercialization of the researches results of the HEIs in Ukraine is proposed. A promising model for implementing the mechanism of commercialization of researches results of HEIs in Ukraine is "Quadruple Helix" (HEIs-business-government-civil society institutions), which is focused on the integrated management of innovation activities, in particular, the process of formation, transfer and implementation of scientific developments, creating technology-intensive technologies on their basis. That is, the implementation of this model can become an effective method and mechanism for the implementation of the priorities of science and technology. In order to successfully implement the "Quadruple Helix" model, a number of complex problems should be solved: institutional nature (solving the issue of regulatory and legal support for the protection of intellectual property rights and technology commercialization); personnel nature (the deficit or lack of qualified trained specialists); financial nature (the lack of funding for research, acquisition of new equipment, insufficient working capital, etc.).

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