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Analysis of the main forms and types of commercialization of R&D in developed countries

Abstract

Object: Identification the main forms and types of commercialization of developments in developed countries in order to use them in the process of university technology transfer to the regional innovation system

Methods: In the course of the study, methods of system analysis, comparative analysis, grouping method, content analysis, methodology of the Global Innovation Index rating were used.

Findings: The article considers the main ways of commercialization in the developed countries of the world. It is shown that in many respects successful models of technology transfer have arisen as a result of the adoption at the state level of legislation that stimulates the process of commercialization. The systematization of approaches to the commercialization of the results of innovative scientific research in world practice has been carried out; practical recommendations have been given for managing this process. The article discusses the main schemes for the distribution of royalties from the implementation of intellectual property between an inventor and a scientific organization. The main forms of technology transfer used in developed countries are studied. Conclusions are drawn about the importance of the commercialization of innovations at various levels of the economy, the impact of state policy on the formation of a model for the commercialization of R&D (research and development) results, and the interaction of universities with the business sector.

Conclusions: The article identifies the main problems hindering the development of commercialization in Kazakhstan. The importance of technology transfer from universities to industry as a necessary condition for the development of an innovative economy is substantiated. The main characteristics of universities that conduct active scientific research are revealed. The main forms of technology transfer used in developed countries are identified, which include patenting, licensing agreements, fulfillment of orders for R&D, creation of spin-off companies. The experience of organizational and legal support of commercialization in developed countries is systematized, which is of interest for the development of technology transfer in developing countries.

Keywords: commercialization, university, technology transfer, third mission, innovation.

Introduction

Today, in all countries, universities are actively participated not only in educational and scientific processes, but are also involved in regional innovation systems, influencing social and economic development. The university becomes a scientific hub that unites the participants in the innovation process, creating, accumulating and transferring knowledge for public use.

Effective development of innovation system and higher education in Kazakhstan requires changes in the approaches of managing intellectual property, innovation infrastructure of the university and the process of transfer of technology. The study and use of foreign experience in the development of their own strategies and experience for the development of innovative activities can give domestic universities the necessary competitive advantages in the market of educational services. The use of effective models and mechanisms of commercialization makes it possible to motivate scientists to implement their own developments, to set a new vector for their professional activities.

The article defines the features of the main models for the transfer of university developments and technologies to business in foreign countries. The current problems of legal regulation of the transfer of the results of intellectual activity are considered.

Literature Review

The development of the knowledge economy along with globalization have contributed to the change and expansion of the tasks of universities around the world. The mention of the “third mission” of universi-

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ties appeared in Western literature in works by Klofsten & Jones-Evans (2000), and the concept itself in Laredo (2007). Universities have always been recognized as generators of knowledge. The concept of the "third mission" recognizes not only the process of generating knowledge, but also its value for improving the welfare of society. In this regard, the performance of universities is also assessed in terms of the successful implementation of scientific development into production (Cesaroni, Piccaluga, 2016).

In general, within the framework of the "third mission" concept, a multidimensional approach has been implemented, which includes both obtaining mandatory profits at the university through the commercialization of academic knowledge, as well as creating and developing social value from state funding of universities (Perkmann et al., 2013).

In the CIS countries, the works of A.V. Zharinov, S.M. Ilyashenko, V.L. Inozemtsev, L.G. Melnik, E.A. Monastyrny, I.G. Dezhina and others are devoted to the problems of commercialization. A great contribution to the classification of various forms and methods of commercialization, their advantages and disadvantages was made by the researchers Anisimov & Danilova (2017).

In Kazakhstan, the issues of commercialization of domestic developments are disclosed in the works of S.K. Bishimbaeva, G. Alibekova, K.R. Amanchaeva, K.S. Mukhtarova and others. Their studies focus on the legislation of the Republic of Kazakhstan in the field of commercialization in terms of its impact on the development of innovative ecosystems of research universities, presents the main problems in the field of commercialization of the results of scientific and technical activities of universities. The problems of evaluating the effectiveness of programs for the commercialization of scientific developments in Kazakhstan are considered in the works of Alibekova *et al* (2018).

Despite the presence of a large number of works in the field of commercialization, the issues of commercialization of university developments are not sufficiently covered. Changing legislation in the field of intellectual property, technology transfer requires further research in order to determine the most effective models of commercialization in the current environment.

Methods

The study used methods of system analysis, grouping, comparative analysis, content analysis. The study of the role of universities was made in terms of the concept of the "third mission", within which universities can create partnerships with the business sector and carry out technology transfer. The data of the Agency for Strategic planning and reforms of the Republic of Kazakhstan Bureau of National statistics, the rating methodology of the Global Innovation Index were used.

Results

The main opportunities for creating competitive advantages for the country are the implementation of innovative potential through the introduction of innovative developments in industrial production. An important problem of the Kazakhstan innovation system is the low demand for innovation by enterprises, a small number of innovation-active firms. As a result, the share of innovative products (goods, services) in GDP in 2021 amounted to 1.71%, which is significantly lower than in developed countries.

The universities of the Republic of Kazakhstan are poorly involved in the process of creating R&D. In 2021, only 21.7% of universities of the Republic of Kazakhstan carried out R&D. The problem is also a decrease in financing the costs of universities from the republican budget, the lack of large sources of funding from the business sector. Also, modern economic processes put universities in a condition of competition for government orders, talented students, and qualified personnel.

Domestic R&D spending as a percentage of gross domestic product was 0.13%, which is extremely low. In many regional universities, there is no infrastructure (incubators, technology parks, etc.) necessary for introducing innovations and acquiring practical skills for students to prepare real start-up projects.

The most important factor in the development of universities at present is the commercialization of scientific developments (Sitenko D.A., Holienka M., 2022). It is the introduction of developments into production that can serve as a new source of income for the university, will allow the university to get involved in the innovative processes of the region, and form a long-term partnership with the business sector. The development of commercialization requires restructuring and internal processes of the university. In addition to educational and scientific activities, the university needs to develop commercial, marketing, technological, and organizational aspects of its activities. Commercialization allows the university to become more successful from a financial and scientific point of view.

In Kazakhstan, the State Program for the Development of Education for 2011-2020 formulated the tasks of strengthening the interaction between universities and the business sector. For this purpose, new concepts

of “research university”, “national research university” were introduced in the new law of the Republic of Kazakhstan “On Science”, a new approach to the innovation development and science was formed. The first research university in Kazakhstan was Nazarbayev University, which was awarded this status in 2012.

On October 31, 2015, the Republic of Kazakhstan adopted the Law “On the commercialization of the results of scientific and (or) scientific and technical activities”, which laid the legal basis for the interaction of the university with the business sector in the transfer of technology. The need to pass the law was due to the underdevelopment of legislation in the field of technology transfer and intellectual property, as well as the lack of incentives to ensure rapid and efficient commercialization of R&D results.

This law defined the commercialization of R&D as one of the functions of universities, along with educational and scientific ones. The law determined the minimum guaranteed amount of royalties. For example, in the case of concluding a license agreement or an agreement on the assignment of an exclusive right, the remuneration to the author is at least thirty percent of the amount of the license agreement (including royalties). Universities, scientific organizations, industrial enterprises have the right to establish higher remuneration by their internal regulations. This practice is present in US universities. However, in the absence of internal regulations, which, unfortunately, is the case today in most organizations in Kazakhstan, the employer is obliged to pay authors only the minimum remuneration established by law.

The “blind spots” in intellectual property legislation and in the vector of the development of the university negatively affects the activity of higher educational institute and make development plans unachievable. Therefore, to address the issues of commercialization of domestic enterprises, it is of great importance to study the experience of foreign countries, the features of the transfer of university developments in assessing the effectiveness of the transfer process.

Most R&D spending in the US is borne by the private sector, although the federal budget still plays an important role in funding basic research. And despite fluctuations in the federal budget for R&D over the past 30 years, the overall ratio of public R&D spending to GDP in the US is still relatively high, despite its tendency to focus on defense and healthcare.

The federal government is also using the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs to expand opportunities for public-private partnerships and strengthen the role of small firms in federally funded innovation.

In the US, market-based instruments are favored, such as corporate tax credits, which allow private firms to reduce marginal costs through deductions for R&D spending. US patent and copyright systems also help provide important incentives for innovation by increasing the potential returns on R&D and by protecting inventors. And in areas where federal public procurement policy creates strong demand for innovative technologies, the absence of large state-owned enterprises means the government must instead contract with a variety of private-sector manufacturers (Melaas, A., Zhang, F., 2016).

Great importance for the development of the commercialization of scientific research of universities was the adoption in 1980 of the laws of Stevenson-Widler technological innovation act and Bay-Dole act. Thanks to the Bayh-Dole act, universities, scientific organizations, and innovators have the right to create, acquire and dispose of the rights to intellectual property created with public funding.

There are about 250 research universities in the USA. The term "research universities" originated in the United States to distinguish higher education institutions that train specialists in doctoral studies from those universities that offer only master's and bachelor's programs without research activities (Hall, Rosenberg, 2010). Researchers (Atkinson, Blanpied, 2008) identified a large amount of research spending as the main criterion for selecting a university as a research university. Data on the largest research universities in the United States show that the effectiveness of the functioning of such universities largely depends on financial and material resources (Amran et al, 2014).

In the early 1970s, the Carnegie Endowment developed the Classification of Higher Educational Institutions of the United States, in which the criteria for a research university were given:

1) the presence of doctoral studies, including a certain number of scientific disciplines for which the degree of Doctor of Philosophy is awarded;

2) a certain number of federal research and teaching grants received by the university;

3) availability of study programs for university students;

4) entry into the list of the best universities in terms of federal financial support for research and development.

Dezhina (2004) identifies a number of features, compliance with which allows us to classify the university as an innovative (research) type:

- a large number of specialties;
- priority of scientific research at the faculty, including fundamental ones;
- development of innovative activity in science and education;
- training of scientific personnel, with an emphasis on postgraduate education;
- participation of foreign scientists in the educational and scientific process;
- introduction of new areas of research and improvement of teaching methodology;
- innovative infrastructure for the implementation of research results, communication with research institutes and scientists in this field.

Also, research activities in the United States are carried out by institutes of higher studies, where personnel for scientific activities are trained from already defended PhD staff, as well as national laboratories that focus on narrow areas of research. Scientific research is also carried out by private corporations, which are engaged in fundamental and applied research at the expense of private capital (Yerzhanova S.K. et al, 2022).

In technical universities, the created technologies are introduced through licensing agreements. As a rule, the created technology is transferred from the university to the industry through venture capital companies. In another case, the technology is created in the research departments of the company itself, as a rule, such departments are present in large companies. The main forms of technology transfer are presented in Table 1.

Table 1. Main forms of technology transfer used in developed countries

Classification	Forms
Directly related to the owner, involving the innovative infrastructure and staff of the university	- consulting services - educational services - technical support services - R&D orders from industry
Based on intellectual property rights	- license agreements, i.e. transfer of rights to various types of intellectual property (patents, trademarks, etc.), transfer of know-how - creation of "spin-off" companies - creation of joint ventures - production and sale of products
Note - complied by authors based on Gromov, 2009; Nazarova & Kirova, 2021	

The distribution of royalties between the scientist and the university is distributed according to a certain mechanism. As a rule, the researcher receives 50% of the first 100 thousand dollars, received by the university for the implementation of the invention (Cornell University, Princeton University, Ohio University). From subsequent receipts, the scientist receives 20-30% royalties. Sometimes the costs of project support (marketing, patenting) are deducted from these incomes (Gromov, 2009).

In the ranking of the Global innovation index, the United States in 2022 occupies the second position after Switzerland.

Research parks at universities have become widespread in the United States. Within the framework of such parks, cooperation between the government, business and the university (Etzkowitz, Leydesdorff, 2000) is implemented. The research park has a diverse innovation infrastructure on its territory, where small innovative firms can develop from an idea to finished production. As a rule, in such parks, startups receive support at the early stages of their development, when the enterprise looks high-risk and does not have much funding. It is in such parks that technology transfer occurs, when the idea of technology arises at a scientific institute (center) and is embodied on the technical base of the park. The most famous US research park Silicon Valley is located around Stanford University. The Stanford Industrial Park has been operating since 1951 and currently has more than 150 resident companies.

In terms of innovative development, the UK regularly ranks in the top 10 and top 5 in a number of international rankings. Thus, in the Global Innovation Index 2022, the UK took 4th place. The UK innovation system is of the traditional type; it presents all the elements of the innovation system, implements a full cycle from scientific research (fundamental, applied) to implementation in production (Nazarova, Kirova, 2021).

In the UK, universities play a large role in the implementation of scientific research. It is home to four of the top ten universities in the world: Oxford, Cambridge, University College London and Imperial College London. Universities host research and development centers that focus on turning innovative ideas into business ventures. The first research parks in Europe appeared in the UK.

In this country, innovation policy was developed in 1993 with the adoption of a number of laws on patent law, as well as cooperation between universities and the business sector.

The development of programs for targeted state financing of the introduction of university developments has contributed to an increase in the role of British universities in the innovation system. By 2010, the UK has become the leading country in the EU in introducing university developments into industry and producing innovative products.

In the EU, the European Network of Innovation Relay Centers (IRC) has been established to provide communication between universities and business. The network includes 71 centers in EU member states, Bulgaria, Iceland, Israel, Norway, Romania, Switzerland, Turkey and Chile. The main goal of the IRC network is to promote innovation in Europe and increase the competitiveness of European industry through innovation.

In Japan, since the 1980s, great attention has been paid to innovation. Japan's innovation system is distinguished by a high level of development of applied scientific research, the ability of private companies to quickly implement and commercialize R&D results. Private capital is actively involved in the financing of research and development. Japanese universities do not play as important a role in research as they do in the US. The weak link of the Japanese NIS is the lack of attention to fundamental research, the weak development of venture financing.

Intermediary organizations have been created in Japan to transfer technology from universities to industry. The adoption of laws in the field of intellectual property has facilitated the transfer of technology from universities to industry, which has increased the number of research and their implementation. Technopolises have received great development in Japan. As a rule, they are based on traditional industries, creating an infrastructure around them for related, new industries: electronics, robotics, biotechnology, production of new materials, green energy.

The organizational and legal mechanisms for technology transfer that have developed in foreign countries are currently presented in Table 2.

Table 2. Organizational and legal support of commercialization in developed countries

Legal mechanisms	Implementation of the mechanism	Implementing countries
Establishment of ownership of R&D	The right to intellectual property created by the employee is assigned to the organization by the employer	Austria, Belgium, Denmark, Germany, USA, Ireland, Great Britain
	Personal property along with mixed one	Finland, Sweden, Italy, Greece
Implementation of property rights to IP	Royalties are formed in an equal share between the scientist and the organization	France
	Preferential taxation of income received by scientists from the introduction of technology	Ireland
Stimulating the participation of scientists in the transfer of results	The right to own shares in established companies, subject to maintaining the status of a state scientific research institute for six years	Germany, Italy, France, Spain, Portugal
	The right of a state research institute's scientist to simultaneously carry out teaching and entrepreneurial activities	France
Transfer of IP obtained at the expense of the state budget	With the help of an innovative infrastructure that provides consulting and technology support services	France
Control over the use of public spending on R&D	Professor has the right to invest budget money in the creation of innovative companies	Belgium, Germany, France, USA
Engagement of HEIs in R&D	Right to do business through holding companies, creation of small innovative firms at universities	Sweden
Cooperation with international partners	Legislating the participation of foreign partners, often at least two	EU
	Protection of technological innovations through a combination of patents, industrial schemes and trademark patents	USA, Japan, EU
Protecting innovation leadership	IP legislative mechanisms, maintaining a register of IP infringers	US
Engagement into international exports and competition	National brand development programs	USA, EU, Japan, South Korea
	Support for small innovative companies through tougher antitrust laws	USA, EU
	Special tax legislation for technoparks and technozones	EU
Note - complied by authors based on Linkov & Sokolova, 2012; Melaas & Zhang, 2016		

Thus, since the 90s of the 20th century, foreign countries have formed legislation in the field of protection of intellectual property rights, transfer of technologies to industry. This contributed to the growth of applied research, the interest of scientists in the implementation of R&D results in production, as well as the development of an innovative infrastructure that promotes the implementation of research results. At the same time, there are still "blank spots" in domestic legislation that do not allow the full use of the scientific potential of universities, and also hinder the massive introduction of R&D.

Conclusions

In order for the intellectual property of the university to become a source of funding as a result of its implementation at the university level, it is necessary to create an integrated innovation management system. This system should include innovation infrastructure, researchers, as well as legal mechanisms for the protection of intellectual property and technology transfer. The distribution of remuneration for the implemented technology can be distributed between the researcher and the organization in accordance with the agreements concluded.

Legislation in the field of innovation, processes of transfer and commercialization of the results of intellectual activity should take into account the experience and legal norms of foreign countries that are leaders in scientific and technological progress.

Additionally, it is necessary to clear the legislation on regional innovation infrastructure like innovation clusters, technology parks for their more effective participation in regional innovation system.

Information centers, technology transfer centers, services for the examination of patent applications and the subsequent patenting of selected inventions, business incubators, etc., should become elements of the organizational infrastructure for supporting innovation activities.

For the effective commercialization of domestic developments, it is necessary to form such a regional system, which will include universities as organizations that create and disseminate knowledge and technologies, as well as a whole range of legal, financial, social institutions that can ensure effective links between scientific, business, educational organizations in regional economy and society.

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Д.А. Ситенко, М. Холиенка

Дамыған елдердегі әзірлемелерді коммерцияландырудың негізгі формалары мен түрлерін талдау

Аңдатпа

Мақсаты: Аймақтық инновациялық жүйеде технологияларды жоо-ның трансферті процесінде қолдану мақсатында дамыған елдердегі әзірлемелерді коммерцияландырудың негізгі нысандары мен түрлерін анықтау.

Әдістер: Зерттеу барысында жүйелік талдау салыстырмалы талдау, топтастыру әдістері, мазмұнды талдау, Жаһандық инновациялық индекс рейтингінің әдістемесі қолданылды.

Қорытынды: Мақалада әлемнің дамыған елдеріндегі коммерцияландырудың негізгі жолдары қарастырылған. Коммерцияландыру процесін ынталандыратын заңнаманы мемлекеттік деңгейде қабылдау нәтижесінде көп жағдайда технологиялар трансфертінің сәтті үлгілері пайда болғаны көрсетілген. Әлемдік тәжірибеде инновациялық ғылыми зерттеулердің нәтижелерін коммерцияландыру тәсілдерін жүйелеу жүргізілді, осы процесті басқару бойынша практикалық ұсыныстар берілген. Сонымен қатар өнертапқыш пен ғылыми ұйым арасында зияткерлік меншікті енгізуден түскен авторлық сыйақыны бөлудің негізгі схемалары айтылған. Дамыған елдерде қолданылатын технологиялар трансфертінің негізгі формалары зерттелген. Экономиканың әртүрлі деңгейлеріндегі инновацияларды коммерцияландырудың маңыздылығы, ҒЗТКЖ нәтижелерін коммерцияландыру моделін қалыптастыруға мемлекеттік саясаттың әсері, университеттердің бизнес секторымен өзара әрекеттестігі туралы қорытындылар жасалған.

Авторлар өнертапқыш пен ғылыми ұйым арасында зияткерлік меншікті енгізуден роялти бөлудің негізгі схемаларын қарастырды. Дамыған елдерде қолданылатын технологиялар трансферінің негізгі нысандары зерттелді. Экономиканың әртүрлі деңгейлеріндегі инновацияларды коммерцияландырудың маңыздылығы, ҒЗТКЖ нәтижелерін коммерцияландыру моделін қалыптастыруға мемлекеттік саясаттың әсері, жоо-лардың кәсіпкерлік сектормен өзара іс-қимылы туралы қорытындылар жасалды.

Тұжырымдама: Мақалада Қазақстанда коммерцияландыруды дамытуға кедергі келтіретін негізгі проблемалар анықталған. Инновациялық экономиканы дамытудың қажетті шарты ретінде университеттерден өнеркәсіпке технологиялар трансфертінің маңыздылығы дәлелденді. Белсенді ғылыми зерттеулер жүргізетін университеттердің негізгі сипаттамалары анықталды. Дамыған елдерде қолданылатын технологиялар трансфертінің негізгі нысандары анықталды, оларға патенттеу, лицензиялық келісімдер, ҒЗТКЖ-ға тапсырыстарды орындау, бөлінетін компанияларды құру жатады. Дамыған елдерде коммерцияландыруды ұйымдастырушылық-құқықтық қамтамасыз ету тәжірибесі жүйеленген, бұл дамушы елдерде технологиялар трансфертін дамыту үшін қызығушылық тудырады.

Кілт сөздер: коммерцияландыру, университет, технологиялар трансферті, үшінші миссия, инновация, лицензиялық келісім.

Д.А. Ситенко, М. Холиенка

Анализ основных форм и типов коммерциализации разработок в развитых странах

Аннотация:

Цель: Выявление основных форм и типов коммерциализации разработок в развитых странах с целью применения в процессе вузовского трансфера технологий в региональной инновационной системе.

Методы: В ходе исследования использовались методы системного анализа, сравнительного анализа, метод группировок, контент-анализ, методология рейтинга Глобального инновационного индекса.

Результаты: В статье рассмотрены основные пути коммерциализации в развитых странах мира. Показано, что во многом успешные модели трансфера технологий возникли в результате принятия на государственном уровне законодательства, стимулирующего процесс коммерциализации. Осуществлена систематизация подходов к коммерциализации результатов инновационных научных исследований в мировой практике, даны практические рекомендации по управлению данным процессом. Авторами рассмотрены основные схемы распределения роялти от внедрения интеллектуальной собственности между изобретателем и научной организацией. Исследованы основные формы трансфера технологий, применяемые в развитых странах. Сделаны выводы о значении коммерциализации инноваций на различных уровнях экономики, о влиянии государственной политики на формирование модели коммерциализации результатов НИОКР, взаимодействию вузов с предпринимательским сектором.

Выводы: В статье выявлены основные проблемы, препятствующие развитию коммерциализации в Казахстане. Обоснована важность трансфера технологий из вузов в промышленность как необходимое условие для развития инновационной экономики. Выявлены основные характеристики вузов, ведущих активные научные исследования. Определены основные формы трансфера технологий, применяемые в развитых странах, которые включают в себя патентование, лицензионные соглашения, выполнение заказов на НИОКР, создание спин-офф компаний. Систематизирован опыт организационно-правового обеспечения коммерциализации в развитых странах, который представляет интерес для развития трансфера технологий в развивающихся странах.

Ключевые слова: коммерциализация, университет, трансфер технологий, третья миссия, инновации, лицензионные соглашения.

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