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## **FACTORS INFLUENCING INNOVATIVE DEVELOPMENT AND INVENTIVE ACTIVITY: EXPERIENCE OF EU MEMBER COUNTRIES**

*The article is devoted to the analysis of factors influencing innovative development and inventive activity in EU member states. It clarifies the changes in Ukraine's positions in international rankings including the Global Innovation Index, and the Global Startup Ecosystem Index. The authors have highlighted the main problems of creating and using inventions in Ukraine and outlined the modern model of commercialization of scientific and technical developments that was formed in the world market. A set of measures applied to increase the level of innovativeness in the European practice is given. To identify the main factors influencing the inventive activity of the EU member states and to assess the nature of such influence, the apparatus of correlation-regression analysis was used. Based on the data of the Statistical Bureau of the European Union for 2009-2021, three regression models of the influence of independent variables on the indicator of the number of patent applications to the European Patent Office (per one million inhabitants) were built. It is substantiated that the priority for Ukraine in the conditions of post-war recovery is taking into account the best standards of European countries, implementing several measures to support scientific and inventive activities, and using intellectual property objects in a practical way.*

**Keywords:** *innovative activity, inventive activity, objects of intellectual property, inventions, commercialization of objects of intellectual property.*

### **Полякова Ю. В., Шайда О. Є., Степанов А. В. ЧИННИКИ ВПЛИВУ НА ІННОВАЦІЙНИЙ РОЗВИТОК ТА ВИНАХІДНИЦЬКУ АКТИВНІСТЬ: ДОСВІД КРАЇН-ЧЛЕНІВ ЄС**

*Щоб обґрунтувати пропозиції для вітчизняної практики, аналізуються чинники впливу на інноваційний розвиток і винахідницьку активність у країнах-членах ЄС. Наголошено, що передумовою досягнення конкурентоспроможності є науково-технологічна активність та інноваційна діяльність, які найповніше відображаються в патентуванні об'єктів інтелектуальної власності. З'ясовано зміни позицій України в міжнародних рейтингах, зокрема Глобального інноваційного індексу та Глобального індексу стартап-екосистем. Виділено основні проблеми створення та використання винаходів в Україні. Окреслено сучасну модель комерціалізації науково-технічних розробок, що сформована на світовому ринку. Наведено сукупність заходів, що застосовуються для підвищення рівня інноваційності в європейській практиці. Для виявлення основних чинників впливу на інноваційну та винахідницьку активність країн-членів ЄС та оцінювання характеру такого впливу застосовано апарат кореляційно-регресійного аналізу. На основі даних Статистичного бюро Європейського Союзу за 2009-2021 рр. побудовано три регресійні моделі впливу незалежних змінних на показник кількості патентних заявок, поданих до Європейського патентного відомства (на мільйон жителів). Незалежними змінними обрано частку активного населення, яке займається НДДКР; частку зайнятого населення, яке працює у сфері високих технологій та наукомісткого виробництва; частку витрат на НДДКР у ВВП. Обґрунтовано, що пріоритетом для України як інтелектуально орієнтованої країни, що прагне сформувати конкурентоспроможну економіку та створити ефективну систему інноваційного менеджменту в умовах післявоєнного відновлення, є врахування краєвих стандартів європейських країн, реалізація низки заходів щодо підтримки наукової та винахідницької діяльності, практичного використання об'єктів інтелектуальної власності.*

**Ключові слова:** *інноваційна діяльність, винахідницька активність, об'єкти інтелектуальної власності, винаходи, комерціалізація об'єктів інтелектуальної власності.*

**Problem statement.** The formation of an effective system for the creation and use of intellectual property objects is an indispensable condition for the innovative

development of countries in terms of globalization of economic development. Modern approaches to justifying the importance of innovative development highlight the

priorities of the development of the information society, the need for the production and accumulation of knowledge, the need for the development of human capital, the importance of sharing the results of scientific and technical activities and objects of intellectual property, the necessity of investing in education and intellectual capital.

It is generally recognized that there is a relationship between the level of protection of rights to intellectual property objects and the activation of the development of advanced technologies, which is caused by capital investments and technological transfer. Accordingly, countries with an imperfect level of protection of intellectual property rights and weak development of scientific and technical activity will not be able to attract significant amounts of investments and technological flows, since subjects of intellectual activity do not have incentives for patenting or concluding licence agreements based on valid protection documents. Today, an important prerequisite for achieving competitiveness is scientific and technological activities and innovative activity, which are most fully reflected in the patenting of intellectual property objects.

**Analysis of recent research.** Innovative activity at various levels is the object of scientific research by many domestic and foreign scientists. H. Androshchuk emphasizes the irreplaceability of innovative economic development, considering inventors to be key figures in the innovation process, as they are the bearers of technology and know-how; they generate knowledge that carries out innovative transformations in technology and industry [1]. I. Sochynska-Sybirseva has been studying the factors of innovative development, emphasizing that the leading innovative countries of the world constantly activate the factor of establishing the interaction of the state and society by creating conditions that promote the development of science and education. They also enhance the activation of scientific developments and research in the context of financial support for innovative development provided by the state. Based on this, the development of the national economy of Ukraine requires the use of the most influential factors of innovative activity [8, p. 75]. The team of researchers under the leadership of Yu. Kapitsa is studying the development of inventive activities, in particular, in scientific institutions of Ukraine. Scientists consider scientific institutions and universities as generators of objects of intellectual property rights, the use of which can significantly affect the development of the economy, especially high-tech industries [2]. Despite the significant number of scientific developments on this issue and the number of works of researchers, the innovative activity requires the identification of essential factors capable of clearly defining the main directions and mechanisms of its activation for economic growth and strengthening competitiveness.

**The paper purpose** is to find out the factors that determine innovative activity and inventive activity, in particular, in modern conditions of significant technological transformations.

**Major research findings.** In 2022, the world was in the midst of global challenges that changed it fundamentally. The global security system, world institutions, economic models, and attitude to the environment have changed. Open access and economic freedoms, that is, the conditions when state institutions are effective, have become the key to the success of countries that have undergone modernization. After the war, Ukraine will be a country with a new social contract, with a rebuilt infrastructure in the state

administration system: new urban infrastructure, new energy, new industry, a new progressive education system, and new adaptive state institutions. The country's priorities will be the development of human capital, science, innovation and entrepreneurship, security, and protection of property rights [3].

According to the Ministry of Economy of Ukraine, in 2021 Ukraine worsened its rating and took the 49<sup>th</sup> position (in 2020 it occupied the 45<sup>th</sup> position) in the overall rating of the Global Innovation Index of 2021 (the country scored 35.6 points out of 100), and also took the 32<sup>nd</sup> position among 39 European economies. Deterioration occurred in terms of the regulatory environment, human capital and research, knowledge and results of scientific research. In 2022, Ukraine took 50<sup>th</sup> place in the annual ranking of the Global Startup Ecosystem Index 2022 by the Global Startup and Innovation Research Centre Startup Blink. The country dropped 16 positions compared to 2021 when it ranked 34<sup>th</sup>. Startup Blink associated such a sharp decline with a full-scale war in our country, which could not but affect the Ukrainian startup system [4].

The importance of intensification of innovative activity is emphasized at the level of many international program documents and national legislative acts. The efficiency criteria of measures adopted by governments to stimulate innovative activity are measured by the following indicators: the number of received patents; the technological balance of the country; expert evaluation of the quality of innovations compared to the world level; the number of companies carrying out research and development works. An important direction in this area is the support of inventive activities, the result of which is the creation of intellectual property objects, their legal protection, and the process of commercialization.

The World Intellectual Property Organization in documents on the development of national strategies in the field of intellectual property emphasizes the importance of the use by the state of a set of means aimed at the generation and applied use of intellectual property objects for the implementation of inventive activities in modern conditions.

To intensify the processes of creating intellectual property objects in EU member states and the USA, a system of measures is being implemented, which includes: financing of public and private partnership programs between scientific institutions, universities, and enterprises; creation of a system of venture funds; tax support for innovative activities; crediting costs for innovative activities; development of the infrastructure of innovative activity and technology transfer; introduction of programs to support the creation of startups by scientific institutions and higher education institutions.

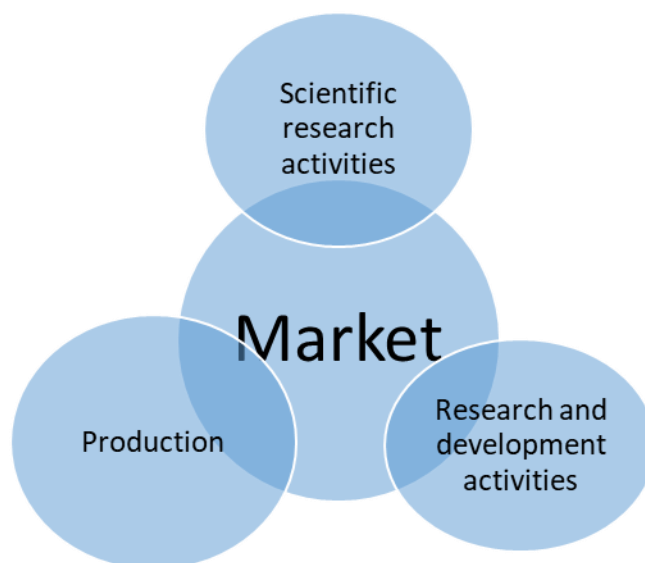
In general, objects of intellectual property include objects of industrial property and copyright. The first ones are used in the field of material production, thanks to which enterprises increase the efficiency of their activities, strengthen the competitiveness of products, and contribute to scientific and technical progress. About 4,000 objects of industrial property are used in the economy of Ukraine, including 1,800 inventions, which is 7% of the total number of valid patents; 2.4 thousand utility models (6%); 393 thousand industrial samples (3%). The number of applications for utility models is 2.3 times greater than the number of applications for inventions, and the number of issued patents for utility models is 3.2 times greater than the number of issued patents for inventions. As a rule, within a year, 75% of patents of national owners lose their validity due to non-payment of fees for maintaining the validity of patents for inventions and utility models. Most of the objects

of industrial property protected by security documents are not used in production and end their life cycle immediately after having been developed and having obtained legal protection. According to the indicators of filing applications for inventions under the international procedure (Patent Cooperation Treaty (PCT)), Ukraine ranks only 40<sup>th</sup> [1].

The main problems in generating and using inventions in Ukraine are: lack of effective financial, tax and credit means aimed at the commercialization of research results and intellectual property objects; low industry demand for research results created in scientific institutions; low reliability and quality of protective documents associated with low standards of legal protection for utility models and industrial designs; lack of effective technology transfer infrastructure and poor development of venture financing institutions; reduction of inventive activity in the industrial sector; lack of a state system of training and retraining of personnel dealing with issues of intellectual property

protection; lack of a support system for licensing activities of scientific institutions, etc. [2]. The above-stated facts have caused the insufficient use of innovative prospects and scientific and technical potential by Ukraine and the loss of positions in international innovation ratings.

Commercialization of technology is the result of the innovative process that involves the creation, development, and dissemination of technical and economic ideas, the practical application of which leads to a certain socio-economic effect. The previously existing linear approach to the commercialization of scientific and technical achievements, which embodied a gradual step-by-step transition from scientific research activities through research and development activities to the sphere of production, has changed to a market approach (a market model), which involves the mediation of this process through the market environment.



**Fig. 1. Modern model of commercialization of scientific and technical developments**

*Source: Developed by the authors.*

To increase the level of innovation in European practice, a number of supporting measures are used: direct financing up to 50% of expenses for the creation of new products or technologies (France); providing loans, including interest-free loans (Sweden, Germany); creation of funds for the implementation of innovations taking into account commercial risk (Great Britain, Germany, France, the Netherlands); reduction of the state fees (state duty) for individual inventors (Austria, Germany); deferment or exemption from payment of duty if the invention provides energy savings (Austria); services provided free of charge by patent attorneys or record keeping for applicants of individual inventors (Germany) [5, p. 23].

World experience proves that the key to innovative development is state support, which is carried out through a system of specific levers for the implementation of the country's policy of innovative potential development. Among the main factors of such a system, one might single out the following [8]:

1. Economic: financial reserves; progressive technologies; scientific and technical developments and infrastructure; an effective system of financial incentives for the results of innovative activities.

2. Legislative: state support for innovative development in the context of patenting and licensing of facilities;

provision of legally enshrined benefits or privileges that stimulate the development of the innovative potential of business entities.

3. Organizational: flexibility of organizational management structures; decentralization; autonomy; creation of target groups.

To ensure the effectiveness of innovation processes, the innovation environment becomes important. An innovation-friendly environment must be understood as a set of mutually agreed conditions of the external macro- and micro-environment, which are outlined by the actions of the mechanisms of the market, state (regional and branch) regulation, and stimulation of creating and implementing innovations, as well as tools and methods that contribute to the development and maximum realization of the potential for the creativity of individuals, organizations and the state in general and that make them be focused on constant search and use of new opportunities to ensure the efficiency of production and consumption, economic growth, and increase of the quality of life. The macro-level methods of forming an innovation-friendly environment should include legal, organizational, economic, political, social, and planning methods. Separately, it is necessary to consider such an important element of ensuring the success of innovative activities as innovative culture, which at the macro level is

considered as a mechanism of social and cultural regulation of innovative behaviour of a person, and at the level of an enterprise is viewed as a system of innovative traditions, beliefs, features of personnel relations that contribute to innovation, orient the staff to development based on innovations [13].

A country's ability to create innovations and, therefore, be competitive on the world market directly depends on what quantitative and qualitative resources it invests in the development of scientific research activities and developments. In particular, it is important to finance such activities from the budget, and attract funds from private domestic and foreign investors. The share of the working population engaged in creating inventions and developing innovations also matters.

In our research, we will focus on identifying the main factors of influence on the innovative and inventive activity of the EU member states and evaluating the nature of such influence. To do this, we will use the apparatus of correlation and regression analysis. Table 1 shows the dynamic series of indicators for 2009-2021, which have been selected for the study (patent applications to the European Patent Office; share of the active population engaged in R&D; share of the employed population working in the field of high technologies and knowledge-intensive production; share of R&D expenditures in GDP).

We have built three regression models that describe the influence of each of the three independent variables X1, X2, X3 on the variable Y. The obtained models and their statistical estimates are presented in the Table. 2.

*Table 1*

**The main indicators characterizing the development of innovative activity in the EU in 2009-2021**

Year	Y (patent applications to the European Patent Office (per one million inhabitants))	X <sub>1</sub> (share of the active population engaged in research and development)	X <sub>2</sub> (share of the employed population that works in the field of high technologies and knowledge-intensive production)	X <sub>3</sub> (share of R&D expenditures in GDP)
2009	129,65	1,0505	42,4	1,97
2010	138,84	1,0803	43	1,97
2011	135,43	1,1119	43,4	2,02
2012	137,11	1,1369	43,7	2,08
2013	138,1	1,1523	43,8	2,1
2014	141,26	1,1713	44,3	2,11
2015	140,96	1,2073	44,5	2,12
2016	139,4	1,2389	44,8	2,12
2017	143,31	1,3007	44,8	2,15
2018	148,17	1,3654	44,9	2,19
2019	148,78	1,4045	45,2	2,23
2020	147,37	1,4413	46,3	2,31
2021	151,41	1,5012	46,8	2,27

Source: [6; 10-12]

*Table 2*

**Regression models of the influence of independent variables on the indicator of the number of patent applications to the European Patent Office (per one million inhabitants)**

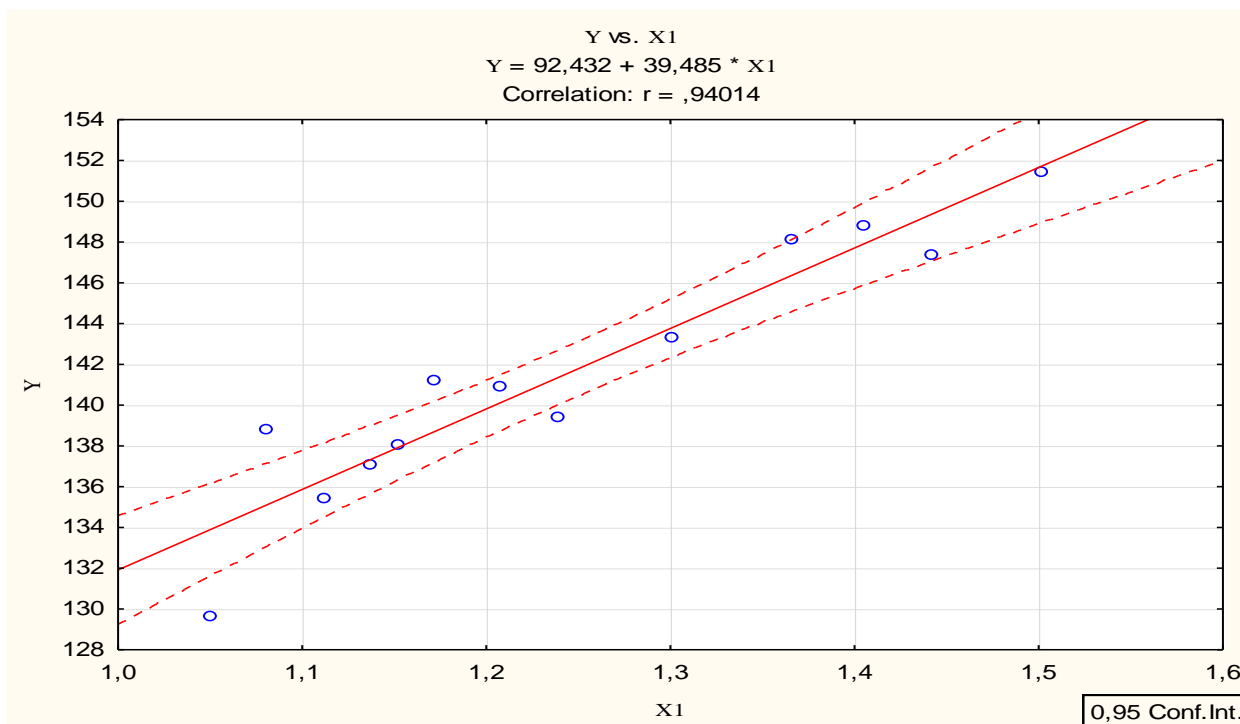
Year	X <sub>1</sub> (share of the active population engaged in research and development)	X <sub>2</sub> (share of the employed population working in the field of high technologies and knowledge-intensive production)	X <sub>3</sub> (share of R&D expenditures in GDP)
Equation of the model	Y= 92,432 + 39,485 X <sub>1</sub>	Y= - 58,20 + 4,4927 X <sub>2</sub>	Y= 30,484 + 52,225 X <sub>3</sub>
Correlation coefficient	0,94	0,90	0,89
Coefficient of determination	0,88	0,82	0,80
F-statistic	83,714	49,431	44,217
t-statistic	9,15	-2,048	1,824
Durbin-Watson statistic	2,33	1,93	2,4

Source: Compiled by the authors.

The intensity of the relationship between the variables included in the regression model is measured by the correlation coefficient, the observed value of which in all models indicates the presence of a close direct relationship between the variables. The coefficient of determination shows that 88%, 82%, and 80% of the dependent variable in each model is explained by the influence of the independent variable, respectively. Verification of the reliability of the regression model and the correlation coefficient based on Fisher's test gives reason to conclude about the adequacy of

the model since the observed value of the F-statistic in all models is greater than the table value at the level of 0.01. The independent variables included in the models are statistically significant (the t-statistic value in all models is greater than the table value at the 0.01 level).

Durbin-Watson statistic recorded the estimated values of DW shown in Table 2, which were compared with critical statistical values for  $\alpha = 0.05$ ,  $p = 1$  and  $n = 13$ ;  $d1 = 1.01$  and  $d2 = 1.34$ . Therefore, the hypothesis about the absence of autocorrelation of residuals is acceptable.



**Fig. 2. Dependence of the number of patent applications on the share of the active population engaged in R&D in the EU**  
 Source: Authors' calculations.

Thus, based on calculations using the statistical data for EU countries for the period 2009-2021, we can assert the positive impact of the growth of the share of the active population engaged in R&D, the share of the employed population working in the field of high technologies and knowledge-intensive production and the share of R&D expenditures in GDP on the number of patent applications to the European Patent Office. Based on the results of the research conducted on the example of EU member states, it is expedient for Ukraine to increase the number of R&D performers, and the number of employees in the field of high technologies and knowledge-intensive production, and to stimulate the growth of R&D expenditures. Some of these tasks are intertwined with the field of innovation management.

In the project of the National Strategy for the Development of Intellectual Property in Ukraine, it is stated that in our country intellectual property management activities are still on the periphery of management interests, and its importance is underestimated or ignored in most cases. Unlike developed countries, a significant number of Ukrainian enterprises, especially state-owned enterprises, currently do not have special divisions focused on the management of intellectual property (knowledge, innovations, and information). As a result of an insufficient understanding of the importance of intellectual property and its weak inclusion in market relations, Ukraine has a low level of its capitalization [7].

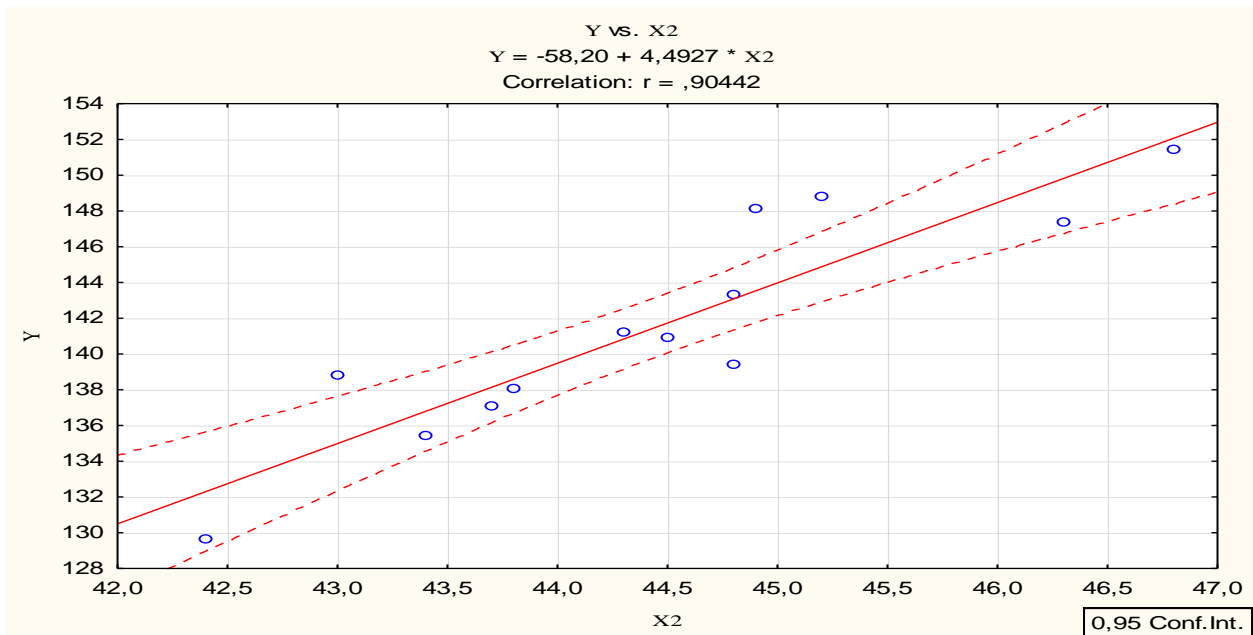
Today, it is almost impossible to respond to technological challenges without the help of the state. The state power, as a driver of digitalization, implements innovation policy, creates institutional conditions, and forms infrastructural opportunities for the development of new technologies, encouraging commercialization and stimulating demand. Feeble interaction between the

government, the private sector, and the scientific and educational community negatively affects the pace of digital transformations, the implementation of key government programs, the introduction of new technologies and business models, and the ability to respond to technological challenges and economic crises [9].

The implementation of effective measures to support inventive activity and the use of intellectual property objects in the sphere of production are considered to be challenges for Ukraine, a modern, innovation-oriented country in the conditions of post-war recovery that seeks to build a strong competitive economy, legislation and an effective management system taking into account the best standards of European countries.

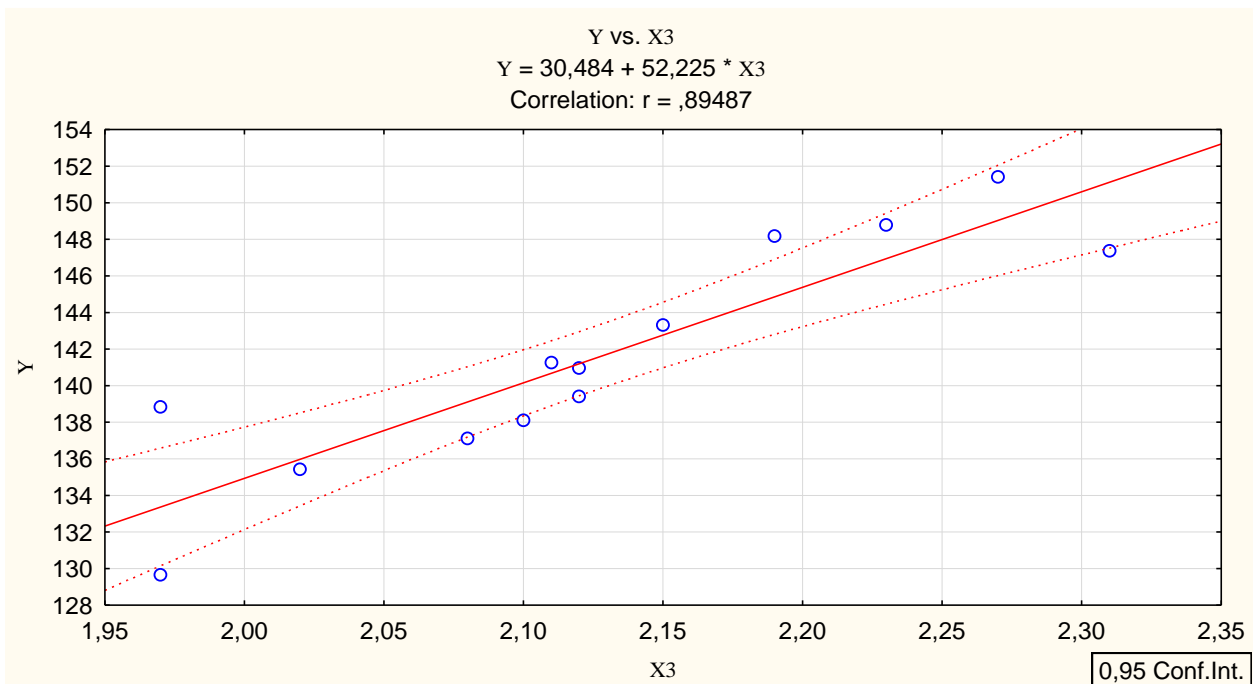
The lack of a developed innovation system and effective mechanisms for supporting innovation activities and technology transfer in Ukraine significantly narrows the possibilities of using intellectual property objects to ensure the technological development of the national economy or expanding the volume of innovative products, including those for export.

An urgent issue is adopting in Ukraine of a system of measures that provide for the improvement of the country's international innovation ratings, in particular the Global Innovation Index, the annual ranking Global Startup Ecosystem Index, the European Innovation Scoreboard, with the implementation of best practices in the application of mechanisms and tools for the development of innovative activities, commercialization of scientific and technical developments in EU member states. This will contribute to a significant increase in the volume of generation and use of inventions and other objects of intellectual property in the economy of Ukraine and its participation in the international technological exchange.



**Fig. 3. Dependence of the number of patent applications on the share of the employed population working in the field of high technologies and knowledge-intensive production in the EU**

Source: Authors' calculations.



**Fig. 4. Dependence of the number of patent applications on the share of R&D expenditures in GDP in the EU**

Source: Authors' calculations.

**Conclusions.** At the level of international program documents and national strategies in the field of scientific and technical innovative development and intellectual property, the importance of the state's use of a set of means aimed at the creation and applied use of the results of intellectual work is emphasized. A country's potential opportunities to create innovations and, thanks to them, to increase competitiveness in the world market are directly determined by the quantitative and qualitative resources it invests in the increase of scientific research activities and developments. A set of measures is being implemented to intensify the processes of creating intellectual property objects in EU member states and the USA.

Increasing the number of R&D performers, the number of employees in the field of high technologies and knowledge-intensive production, stimulating the growth of R&D expenditures in Ukraine based on the positive experience of EU member states will contribute to the enhancement of innovative activities, the development of inventions, the commercialization of intellectual property objects both domestically, and at international levels.

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