

*This study examines a system of procedures and techniques for regulating relations that create, transfer, and implement high-tech innovations in the European Union, through the prism of the promising EUROPEAN INNOVATION ACT (EIA). The current means of identifying high-tech innovations in the European Union have been studied, as well as the prospects for their improvement when implementing the EIA.*

*This work has found that the process of regulatory influence on innovation circulation in the EU is not uniform. It has been proven that the current model of regulatory influence in the EU is not focused on the proper identification of high-tech innovations. It also does not provide simplification or stimulation of their use but only has a general focus on the intensification of all innovations in the EU economy. It was determined that within the EU there is a need to improve the methods for regulating the circulation of high-tech innovations.*

*A study of directions to reform the innovation ecosystem through the implementation of the EUROPEAN INNOVATION ACT has been conducted. The feasibility of forming a definition of high-tech innovation was substantiated. The necessity of registering the criteria for distinguishing high-tech innovation from its other varieties has been proven. The need for the formation of a holistic system of regulatory influence based on the life cycle (Innovation Life Cycle) of high-tech innovation was identified.*

*This study is aimed at compiling proposals for improving the regulatory processes of innovation circulation in the EU. The results could be used in improving the official rules of innovation circulation in the EU, as well as at the level of national systems of EU member states. They could also be applied to make strategic public management decisions, form state policy on the circulation of innovations; the findings might lay the groundwork for further scientific research on these issues*

*Keywords: high-tech innovations, EU innovation circulation, state regulation of innovations, international law*

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# IDENTIFYING DIRECTIONS FOR IMPROVING THE REGULATION OF THE CIRCULATION OF HIGH-TECHNOLOGY INNOVATIONS IN THE EUROPEAN UNION

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## 1. Introduction

Innovations are a key object in the economic system of the European Union (EU). They are the basis of its production

processes and are a decisive guarantee of the stable growth of this interstate entity. High-tech innovations actually play the role of a basic element of this system. The key position of regulatory influence on the circulation of innovations in the EU

is that they require large-scale support at the stage of their development and implementation. Conversely, after a certain period of their use by the developer, they should become available to the general public. Such an approach helps enable the sustainable development of scientific and technological progress and ensure economic dominance in the region.

Such patterns of development of the life cycle of innovations in the EU require the introduction of special means and methods of state regulatory influence on the circulation of innovations. However, the existing regulatory system is more focused on overcoming organizational, administrative, and other barriers in the course of innovation circulation. Under such conditions, the issue of stimulating the circulation of high-tech innovations recedes into the background and is not provided with appropriate regulatory means.

Negative macroeconomic events in resource markets, as well as active military operations on the borders of the EU, demonstrated the need for a radical reform of many areas of economic life. One of the areas of change in the regulatory approach was innovation circulation, as a key basis for EU economic growth.

According to the results of scientific research conducted during 2024 in the EU, several basic principles of the process of reforming the means of regulatory influence on innovation circulation in the EU were formed. Thus, the feasibility of introducing a single regulatory system of influence for the entire EU (29-th regime) was substantiated [1]. In addition, the relevance of changing the current regulatory approach and the need to focus it on advanced, breakthrough, high-tech innovations was proven [2]. On that basis, in 2025, a comprehensive improvement of the system of state influence on the EU economic system was initiated. It was given the personalized name “A Competitiveness Compass for the EU” [3]. The decisive place in the reform processes was given to the regulatory impact on the innovation circulation and its further stimulation and scaling. The task was set to build a system of special means and methods for regulating the use of high-tech innovations. All the resulting proposals should be reflected in a separate EU agreement – the “European Innovation Act” [4]. The final draft of this agreement has not yet been published but the main directions of its content have already been reflected in the decisions of the EU institutions.

All of the above indicates the relevance of scientific research into this area in order to compile relevant scientific proposals to improve the circulation of high-tech innovations.

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## 2. Literature review and problem statement

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Issues related to the influence of high-tech entrepreneurship in the formation of regional innovation ecosystems were studied in work [5]. It was proven that the introduction of high-tech innovations contributes to a significant increase in the level of economic efficiency of economic activity. It was substantiated that high-tech entrepreneurship significantly increases the efficiency of all participants in the innovation ecosystem, thereby demonstrating the macroeconomic effect of its activities. However, the study was aimed solely at establishing the fact of the presence or absence of certain patterns of development of high-tech innovations. Within the framework of the study, attention was not paid to the conditions for increasing the efficiency of the introduction of high-tech innovations. And the aspects of the influence of the means of regulating the circulation of innovations were not studied.

In paper [6], an analysis of the efficiency of the introduction of innovations in various sectors of the German economic system was conducted. Using the methods of VAR-LiNG analysis, it was proven that the introduction of high-tech innovations demonstrates a significantly higher level of efficiency. However, within the framework of the work, the degree of influence of the current regulation of the circulation of technologies was not studied. No proposals were made to improve the methods and techniques of regulatory influence.

In [7], the adequacy of innovation incentives within the framework of the Horizon Europe Framework Program was analyzed. The inconsistency of regulatory tools and techniques with the needs of innovation circulation participants was substantiated. The main directions for improving existing regulation were formed. However, the authors did not pay attention to high-tech innovations. And the content of the promising “European Innovation Act” was not taken into account.

In work [8], the adequacy of regulatory approaches to regulating innovation circulation in the EU was analyzed, with the requirements of sustainable development policy. It was proven that the current rules for regulating innovation circulation do not contribute to achieving the goals of sustainable development of the EU. The need to change existing regulatory structures was substantiated. A number of proposals were formed to improve the means of regulating innovation circulation in the EU. However, only incentive tools were studied and the issue of circulation of high-tech innovations was not investigated. Also, the study did not take into account the role and significance of the “European Innovation Act”.

In paper [9], the dependence of effectiveness of the implementation of high-tech innovations on the existing regulatory rules was analyzed. It was proven that in the case of using special mechanisms for regulating innovation circulation, similar to the framework programs in the EU, their effectiveness decreases. Conversely, in the case of introducing a separate, holistic regulatory act into the regulatory system, as well as its systematic implementation by public administration bodies, leads to a greater economic effect. Such conclusions are drawn on the basis of a basic comparison of methods and techniques of regulatory influence in the EU and India. However, within the framework of the study, no proposals were suggested for further improvement of regulatory structures. The conclusions of the study were limited only to the fact that holistic systemic regulation is more effective. Also, no proposals were offered for regulating the circulation of high-tech innovations.

In the framework of work [10], the EU regulatory approach to innovation circulation and technology transfer was studied. The inconsistency of the current regulatory structures with the needs of participants in these economic relations was substantiated. Proposals were made to improve the means and methods of regulatory influence on innovation circulation. However, the work did not investigate the features of regulating the circulation of high-tech innovations, as well as the role and significance of the promising “European Innovation Act”.

When conducting study [11], the dependence of the efficiency of innovation circulation processes on the efficiency of its regulatory means was analyzed. The dependence between the simplicity of regulatory structures and the level of efficiency of innovation implementation was determined. The conclusion was drawn that greater efficiency of regulatory means has a significant positive impact on the implementation of innovations. Conversely, the complexity of regulatory

means reduces the level of effectively implemented innovations. It was substantiated that a critical level of regulatory influence has a negative impact on the level of economic development as a whole. However, within the framework of the work, no proposals were offered to improve existing regulatory structures. The issue of the influence of regulatory means on the circulation of high-tech innovations was not investigated. The provisions of the “European Innovation Act” were not taken into account.

In [12], a general analysis was conducted on the main directions of improving the means of regulating innovation circulation in the EU, in the context of the “European Innovation Act”. It was determined that within the EU there is a need to improve the regulatory approach to determining the rules for the functioning of innovation circulation. Proposals were suggested to amend the provisions of the “European Innovation Act”. The need to introduce a single definition of innovation, the formation of a preferential tax regime was substantiated. The need to change the object of regulation and its focus on the system of economic relations “Innovation Life Cycle” was proven. However, within the framework of the study, the features of the formation of regulatory means and methods of influencing the circulation of high-tech innovations in the EU were not studied. No assessment of the compliance of the processes of regulating innovation circulation with the possibility of using high-tech innovations was provided.

In [13], based on the analysis of statistical data on the main results of innovation circulation in the EU, an assessment of their level of effectiveness was provided depending on the current regulatory rules. The existence of dependences between the efficiency of innovation circulation and the level of effectiveness of existing regulatory structures was established. It was proven that the higher the level of complexity of regulatory influence, the lower the level of efficiency of innovation circulation. The inverse dependence was also proven. However, within the framework of the work, no proposals were offered regarding the improvement of regulatory methods. The features of the circulation of high-tech innovations were not studied. The possible consequences of the introduction of the “European Innovation Act” were not taken into account.

Our review of the literature [5–13] demonstrates that it is advisable to conduct a study aimed at improving the circulation of high-tech innovations in the EU. The would-be proposals should be aimed at ensuring a higher level of efficiency in the regulation of these economic relations. The results of the study could be used to define the “European Innovation Act” and become the basis for further scientific developments. That, in turn, would make it possible to enable the implementation of relevant international and domestic regulatory acts of a more effective order.

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### 3. The aim and objectives of the study

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The purpose of our study is to substantiate directions for improving the existing rules for the circulation of high-tech innovations in the European Union. This will make it possible to increase the overall level of efficiency of innovation circulation processes and create the prerequisites for economic growth.

To achieve this goal, the following tasks have been set:

- to identify the features of the regulation of the circulation of high-tech innovations in the European Union;
- to formulate proposals for the directions for improving the regulation of the circulation of high-tech innovations in the European Union.

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### 4. The study materials and methods

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The object of our study is a system of methods and techniques for regulating relations related to the creation, transfer, and use of high-tech innovations in the European Union, through the prism of the promising EUROPEAN INNOVATION ACT.

The hypothesis of the study assumes that the existing methods of regulatory definition of high-tech innovations do not contribute to achieving efficiency from their use and therefore require refinement. It is assumed that the inadequate level of current regulation of the circulation of high-tech innovations reduces the effectiveness of their implementation.

A simplification is adopted in terms of improving the means and techniques for regulating relations of circulation of high-tech innovations at the level of individual member states of the European Union. It is permissible due to the introduction in the European Union of a single unified algorithm of regulatory influence in the short term.

The study used official regulatory acts of the European Union, information from public sources, recommendations by governing bodies and institutions of this intergovernmental organization. In addition, statistical data, analytical reports, as well as official information from various international organizations were applied.

When conducting the study, general scientific theoretical methods were used, namely deduction, induction, synthesis and analysis, comparison and abstraction, modeling, formal and logical interpretation of the content of regulatory categories. To model proposals for improving the regulation of the circulation of high-tech innovations, systemic and functional methods were applied.

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### 5. Results of investigating directions for improving the circulation of high-tech innovations in the European Union

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#### 5.1. Identifying features in the regulation of circulation of high-tech innovations in the European Union

The regulatory approach to influencing the circulation of innovation in the EU is not holistic but on the contrary, is characterized by fragmentation and non-uniformity [7, 12]. This leads to confusion and errors during their implementation [8]. This creates prerequisites for the complexity of understanding the purpose and content of regulatory tools by participants in innovation circulation [11, 13]. One of the main shortcomings is that official acts and agreements of the EU do not contain key definitions of innovation circulation [9]. Instead, the method of borrowing basic regulatory structures from other systems of influence on economic relations is used [10]. This is due to both the internal complexity of the content of innovation and the desire of EU member states to retain the monopoly right to regulate them [9].

The main features of the regulatory design of the definition of innovation in the EU are determined at the level of recommendations of international institutions [12]. They define not only the concept but also provide certain divisions into their special varieties. It is customary to distinguish the following sources of borrowing the concept of innovation in the EU.

The approach formed by the World Trade Organization (“WTO”). Specifically, the WTO agreement on trade-related aspects of intellectual property rights (the “TRIPS” agreement) [14]. Article 7 of this agreement states that innovation is a further development of the object of intellectual property rights [14]. Here, the possibility of functioning within the economic system of such a special object as technological innovation is noted [14].

A similar approach was devised by the World Intellectual Property Organization (hereinafter referred to as “WIPO”) [15]. However, here an innovation is identified as an idea that has been brought to its level of industrial suitability and therefore has the characteristics of an object of intellectual property rights. [15]. Within the framework of the “WIPO” recommendations, technological innovations, revolutionary innovations, and innovative technologies are mentioned.

A special approach was developed by the International Organization for Economic Cooperation and Development (“OECD”) and Eurostat [16]. Under the guidance of these international organizations, handbooks on the main approaches to understanding the innovation cycle are being compiled on a systematic basis. Each response to such recommendations has its own name. Thus, the 2015 edition is called the “Frascati Guidelines”, and the latest edition, 2018, is the “Oslo Guidelines” [16]. Within the framework of these recommendations, innovation is defined as a special product (thing, object) and a special process. It was indicated that innovation is a new or improved product or process (or their combination). They must be significantly different from previous products or processes. And they must be introduced into economic circulation, that is, be available to potential users, or introduced into their own use [16]. Within the framework of the “Oslo Guidelines”, a number of types of innovations have been formed that can become the object of economic relations. Specifically:

- business – innovations;
- business – process innovations;
- product innovations;
- marketing innovations;
- scientific – technological innovations;
- digital innovations;
- innovations of high-tech sectors of the economy [16].

An additional approach to the definition of innovation is given within the EU Framework Program “Horizon Europe” (hereinafter referred to as “Horizon Europe”) [17]. However, the main definition of the concept of innovation is not defined within this Framework Agreement. Its content contains a corresponding reference to the “Oslo Guidelines” [17]. However, the text of “Horizon Europe” defines additional types of innovations that can be used in the field of EU innovation circulation:

- technological innovations;
- social innovations;
- environmental innovations;
- system innovations;

- innovations for global challenges;
- innovations in the field of data and digitalization;
- innovations through partnerships;
- innovations in the field of defense.

The first conclusion that can be drawn based on the above is that innovation is an independent object of regulation and influence by EU institutions.

The second is that innovation exists as a special generic category, which includes both the concept of an object (thing) and the concept of a process (system of actions).

The third is that directly in economic relations, innovation enters in certain, special external forms. These forms coincide (are identical) with those types of innovations that are mentioned in official regulatory acts. For a more accurate understanding of how innovation is involved in participation in economic relations, it is necessary to systematize all those forms of its manifestation that are used in the EU. The results of the systematization are shown in Fig. 1.

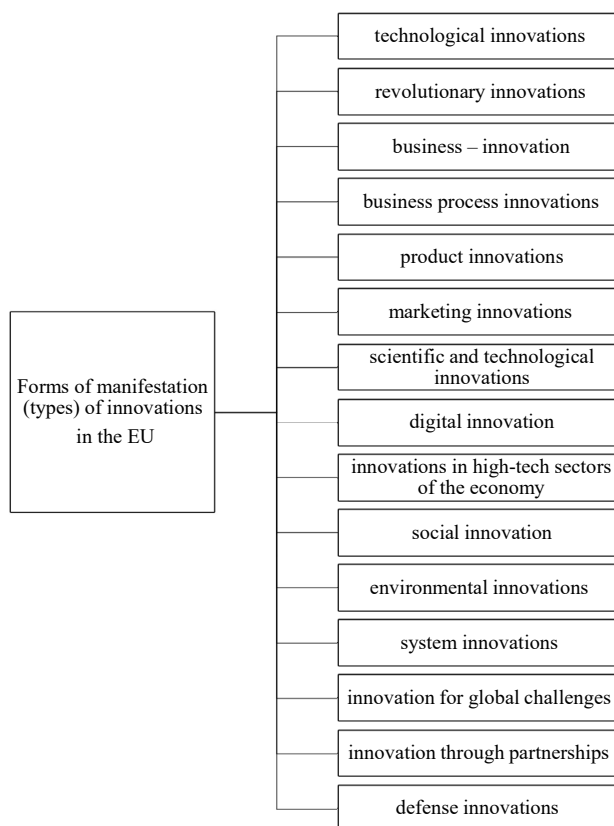


Fig. 1. Forms of manifestation (types) of innovations in the European Union

Each of the objects, which are defined in Fig. 1 as a form (type) of innovation, is an independent object of regulatory influence. Separate rules of transfer, use, and circulation are determined for it. In addition, separate means of stimulating and supporting innovation circulation are established.

In addition, during the analysis of the data shown in Fig. 1, it can be concluded that the main regulatory acts of the EU do not contain a direct definition (definition) of high-tech innovations. There are similar definitions in other countries, for example, innovations in high-tech industries

of the economy. At the same time, high-tech innovations are a common and frequently used object of economic relations [5, 6]. High-tech innovations are actively used in the innovation sphere. And a regulatory approach that does not use the definition of an object that actually actively circulates in the economic system cannot be guaranteed to be effective. Similar conclusions in content follow from the results of similar scientific studies on related issues [5–12].

A study of the content of the category of innovation in high-tech sectors of the economy, which is named in the “Oslo Guidelines”, allows us to conclude that there are no single criteria for identifying its content. The regulatory approach is built in a way that does not involve the formation of a holistic definition. On the contrary, we are talking about indicative criteria for the belonging of a certain innovation to a certain sphere (industry) of the economy. Thus, if an innovation is introduced in the field of biotechnology, pharmaceutical industry, aviation, and space exploration, it automatically acquires this status. Such an approach is discriminatory since it does not allow innovations in other industries to receive appropriate support and incentive measures. This indicates the ineffectiveness of the regulatory approach to defining innovations through a list of sectors (industries) of its implementation.

These and other reasons became the basis for initiating the process of improving the regulation of innovation circulation. Within the framework of the EU public policy reform program “A Competitiveness Compass for the EU”, special attention is paid to changing the regulatory approach to innovation circulation in the EU [3]. The main thing is that the status of innovation and the rules for its circulation will be determined by a separate regulatory act. We are talking about the European Innovation Act (European Innovation Act) [3, 4].

Despite the fact that the unified content of the “European Innovation Act” is not yet widely available, its main provisions are already available for public discussion. It is precisely because of this that it is advisable to conduct relevant research on this topic in order to timely formulate proposals for improving the regulation of the circulation of high-tech innovations in the EU [18].

However, we must not forget that within the EU there is already an imperfect, but still an innovative circulation regulation and support system. The key among them is the functioning of the Horizon Europe Framework Program. The main feature of this program is that it provides for an extensive system of measures to support the processes of innovation implementation. A significant change in such support measures is guaranteed to lead to a disruption of the existing economic relations of innovation circulation.

According to Eurostat data, the average amount of financial receipts for innovation support for the period from 2015 to 2023 remains at the level of 59–55 million euros each year [19]. Detailed information on the amount of funds attracted to the sector of innovation circulation in the EU is given in Table 1.

The data given in Table 1 indicate a relatively stable amount of financial (monetary) assets that are systematically involved in the sector of innovation circulation in the EU. Because of this, any processes of reforming and improving the processes of regulating the circulation of innovations should not occur radically, but gradually. Only in this case it is possible to obtain a gradual improvement of the current regulatory rules, without violating the conditions of the already existing system of innovation circulation.

**5. 2. Compilation of proposals on directions for improving the regulation of the circulation of high-tech innovations in the European Union**

All identified inconsistencies in the regulation of the circulation of high-tech innovations in the EU can be eliminated during the adoption of the “European Innovation Act”. It is precisely because this regulatory act is currently undergoing a stage of public discussion of its content, the relevance of the conclusions that will be formed is of a high nature.

According to the results of our study, it is advisable to propose the following directions for improving the process of regulating high-tech innovations in the EU.

Firstly, this is the preservation of existing approaches to regulating the circulation of high-tech innovations. We are talking about a gradual (phased) change in the objects of regulatory influence. The means of achieving this is the implementation of the following directions for improvement.

Secondly, this is the modeling of fundamental criteria by which any innovation can be distinguished from high-tech. As such criteria, it is advisable to propose:

- focus on the production economic process;
- inclusion of technology as a separate object of economic circulation in its composition;
- the end result of the implementation of such an innovation should be the process of manufacturing products for industrial and technical purposes or (or) consumer goods;
- the ultimate result of the implementation of such an innovation should either create a new consumer product, or significantly scale the production process, or satisfy new consumer needs.

Thirdly, this is the introduction into the EU regulatory system of a separate independent definition of high-tech innovations and the concept of their innovation circulation. This will contribute to the centralization and systematization of the regulatory influence on the relations of innovation circulation. At the same time, such a definition should already take into account the main existing definitions defined by the “Oslo Guidelines”. As an indicative regulatory construction of the definition of high-tech innovation, it is possible to offer the following:

High-tech innovation is a new or improved product or process (or their combination), which is focused on the sector of production, based on relevant technologies and is capable of ensuring the manufacture of competitive products.

Table 1

Information on the amount of funds attracted to the sector of innovation circulation in the EU over 2105–2023

Time	2015	2016	2017	2018	2019	2020	2021	2022	2023
Units	EUR million	EUR million	EUR million	EUR million	EUR million	EUR million	EUR million	EUR million	EUR million
EU (27 countries)	56.96	58.18	59.03	59.31	58.96	57.86	57.61	–	56.72

The circulation of high-tech innovations is their transfer between participants in innovation relations for the purpose of further implementation in the production economic activities of business entities.

Fourthly, this is the construction of a holistic system of regulation of high-tech innovations. The basis for such systematization is appropriate to take the life cycle of innovations, from the moment of its creation to the moment of its implementation or implementation within the production sector of the economic system.

The optimal place for the implementation of certain areas of improving the regulation of the circulation of high-tech innovations in the EU should be their official regulatory acts. These include:

- 1) the Horizon Europe framework program;
- 2) the European Innovation Act.

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### **6. Discussion of results based on investigating directions for improving the circulation of high-tech innovations in the European Union**

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The conclusions regarding the directions for improving the process of regulating the circulation of high-tech innovations in the European Union are due to the need to comprehensively overcome the identified conflicts and gaps. It has been established that the forms (types) of innovations, systematized in Fig. 1, are objects of direct regulatory influence. It has been found that none of the above forms (types) of innovations covers high-tech innovations as a special object of regulatory influence. As a result, the current regulation of the processes of circulation of high-tech innovations does not take into account the essential characteristics of this object of economic relations.

Despite that, the current regulatory approach provides positive dynamics of financial support and scaling of innovation activity within the European Union. This is fully confirmed by the data given in Table 1. The established directions for improving regulatory mechanisms allow us to eliminate most of the identified inconsistencies, while maintaining the integrity and stability of the existing system of regulatory influence tools.

During the research, a number of objective limitations were identified, caused by closed access to the project “EUROPEAN INNOVATION ACT” and the ongoing process of reforming the rules of innovation circulation in the EU. The absence of a fixed regulatory construct “high-tech innovation” at the level of official acts of the European Union prevents the analysis of the content of this category. The uncertainty of the regulatory nature of innovations in the absence of the “EUROPEAN INNOVATION ACT” can be partially compensated by implementing approved mechanisms for regulating innovation circulation.

An additional limitation of our work is the lack of consideration of the experience of regulating innovation circulation by individual member states of the European Union. However, national systems of regulating innovation circulation differ significantly, and their systematization and unification require a separate comparative legal study.

The advantage of the proposals formed is their comprehensiveness and ability to improve the key shortcomings of

the existing process of regulating the circulation of high-tech innovations. Unlike the results from previous studies [5–13], which focus only on individual aspects of regulating the circulation of high-tech innovations, the devised approach is characterized by universality and systematicity. The results could be integrated into official regulatory acts of the European Union and used in the formation of state innovation policy. The conclusions formed in the course of this study could become a theoretical and methodological basis for both further scientific research and the basis of official regulatory acts. The identified vectors for improving the process of regulating the circulation of technologies demonstrate higher efficiency compared to the approaches reported in similar studies [5–13].

Since the proposed universal regulatory structures are of a general nature, their main limitation is that their implementation in the national systems of the European Union member states will require additional detailing and adaptation. Further development of the research is seen in the design of mechanisms for improving national regulatory means of influence, as well as studying the specificity of innovation regulation within individual sectors of the European Union economy.

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### **7. Conclusions**

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1. We have determined that the existing regulation regarding the circulation of high-tech innovations does not meet the needs of its participants, as it is fragmentary and therefore disrupts their systemic activities.

2. The following directions for improving the regulation of the circulation of high-tech innovations in the EU have been determined:

- to define high-tech innovation;
- to define criteria for distinguishing high-tech innovation from its other varieties;
- phased reform of the existing system of regulation of the circulation of innovations;
- formation of a holistic system of regulatory influence based on the life cycle of high-tech innovation.

It was determined that the main place (form) of changing the regulation of technology transfer in the EU should be the Horizon Europe Framework Program and the European Innovation Act.

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### **Conflicts of interest**

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The authors declare that they have no conflicts of interest in relation to the current study, including financial, personal, authorship, or any other, that could affect the study and the results reported in this paper.

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### **Data availability**

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All data are available in the main text of the manuscript.

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### Use of artificial intelligence

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The authors confirm that they did not use artificial intelligence technologies when creating the current work.

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### Authors' contributions

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**Oleksandr Davydiuk:** Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review & ed-

iting, Visualization; **Olga Bakalinska:** Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review & editing, Visualization; **Oleksii Malovatskyi:** Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review & editing, Visualization; **Oleh Tarasov:** Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review & editing, Visualization; **Yurii Senyk:** Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review & editing, Visualization.

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