

FORMATION AND IMPLEMENTATION OF INNOVATION POLICY OF CROSS-BORDER REGIONS

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Abstract. *The subject of the research* is theoretical, methodological and applied bases of formation and realization of innovative policy of cross-border regions. The following methods were used: analysis and synthesis, induction and deduction (to reveal the essence and characteristic types of innovation policy of cross-border regions), generalization, comparison, grouping (to study the condition and innovation potential of the EU countries and Ukraine), strategic analysis (to develop the basic principles of innovation policy of cross-border regions), and others. The *purpose* of the article is to reveal the essence, the order of development and instruments of implementation of innovation policy of cross-border region development, as well as systematization of types and justification of approaches to the definition of innovation potential of the cross-border region. *Results.* The essence, the basic stages of development of innovative policy of the cross-border region were revealed. It was proved that such policy is formed taking into account the innovation component and overcoming the barrier function of the border and the interaction of border territories of 2 or more countries in the implementation of innovations. To create a high degree of interaction in innovation, it is necessary to ensure the development, implementation and realization of innovation on the basis of joint institutional, scientific, educational, financial and resource potentials. The main stages of development of an innovation policy of the cross-border region, in particular: 1) analysis of innovation potential, 2) substantiation of the process of creating a regional innovation system and its management, 3) development of a joint vision, 4) identification of priorities, 5) development of a plan of action with a narrow set of policies, 6) monitoring and evaluation. It characterizes the types of inclusive innovation policy of the cross-border region on the basis of territorial, production and social inclusiveness. It is proved that the innovation policy of a cross-border region provides its innovation functionality, cross-border critical mass and cross-border cooperation. It is reasonable to measure cross-border interactions using quantitative indicators, such as co-financing of innovation, venture capital volumes for innovative start-ups, co-patents, volumes of innovation cooperation, joint publications, mobility of highly qualified personnel to the total number of interactions. The modern financial toolkit for the implementation of cross-border cooperation on an innovative basis is characterized and the practical importance and area of use of the latest financing tools, such as: "Pathfinder", "Accelerator", "Transition", crowdfunding, crowdlending, venture capital, etc. The parameters of identification of the cross-border territory as an innovative region were defined, namely: 1) a developed system of research organizations and educational institutions, 2) a common program for the production of innovative products and technologies, 3) the formation of cross-border business innovation, 4) the use of modern funding tools, 5) achieving cross-border interaction and mutual benefit, 6) the creation of cross-border technology parks and technology incubators, innovative cross-border start-ups, cross-border clusters and growth poles. It is analytically confirmed that in order to create a multifunctional innovative cross-border region it is necessary to enhance the intensity of innovative activity.

Key words: cross-border region, innovative policy, innovation potential, financial tools, cross-border effect.

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1. Introduction

Existential challenges and threats, such as global warming and overcoming the effects of the COVID-19 pandemic, require international cooperation at the supranational level in innovative ways. The European policy of consolidation is based on innovation and focuses on the development of regions within the framework of smart specializations. At the meso-level, the formation of a new paradigm of regional development is based on the principles of regional policy aimed at convergence and cohesion, as well as the intensification of processes of inter-regional and cross-border cooperation. Solving common problems in boundary regions, achieving added value and cross-border effect is the basis of cross-border cooperation of boundary regions aimed at their convergence. The introduction of innovations and the implementation of the "smart specialization strategy" focus on new opportunities for cross-border cooperation in science, technology and engineering, innovations in specifically defined areas and projects. In this regard, it is advisable to form cross-border policy with an emphasis on the innovation component, overcoming the barrier function of the border, as well as the ability and interaction of the boundary regions of neighboring countries to implement the innovation potential. These innovation policies aim to promote inclusive growth and remove barriers to the participation of people, social groups, firms, sectors, and regions that are underrepresented in innovation (OECD, 2011). Innovative cross-border programs and projects make it possible to increase regional competitiveness, improve the investment climate and implement specific targets in the areas of accessibility, culture, security, production, science and technology. Boundary regions, which are focused on innovation in their development, reach a higher level of cross-border cooperation and use innovative approaches to financing and instruments of EU structural funds, grants, loans, etc. The main emphasis is on a wider use of innovation potential by defining cross-border interaction and cross-border critical mass as important parameters for the functioning of boundary regions. Interactions lead to technological convergence. The effects are particularly strong for innovative processes and those countries that lag behind in technological development or have weak domestic institutions (Bian, Meier, Jean-Marie and Xu, Ting, 2021). Innovation is characterized by positive consequences and the combining of different resources (Wuchty, Jones, Uzzi, (2007), Bloom, Schankerman, Van Reenen, 2013). Consequently, innovation policy of development of cross-border regions should be coordinated and formed in participating regions on both sides of the border,

focus on the sources of funding and tools to support cross-border innovation, and correspond to the common target, namely the cross-border territory as an innovation region.

The purpose of the article is to reveal the essence, the order of development and tools for implementation of innovation policy of development of a cross-border region, systematization of its types and justification of approaches to the definition of innovation potential of a cross-border region.

2. Methodology

The global crisis caused by COVID-19 led to the closure of borders between countries, which hampered the mobility of people and slowed the development of tourism and communications. At the same time, in some problematic areas that require joint solutions, cross-border activity is intensified in the aspect of healthcare, institutional cooperation, ecology, transportation and security issues. Consequently, the further development of information technology, the need to solve common problems and ensure modernization breakthroughs in the functioning of cross-border territories have entailed the emergence of the latest innovative forms and tools of cooperation.

In the methodological aspect of the study of the principles of formation of innovation policy of cross-border regions development is sufficiently disclosed and based on the use of general scientific and specific scientific methods. Among the scholars who have investigated the problem of innovation in regional development are (Cappellano, Kurowska-Pysz, 2020), who proposed a mission-oriented approach for cross-border regional development. The authors presented the MOA concept in three main aspects: 1) sound public problem solving; 2) research and development (R&D) of territories involved in cross-border regional development; 3) mobilization of many cross-sectoral projects (Cappellano, Kurowska-Pysz, 2020).

According to the OECD, issues of innovation policy support in cross-border regions address three main questions, namely: 1) Why and when does it make sense to collaborate for innovation across borders? 2) How can public and private actors cooperate across borders? 3) What policy instruments are used for cross-border innovation cooperation? (OECD, 2013).

The formation of innovative cross-border cooperation based on a systems approach has been proposed by (Makkonen, Weidenfeld Williams, 2017) and it has been noted that a cross-border regional innovation system (CBRIS) is an adaptation of a regional innovation system to a cross-border regional context. Moreover, CBRIS is used to assess the potential for the development of innovativeness in boundary regions.

Foreign scientists consider the stages and measurements of the degree of integration of cross-border regional innovation systems, distinguish asymmetric cost management system, the system aimed at the formation of knowledge and symmetric innovation system using such criteria as economic synergy, research synergy, knowledge flows, institutional building, policy building, persistence (Korhonen, Koskivaara, Makkonen, Yakusheva, Malkamäki, 2021). Thus, it can be stated that the achievement of cross-border synergies and effects are characteristic features of the construction of integrated cross-border innovation systems and the formation of policies for their development.

Problems of cross-border regional innovation systems, their conceptual preconditions, empirical evidence and policy foundations are revealed by (Makkonen, Weidenfeld, 2016). The drivers of innovation globalization (Bian, Meier, Ting Xu, 2021) consider strong cross-border institutions to help reduce imbalances in collaboration as well as increase the mobility of innovation processes across countries. The authors argue that, first, cross-border institutions are less affected by shocks, since their processes are mainly domestic rather than international; second, it is difficult to organize and determine the level of innovativeness within a large number of countries. Therefore, (Archibugi Michie, 1995) suggest activities within the three stages of innovation globalization as follows: adopting existing foreign knowledge, seeking foreign knowledge in the production of innovation, and intensifying international cooperation in the production of innovation.

It is believed that cross-border regions can become the innovation core, which means that the development of an integrated cross-border innovation policy will ensure convergence and rapprochement on the basis of innovation. It should be noted that the literature defines such territories as functional regions for innovation, which are understood as boundary innovation regions that demonstrate a high degree of internal interaction in innovation activities (Nauwelaers, Walburn, 2013). It can be stated that for the creation of innovative cross-border regions the following is necessary: 1) high level of cross-border flows of knowledge and technologies, as well as their mutual coordination in the functional aspect; 2) cross-border cooperation in research and educational activities for the formation of advanced innovative knowledge and technologies; 3) joint innovative products, services, transfer of technologies; 4) basis of co-financing and determination of diversified sources of financing of subjects and participants of innovative activity; 5) directions of overcoming of barrier function of border and formation of joint cross-border innovative structures; 6) derogation of legislation; 7) cultural, historical and ethnic affinity.

3. Results and discussion

3.1. Principles of innovation policy of cross-border regions

According to (Nauwelaers, Walburn, 2013) cross-border regional innovation policies are those that are defined according to functional areas, crossing the boundaries of administrative regions. It is characterized by a greater ability to "absorb" regional innovation systems. In particular, the increase in investment in research and development (R&D) has different effects on economic growth in regions, depending on the degree of "absorptive ability" (Ahlin, Drnovšek, Hisrich, 2014).

The Organization for Economic Cooperation and Development (OECD) presents innovation policy on the basis of inclusiveness, emphasizes its goal and a new focus on development while engaging in research, innovation and entrepreneurship (OECD, 2020). We believe that such a policy target defines development, implementation and realization of innovations created in the joint cross-border space, provides cross-border interaction on the basis of joint institutional, scientific, educational, financial, resource potentials.

According to modern studies innovation policy on the basis of inclusiveness is differentiated into the following types: territorial, social, industrial, the characteristics of which are summarized in Table 1.

The integrated innovation policy of the cross-border region is based on the exogenous cross-border potential of the boundary territories and is aimed at overcoming disproportions, increasing competitiveness and ensuring inclusive development (territorial, industrial, social) of the cross-border region on innovative principles.

According to (Nauwelaers, Walburn, 2013) the development and implementation of cross-border innovation policy covers 6 stages, at each of which participants from different regions should coordinate their plans, resources and actions. Researchers have identified the following as the main stages:

1. Analysis of innovation potential.
2. Rationale for the creation and management of the regional innovation system.
3. Developing a common vision.
4. Prioritizing.
5. Developing an activity plan with an agreed set of policies.
6. Monitoring and evaluation.

Based on the use of the positions of this study, it is proposed to consider the integrated innovation policy as an integral part of the regional policy of the cross-border region, taking into account the functional capacity for innovation. The peculiarity of this policy is that it covers the following key aspects:

Table 1

Characteristics of inclusive innovation policy types of cross-border regions

Policy type	Policy content	Characteristics
Cross-border territorial inclusiveness	Policy aimed at convergence by overcoming disproportions through innovation and the development of innovative advantages in 2 or more boundary regions of different countries.	Recognition of innovation as a means of overcoming backwardness and forming a cross-border region of innovation through the development of research centers, technology parks, technology incubators, implementation of networking programs and projects of technology financing, startups, etc.
Cross-border production inclusiveness	Innovation policy, taking into account the sectoral and industrial smart specialization of the cross-border region, the involvement of enterprises and other structures in R&D, the creation of an inclusive entrepreneurial environment.	Implementation of innovative projects in the priority sectors of the economy of the cross-border region, the development of small and medium-sized businesses, startups based on smart specializations.
Cross-border social inclusion	Policy of innovative social breakthrough in the alignment of social parameters of the cross-border region through participation in innovative programs and projects, access to innovative forms of cross-border cooperation.	Increased social indicators of cross-border region development, wage and living standards, reduced unemployment and greater access to innovative and investment sources of funding for common social programs and projects.

Source: systematized by the authors on the basis of OECD

- 1) analysis of exogenous innovation cross-border potential;
- 2) assessment of the innovation capacity of the cross-border region;
- 3) determination of innovative functionality and critical mass of the cross-border region;
- 4) prioritizing, forming innovative methods of cooperation;
- 5) institutional, financial and organizational support of the built-in innovation policy;
- 6) development of an action plan and a way to implement the policy;
- 7) monitoring, auditing, and controlling the implementation of the policy;
- 8) basic principles of policy adjustment.

Innovation functionality of a cross-border region is the density of cross-border interaction in the field of innovation and achieving high critical mass.

It is reasonable to measure cross-border interactions using quantitative indicators, such as co-financing of innovation, venture capital volumes for innovative start-ups, co-patents, volumes of innovation cooperation, joint publications, and mobility of highly qualified personnel to the total number of interactions.

The cross-border critical mass is determined by calculating the share of innovative economic sectors in the cross-border region to their total number, the share of nominal gross value added in the technology sector, the number of patents and total publications in the cross-border region.

The sequence of actions for the development and implementation of integrated innovation policy of the cross-border region one of the key stages determines the financial support of this process with the specification of sources and tools for implementation.

3.2. Innovation policy instruments of the cross-border region

Innovation policy of the cross-border region is implemented with the help of financial instruments, which can take the form of capital, quasi-capital, investments, loans, guarantees or other instruments to minimize risks, and, if necessary, can be combined with grants (Regulation of the European Parliament and of the Council, 2012). The implementation of cohesion and convergence policies in the EU involves improving the financial instruments of cross-border cooperation, attracting capital on a cyclical, renewable basis to achieve the highest financial leverage, which reflects the ratio of public and private capital.

For the planning period of 2021–2027 along with traditional instruments of cross-border cooperation (grants, programs, projects, mezzanine capital, venture capital, clusters, technology incubators, innovation agencies, business associations, accelerators, offices of technology transfer) the newest instruments are introduced which are directed to realization of one of the goals of cross-border cooperation ("Interregional innovation investments"). The amount of funding for cross-border innovation was approved at 11.5% of the overall indicative budget (a total of 970 million euros). The latest instruments of financing cross-border innovations "Pathfinder", "Accelerator", "Transition" ensure the implementation of innovative projects and cover high risks of breakthrough innovations (Horizon Europe framework programme for research and innovation, 2021–2027).

"Pathfinder" is a tool used by a consortium of at least 3 cross-border legal entities as part of the implementation of large grant projects (3-4 million euros) with a clear focus on technological research (TRL-1).

"Transition" is a tool for implementing the results of research on the innovation capabilities of single applicants, small start-ups, research organizations, universities with funding up to 2.5 million euros.

"Accelerator" is a tool to accelerate access to the innovation ecosystem to global scientific advances as part of business acceleration, investing in cross-border projects in the form of grants with funding amounts up to 2.5 million euros.

Cross-border crowdfunding based on a digital crowdfunding platform to support the development of small and medium-sized enterprises that do not require large investments is becoming an innovative form of financing cooperation. The cross-border crowdfunding mechanism aligns the interests of project owners, intermediaries, and investors, i.e., individuals able to finance through online platforms. Funding on such beginnings takes the form of loans or through the purchase of securities. Therefore, Regulation (EU) 2020/1503 of the European Parliament and of the Council of 7 October 2020 on European crowdfunding service providers for business distinguishes between credit-based and investment-based crowdfunding, regulates the framework for cross-border business financing through common approaches, rules and authorizations across the EU and extending crowdfunding services from national to cross-border scales. The regulation governs unified rules on the disclosure of information about project owners, platforms and crowdfunding risk management, the powers of national authorities to supervise the functioning of the platforms (Regulation (EU), 2020/1503).

Online crowdlending platforms, as an innovative form of financing, provide solely credit coverage of the needs of project owners by attracting lenders-individuals. The interest rate is set by the crowdlending platform and is determined by the risk rating for each project. Crowdlending is an investment in which investors receive a regular return on invested capital. Crowdlending is often performed with the security of assets, shares and/or personal guarantees. Investors usually have the right to return their investment with interest. Profits can be withdrawn or reinvested into other projects on the crowdlending platform (Crowdlending platform, Zwebb Fintech).

Any credit activity facilitated by an online electronic platform that matches loans with lenders' interest is variably called "crowdlending", "loan-based crowdfunding", "P2P lending" or "marketplace lending" (Gregory).

Venture capital is used as a collective investment tool for cross-border SMEs through funds that invest no more than 70% of equity and reserve capital in assets that are eligible investments. At the same time, the enterprise should meet the requirements of the "portfolio". A "portfolio company" in the EU is

a company that is not admitted to trading on a regulated market or in the multilateral trading system, has at least 250 employees, and is not a credit or investment institution. In this case, its annual turnover should not exceed 50 million euros, and the annual balance sheet should not be more than 43 million euros. Venture capital financing is carried out through unit or quasi-equity instruments, taking into account returns and costs, providing for fees, payments and charges of investors and agreed with the managers of the venture capital fund (Regulation (EU), 2013).

An important tool for innovation remains "Innova-FI" ("ИННОВА-FI"), which provides funding for innovation, including cross-border from the European Regional Development Fund (ERDF) for Interreg programs. This tool makes it possible to move away from the grant system of financing research and development work to financing under the new component "Interregional Innovation Investments".

Financial instruments of realization of innovation policy of the cross-border region have distinctive features, spheres of use, mechanisms of co-financing, as well as monitoring aspects of targeted use of funds at different stages of cross-border cooperation. Involvement of financial instruments for the implementation of innovative development programs allows the efficient use of funds in programs and projects, diversify revenue sources, and ensure the recoupment of innovative investments and efficiency in cyclical and renewable financial resources.

The implementation of cross-border innovation policy will ensure innovative partnership, expand the use of various sources of financing, economic, social, cultural and cognitive convergence, and also erase the barrier functions of borders.

3.3. Innovation potential in the implementation of innovation policy of cross-border regions

Boundary territories should create conditions for identifying the cross-border region as functional for innovation. A cross-border innovation region should be characterized by complementarity, a high level of cross-border flows of knowledge, capital, people, goods and services, a common social, cultural and institutional environment. National regulatory, administrative and institutional differences should not hinder the realization of innovative potential.

It is believed that the cross-border innovation region should have the following key characteristics:

- 1) a well-developed system of research organizations, educational institutions, and information transfer agencies with a focus on cross-border cooperation;
- 2) general economic and production program with a focus on the production of innovative products and technologies;

- 3) formation of cross-border business innovations;
- 4) the usage of modern sources and instruments of financing and the possibility of implementing projects through the resources of European Structural Funds;
- 5) cross-border interaction, mutual benefit, and value-added in the process of forming a "region of innovation";
- 6) creation of cross-border technology parks and incubators, innovative cross-border start-ups, cross-border clusters and growth poles.

The basis for determining the innovation potential of the countries and boundary regions of the EU and Ukraine is the information published on the website of the European Innovation Scoreboard (EIS). Based on the calculation of 27 indicators covering human resources, innovation in companies, innovation in R&D, financing, SME innovators, intellectual assets, impact on employment, impact on sales, key drivers of innovation, and innovation environment, a total innovation index is determined. All EU countries in 2021 are divided into innovation leaders with fluctuations of the total innovation index more than 140 (Switzerland, Sweden, Denmark, Finland, Belgium), strong innovators with fluctuations of the total innovation index within 120-140 (Norway, the Netherlands, Germany, England, Luxembourg, Estonia, Austria, France, Israel, Ireland), moderate innovators with a fluctuation of the total innovation index from 80 to 120 (Croatia, Cyprus, Italy, Lithuania, Slovenia, Spain), demonstrating innovation indicators below the EU average, novice innovators with a fluctuation of the total innovation index below 80 (Poland, Latvia, Slovakia, Hungary, Serbia, Bosnia and Herzegovina, Montenegro and others). Ukraine showed a downward trend in this indicator from 39.31 in 2016 to 33.58 in 2021. (European innovation scoreboard, 2021).

Statistics on innovation indicators in the EU and Ukraine have significant differences, not carried out in the framework of cross-border cooperation. Border regions in Ukraine and neighboring regions in Poland, Hungary, Slovakia, Romania did not demonstrate high innovation potential. In countries that develop cross-border cooperation with Ukraine, this indicator showed a positive annual growth trend, in particular in Poland it increased from 54.27 to 65.88 in 2016–2021, in Hungary – from 72.65 to 76.42, Slovakia – from 68.33 to 70.98, Romania – from 31.32 to 35.09. That is, to create a functional innovative cross-border region in the boundary regions of Ukraine and the EU it is necessary to enhance the intensity of innovation activity, to implement joint programs, projects and enterprises, which have innovative orientation and provide cross-border effect.

To evaluate the cross-border innovation activities and calculate the total index it is proposed a number

of indicators: the number of institutions carrying out research work in the cross-border region, the number of personnel involved in the implementation of research work, the cost of research work by source of funding with the allocation of EU structural funds, innovative activity of enterprises and their activity in the cross-border region, the number of acquired and sold new technologies in the cross-border region, the implementation of innovative industrial products. These indicators will allow to identify a cross-border region as functional for innovation or a cross-border region with a low level of innovation attractiveness.

4. Conclusions

In modern conditions, cross-border cooperation develops on the basis of convergence, smart specialization and innovative orientation. Innovation policy of cross-border regions should be formed on the basis of integration, functionality and innovation capability. It is aimed at solving common problems, achieving a cross-border effect, added value in the economic, social, cognitive spheres.

Functioning of innovative cross-border regions is provided by cooperation in research and educational activities to create innovative knowledge and technologies, innovative products and services, accompanied by cross-border flows of knowledge, people, capital, derogation of legislation, common cultural and ethnic heritage.

Innovative policy of cross-border regions as a target defines development, implementation and realization of innovations created in common cross-border space, provides cross-border interaction on the basis of joint institutional, scientific, educational, financial, resource potentials. The basic stages of innovative policy of the cross-border regions are suggested, in particular:

- 1) analysis of the innovative potential;
- 2) substantiation of the process of creation and management of the regional innovative system;
- 3) development of a joint vision;
- 4) prioritization;
- 5) development of an action plan with an agreed set of policies;
- 6) monitoring and evaluation.

The content and characteristic of the types of inclusive innovation policy with the allocation of territorial, production and social inclusiveness are presented. Cross-border territorial inclusiveness is a policy of introduction of innovations for achievement of convergence at the expense of innovative advantages in 2 or several boundary regions of different countries. Cross-border production inclusiveness is a policy of innovation taking into account the sectoral and production smart specialization of the cross-border region, the involvement of enterprises, organizations,

institutions in R&D. Cross-border social inclusion is a policy of innovative social breakthrough in equalizing the social parameters of the cross-border region through participation in innovative programs and projects aimed at social convergence.

To implement the innovation policy of the cross-border region, a modern financial toolkit is used, which is cyclical, renewable, co-financed and targeted. Along with traditional tools of cross-border cooperation, such as grants, programs, projects, mezzanine capital, venture capital, clusters, incubators, innovation agencies, business associations, accelerators, technology transfer offices, the newest tools implementing one of the goals of cross-border cooperation "Interregional innovation investments" are introduced. The scope of cross-border innovation financing tools such as "Pathfinder", "Accelerator", "Transition", crowdfunding, crowdlending, venture capital, and others is disclosed.

For definition of the cross-border region as innovative it is offered to allocate the following key parameters:

- 1) developed system of research organizations, educational institutions;
- 2) common program for production of innovative products and technologies;
- 3) formation of cross-border business innovation;
- 4) use of modern tools of financing;
- 5) achievement of cross-border interaction and mutual benefit;
- 6) creation of cross-border technology parks and incubators, innovative cross-border startups, cross-border clusters and growth poles.

Prospects for further research in this direction should be aimed at developing methodological approaches to assessing the innovation potential of the cross-border region and the development of directions to achieve modernization innovation breakthroughs.

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