

Ilia Kuzmin

Vologda Research Center of Russian Academy of Sciences

Guest researcher at Technische Universität Dortmund –

Sozialforschungsstelle

Theory, analysis and practice of public administration in innovation based on international cooperation measures

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Sozialforschungsstelle Dortmund (sfs)

Zentrale Wissenschaftliche Einrichtung der Technischen Universität Dortmund

Evinger Platz 17

D-44339 Dortmund

Tel.: +49 (0)2 31 – 85 96-0

Fax: +49 (0)2 31 – 85 96-1 00

Email: kontakt@sfs-dortmund.de

<http://www.sfs-dortmund.de>

Abstract

Against the background of globalization and regionalization of innovation activities an important role in development of economic systems is played by so-called technological spill-overs. As a result of this, there is an increasing need for fundamental research on innovation development from the perspective of the issues concerning the potential that recipient territories should have in order to absorb new knowledge effectively and, thus, increase their innovation capability. It is necessary to obtain a deeper understanding of these processes, their factors and economic effects, as well as of possibilities of regions to purposefully influence them.

Under the conditions of insufficiently high innovation potentials the role of international collaboration in terms of innovation activity stimulation is increasing. Using it within public innovation policies is to ensure that adoption is not carried out as simply “borrowing” of technologies, which would threaten to depend on other countries, but provides accumulation of territories’ own innovation potentials. Weighed managerial decisions, however, call forth the need for data on the existing reserves for strengthening international collaboration in innovation of the regions, as well as on the first-priority needed improvements in this sphere.

With regard to this, the conducted dissertation research of the author, on which this publication is based, develops methodological tools that allow, in particular on the basis of mathematical operations, building integral coefficients (indexes) to reflect levels of international innovation cooperation development of regions and comparing the

regions comprehensively in terms of development of their international collaboration directions. The project provides for: integrated research on international activity dynamics in regions; detailed analysis of international innovation cooperation of regions on the basis of the suggested methodological assessment tools; development of a region typology that allows characterizing regions in terms of their international collaboration specifics and identifying what measures of innovation activity intensification based on international collaboration development are of the first priority in concrete regions. By means of using economical and mathematical methods and the methodological tools developed within the project it was planned to mathematically assess correlations between international innovation cooperation development levels in regions and their innovation activity results.

The conducted research will allow forming priorities and directions of regional innovation policies on development of international innovation cooperation, as well as improving the instruments of regional public administration in the field of innovation activity that are based on international collaboration development, which defines its topicality and importance. The results obtained within the dissertation research will also allow making a contribution to development of studies in the area of international innovation cooperation of regions and design of strategies and conceptual propositions of long-term innovation policies of economic systems with the account of the scientific knowledge and practical experiences stored in the world.

Foreword



Dear readers,

First and foremost, let me say a special thank you to Antonius Schroeder, Member of Management Board of the Technische Universität Dortmund – Sozialforschungsstelle (TUDo – sfs). Our cooperation began in 2011 with a joint research proposal submitted in response to a call of the European Union’s Seventh Framework Programme (FP7), and I was impressed with his professionalism and organizational talents right away. During the last years this opinion has only strengthened and my respect has grown. Later, as a coordinator of a major FP7 project called “Social Innovation: Driving Force of Social Change” (SI-DRIVE, 2014 – 2017; <https://www.si-drive.eu/>), Antonius made it possible for me to join SI-DRIVE and work in it for 4 years, in particular as a translator and interpreter, which is significant to me. My stay as a guest researcher at TUDo – sfs, within its Work and Education in Europe Research Area, under his supervision became an outstanding finish of this unique experience. In every kind of activity, especially in research, exchange of expertise and opportunities of looking up to someone accomplished in this area is important. I am very glad to be able to work side by side with such a great specialist. I can say that Antonius’ successful background, which, in addition, has been achieved on the international level, makes him a role model for one to follow. I hope to continue our close cooperation, which would not only be useful for work, but also make me glad personally.

I would also like to thank: Prof. Dr. Juergen Howaldt and Ellen Hilf, Director and Deputy Directress of TUDo – sfs respectively, for supporting my stay at TUDo – sfs, as well as for their interest in my dissertation research and practical advice in this field; Dr. Christoph Kaletka, Member of Management Board of TUDo – sfs, and Dr. Bastian Pelka, TUDo – sfs' Work and Education in Europe Research Area Co-ordinator, for their valuable participation in organizing my research activities at TUDo – sfs and recommendations; Tanja Burda, Head of TUDo – sfs' Administration, for her aid with regard to the administrative issues.

I am very grateful to Jens Maylandt, TUDo – sfs' gifted research fellow and employee committee expert, with whom I shared a workplace in the room number 82 at TUDo – sfs, for his numerous consultations and business and individual qualities that both helped and inspired me a lot.

I appreciate the experience, the knowledge and the assistance that I received from my communication with the members of TUDo – sfs' Work and Education in Europe Research Area Mathias Cuypers, Dmitri Domanski, Jennifer Eckhardt, Christopher Graetz, Sabrina Janz, Michael Kohlgrueber, Daniel Krueger, Luise Kuschmierz, Mona Markmann, Beata Lewandowska, Janosch Sbeih, Ann Christin Schulz, Marthe Zirngiebl, and its trainees Joerg Baumann and Janak Howard, with TUDo – sfs' great IT specialists Michael Boedeker, Julia Pfeil, and their wonderful colleague Iryna Denysenko, with the members of the other TUDo – sfs' units, especially Eva Alshuth and Marina Berchem, Roswitha Gerds, Miriam Gothe, Christian Koepnick, Hendrik Lager, Baerbel Meschkutat, Jan Nguyen, Silke Peter-Golfmann, Barbara Schmidt, Juergen Schultze, Christian Teichmann, Birgit Ziese, and with the rest of the colleagues at TUDo – sfs.

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All in all, at TUDo – sfs I witnessed very professional and at the same time friendly attitudes and readiness to cooperate, which made me feel comfortable and was encouraging. Taking this opportunity I wish TUDo – sfs to continue working this fruitfully and extending the list of its impressive achievements.

Secondly, for the purposes of explaining the context of the work better, I should also briefly describe my educational, professional and research background. In addition to my university degree in economics and management, I have finished postgraduate school (“Economics and National Economy Management” specialization) and got an additional higher education (“Translator in the Field of Professional Communication” (English) specialization). I have been working at the Federal State Budget Institution of Science “Vologodskiy Scientific Center of the Russian Academy of Sciences” (FSBIS VolSC RAS; before September 2017 it was called ISED T RAS) since 2010. Throughout these years my duties, beside scientific research, included development of the institute’s international scientific cooperation and translation.

Establishing ties and developing cooperation with a range of scientific and research organizations from Europe and other world regions has become one of my most important

achievements in the mentioned tasks, which, in particular, allowed ISED T RAS to join an international consortium that prepared and submitted the SI-DRIVE proposal for the FP7. It was a wonderful thing to celebrate when the European Commission subsequently supported SI-DRIVE. Since 2014 I have represented ISED T RAS and subsequently TUDo – sfs at 3 General Assemblies and 4 international scientific conferences held within SI-DRIVE (2014 – Dortmund, Germany; 2014 – Lisbon, Portugal; 2015 – Vienna, Austria; 2017 – Dortmund, Germany and Brussels, Belgium).

As regards scientific research at ISED T RAS, my main achievements include:

1) dissertation on public administration, innovation, and international collaboration in innovation;

2) repeated laureate of all-Russian and international conferences and contests (altogether, more than 60 conferences and workshops). In December 2016 my paper was awarded one of the best ones at the Third Russian Economic Congress (organized by Moscow State University and the Institute for Economics of the Russian Academy of Sciences);

3) author of close to 70 research publications in Russia, Europe and China, among which there are “A Methodology for Assessing Regional International Cooperation in Innovation”, “International Cooperation as a Form of Stimulating Innovation Activities”, as well as “The English Language. Teacher and Learner’s Guide for Economic Educational Programs”;

4) participant of around 20 research works and contracts (with: the Russian Academy of Sciences; Russian

foundations; other Russian and foreign public and private organizations; national, regional, and local government bodies). In 2017 I received a Vologda Region's Government award for contribution to the region's economic development and professional achievements.

Thus, within my work I deal with studies and practical tasks of innovation activities, as well as international cooperation and public administration in this field. An important part of this, toward which I would like to direct further great efforts, is to study the practices of other countries.

Finally, I hope that this publication will be of interest and use to you, at least from a general educational point of view. It contains the references to the results of the studies that were conducted by me during the preparation of my dissertation. Since I have studied and worked in Russia, the focus of my research on the whole and my dissertation in particular is now inclined toward the socio-economic issues that are closer to the Russian Federation's specifics. In future I would like to study more foreign experiences in the area of regional innovation development for improving and proposing better recommendations. I should also note that sometimes I had to present the obtained results and theses in a more summarized way and leave out some details while preparing this publication, which was primarily caused by the fact that the dissertation has not been defended yet and is only awaiting to be published, so it is reasonable to hold on to its materials for the moment. Nevertheless, it was seen that the presented data should be enough to get the idea about the conducted studies and the obtained results. In case you are interested, I suggest taking a look at my other publications and following my future works. I hope that I will have opportunities of publishing in European and other

countries. For both research issues in general and suggestions concerning further publications, including, perhaps, joint ones, it is possible to communicate via e-mail.

With best wishes,

Ilia Kuzmin

Federal State Budget Institution of Science “Vologodskiy Scientific Center of the Russian Academy of Sciences” (FSBIS VolSC RAS)

Guest researcher at Technische Universität Dortmund – Sozialforschungsstelle

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List of abbreviations

EU	European Union
fig.	figure
ICI	international collaboration in innovation
OECD	Organization for Economic Co-operation and Development
R&D	research and development
Rosstat	Federal State Statistics Service
S&T	science and technology
tab.	table
TE	technology exports
TI	technology imports

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1 Introduction

Under the modern conditions an intensive and sustainable economic growth is ensured on the basis of systematic development, production, and spread of innovations. However, developing countries face problems in the area of innovation development. According to the data of Rosstat, the innovation activity in the European countries that lead the innovation development is at the 50% levels and more. It is not uncommon for studies of developing countries to testify that their innovation potential levels, at least in a big share of their territories, are not high enough.

Overcoming the tendencies that strengthen technological gaps requires using all of the possibilities to accumulate resources and results of innovation activities and designing comprehensive measures to ensure development of innovation activities of national enterprises.

Due to the fact that ensuring the whole innovation life cycle independently is extremely difficult the innovation sphere a priori has issues of developing international collaboration. Nevertheless, collaboration requires systematic policies, substantiated priority directions, efficient costs, and special knowledge. It is necessary to ensure that innovation enterprises are ready to develop beneficial international relations. Those questions are one of the main subjects of public administration. In connection with this, problems of managing innovation activities on the basis of international collaboration development are gaining special significance.

The topic of the dissertation research, the main theses from which became the basis for this publication, was, therefore, defined by the scientific and practical importance of the

described problems and set a goal to theoretically substantiate and design an organizational and economic mechanism of public administration in innovation based on international collaboration development measures. The relevant tasks covered defining the role of international collaboration in territorial innovation strategies and innovation activity stimulation, systematizing its types and varieties, designing and testing methodological instruments to assess the relevant practices in regions, as well as to propose regional innovation policy recommendations.

In order to reach the set goal the research was divided in three parts of theoretical, analytical, and practical character. The first part corresponding to the “Theoretical bases of public administration in innovation on the basis of international collaboration development” chapter (chapter 2) studies and summarizes scientific approaches to territorial innovation development, considers the role of public administration, systematizes the world’s experiences in this field and the place that international collaboration development gets within them, as well as examines scientific bases of international collaboration in innovation as a factor increasing regional innovation activity. The second part used for the “Analysis of international innovation cooperation on the regional level” chapter (chapter 3) develops and tests a methodological technique for assessing international collaboration of regions in innovation, designs a region typology, and conducts a regression analysis to identify a correlation between international collaboration development levels and results of regional innovation activities. The third part provided the main results to be used in the “Regional economic and organizational measures of public administration in innovation based on international

collaboration development” chapter (chapter 4) by studying priorities and substantiating innovation policy directions dealing with development of international collaboration in innovation on the regional level, develops a regional mechanism for public administration in innovation based on international collaboration development, and proposes its goal, tasks, methods, and instruments that allow increasing regional innovation activity. In the end, the main results, conclusions and suggestions are summarized.

The research uses:

1) a multidisciplinary approach (economics, economic geography, mathematics, international relations) to study issues that are relevant to development of innovation activities;

2) a systemic approach to studying theoretical and methodological aspects of public administration of regional innovation activities based on international cooperation, which particularly takes account of research-based findings concerning problems of developing and implementing instruments that are used to develop international innovation cooperation and increase regional innovation activity.

Data analysis and collection, as well as substantiation of theoretical and methodological aspects, are based on methods of economical and statistical analysis (e.g., regression analysis), cause and effect analysis, comparative geography, mapping, and index methods alongside with general scientific methods (synthesis, induction, deduction, scientific abstraction), which allows reliability and evidence of conclusions and suggestions.

2 Theoretical bases of public administration in innovation on the basis of international collaboration development

Socio-economic development of regions encompasses strategic aims set to ensure, on the one hand, economic growth and, on the other hand, better living standards and human potential reproduction (Gulin, 2012; Zadumkin et al., 2006). In view of that, economic growth per se is not enough to develop national economy. Characteristics that accompany increased GDP indicators and reflect the qualitative side of the growth gain importance.

Investments in fixed capital and high added value production of industry and agriculture are significant with regard to economic characteristics. Among social ones, it is real incomes of the population, as well as reducing the population's inequalities. Ecological ones include protection of the environment and use of the natural resources.

There are different ways to create general economic capabilities in order for a national economy to deal with the above mentioned aims. One option is to increase production when using more of its factors. In such a case the growth of the economy has an extensive character while a larger social product is accompanied by a comparable or even greater increase in the volume of spent resources. For example, the higher labor costs are, the larger the amount of paid salaries gets, and the fewer funds there are to provide expansion of the production. Furthermore, extensive factors (additional labor force, investments, natural resources), as a rule, are considerably limited. Another option is to increase the efficiency of the use of spent resources. Then the growth of

the economy becomes intensive, and an increase in the economic system's efficiency is provided through improving labor productivity, returns of fixed funds, and the use of materials. The production's volume can grow faster than the total costs of production factors.

Modern economies possess both intensive and extensive growth sources. Nevertheless, the rates of the scientific and technological progress are speeding up, which leads to the fact that the intensive growth based on constant development of innovations gets to prevail. Adoption of innovations lays the foundations for competitiveness of enterprises, industries, regions, and countries and, therefore, becomes crucial to overcome the problems of economic growth quality while being one of the main drivers for socio-economic development.

2.1 Developing innovation activities

Those problems have a special significance in developing countries. The account taken of the issues of adoption of innovations by economies allows pointing out two main variants of a long-term strategy for socio-economic development of the state. According to many Russian and foreign economists, implementation of these scenarios will lead to essentially different results (see tab. 1).

A range of famous Russian and foreign economists agree that low added value production is sensitive to negative manifestations of the inertial market scenario and, therefore, cannot guarantee socio-economic development. In addition, the cases when the state decreases its participation in administration of innovation activities as a result of following neoliberal economic concepts and the one-sided

interpretation of the western countries' experience are not unusual.

Table 1: Main variants of a long-term strategy for socio-economic development (composed by the author based on: Gubanov, 2015; Gusakov, 2014; Kuzyk et al., 2004; and others)

Main strategies for socio-economic development	
Inertial market	Innovation breakthrough
Market regulation by the state	
Minimal participation of the state in market processes. The state's main task is to favor establishment of market mechanisms by supporting normal conditions for the market to function. Uncontrolled openness of the economy.	The state influences market by means of setting priorities, as well as preferences for specific market segments and economic agents. The participation by the state is necessary to speed up economic growth, increase its quality and correct the market's defects.
Public innovation policy	
The state refuses active innovation policies, support of basic innovations and strategic planning in the area of territorial innovation development. Decrease in public spending on science, education and social support.	Choice and implementation of concrete strategies of territorial innovation development; creation of effective mechanisms for public administration of innovation activities.
Forecasted consequences	
Comprador export model. Lack of interest in national consumer goods. Export outrun by import.	Increased responsibility of the state for territorial innovation development and innovation

Main strategies for socio-economic development	
Inertial market	Innovation breakthrough
Low innovation potential and rates of economic growth.	activity increase. Innovative modernization of fixed assets, increased product competitiveness. Quality economic growth. Social development.

The consequences of this show themselves in gradually appearing tendencies of losses in scientific and technological potentials. On the one hand, the enterprises carry out innovation activities, and there is a potential to develop them further. On the other hand, the internal capabilities of the regions are limited in the modern conditions. The reason for this, in our opinion, is the economic conditions (see tab. 2).

Table 2: Challenges hindering innovation (composed by the author based on: Gohberg et al., 2012; Polterovich, 2009; and others)

Challenges	Essence
Developing countries' specificities	
Interest rates, tax rates	Unfavorable. Lower profitability.
Inflation	Not low. Problems with returning technological capital investments.
Technologies	Outdated machines, lower numbers of inventions.

Challenges	Essence
Human resources	Lack of highly trained professionals.
Public financing	Insufficient public financing of innovations.
Costs	High costs of all of the various types of input for innovation. Resource insufficiency.
Universal ones	
Innovation requires adoption of created new technologies	Innovation in one part of production quite often requires changing the whole process and its stages. Problematic for small and medium enterprises. Tendencies to ignore innovations.
Simple purchasing	Buying ready-to-use innovation to reduce costs and risks. Little motivation for own developments.
Research	Limited technological bases, low financing, and human capital flight (brain drain).
Innovation institutions	Technical creation of innovation institutes while not taking account of the essence of the challenges cannot change the state-of-the-art.

It may be concluded that the low innovation intensity stems from high consumption of all types of resources. As a result, it is not uncommon for enterprises to lack motivations to design and adopt innovation, which particularly is not their main kind of business activity. Thus, the transition of the economy to the innovation way of development is raised to be among the most important national objectives.

Public administration in innovation, nevertheless, has to be based on a solid scientific foundation. Weighed decisions in this area involve accurate and contemporary comprehension of the essence and contents of the managed object.

2.2 Essence of the notion of innovation

Points of view considering the essence of the “innovation” notion differ rather significantly in Russian and foreign research depending on aims, objectives, and specificities of a concrete study. Nevertheless, it was possible to single out the principle approaches explained in tab. 3.

Table 3: Principle approaches to define the essence of the “innovation” notion (composed by the author based on: Innovation Economy: Encyclopedic Dictionary and Reference Book, 2012; The Measurement of Scientific and Technological Activities. Oslo Manual. Guidelines for Collecting and Interpreting Innovation Data, 2005; and others)

Number	Approach	Definition
1	Novelty, introduction.	Appears as a result of applying achievements obtained by science and leading experiences.
2	Introduction.	Understood as a practical use of a novelty.
3	Change.	Consists in providing scientific and technological newness, capabilities of production applications, and possibilities to be commercially implemented.
4	Result of introducing a novelty.	Consists in obtaining a required effect.

The notions behind the words novelty and introduction are quite closely related and may be named differently. These particular words were chosen in connection with that their definitions given in English dictionaries allow reflecting the important nuances. A novelty is interpreted as a new or

unfamiliar thing or experience while an introduction is understood as a thing newly brought into use or introduced to a place for the first time.

From the practical point of view it was reasonable to make an effort to combine the identified approaches. As a result a definition was suggested according to which an innovation should be understood, at least for the purposes of the research, as a result of activities related to application of results of scientific research and development that gets embodied as a new or improved product, work, service, or solution of technological, organizational, or other nature, is introduced to the market or used on practice, and produces a positive effect.

Such a broader approach and a definition suggested are based on the principle interpretations of the notion of innovation described within the dissertation. They seem to be the most informative in that they virtually combine the definitions of different varieties of innovations, including those used in the methodologies of Rosstat and OECD.

2.3 S&T driven innovations

Different opinions exist on the issues of priorities of effects that are obtained from introducing innovations. Quite often within the studies it becomes a basis for singling out different innovation varieties. Among the ones on which there is more agreement to identify them, both in Russia and Europe, it is possible to name organizational, ecological, and social innovations. The most viewed ones are classified and described within the dissertation in order for different varieties of innovations to be taken into account.

For the purposes of solving the tasks set within the dissertation research the focus of the studies was put on science and technology driven innovations taking place in small and medium business that in the majority of the cases are primarily considered to be economic or organizational ones. However, it should be noted that it may be possible, while differentiating and classifying, for example, social innovations, to single out those of them that are also science and technology driven, in which case they are likely to be closely related to economic and organizational innovations as well.

The reasons for such a focus within the research were threefold. Firstly, the dissertation was written within the field of economics and national economy management. Secondly, it is of utmost importance for developing countries to prevent the inertial market scenario described in the section 1.1 through increasing their innovation activity. The latter is firstly measured, in particular in state statistics of research and innovation, by examining economic and organizational activities of enterprises that directly deal with the issues of improving themselves. Finally, as it was also explained in the section 1.1, in the dissertation research worse economic conditions and low intensity of innovation activities were seen to be closely interrelated, as a result of which the only way to achieve better production competitiveness and efficiency, i.e. to improve economic conditions and enlarge the basis for further innovation, is to employ all of the limited possibilities to design, implement, and spread S&T driven innovations within the economy.

2.4 Public administration in innovation

Analyzing the views on the contents of innovation activities that can be found in the scientific literature on the relevant topics allowed to summarize the data by describing certain components of innovation activities (see tab. 4).

Table 4: Components of innovation activities (composed by the author based on: Ivanov, 2015; Mindeli et al., 2008; Terebova et al., 2009; and others)

Component	Contents
Goal	Competitiveness, reducing costs.
Objectives	Up-to-date renewed products.
	Modern production bases, high fixed capital investments.
	High level of technological progress as an important socio-economic potential characteristic.
	High budget, business and personal revenues.
Participants	Research, education, enterprises, third sector, individuals.
Forms	Science and technology, organization, economics.
Stages	Knowledge generation (research); innovation creation (developments, production); innovation diffusion (learning, marketing, sales, service).
Features	Based on research.
	Effect on socio-economic development.
	Inferior to economic capabilities.
	High costs of resources.
	Unclear character, long time to get returns, instability.
	Permanent modifications, heterogeneity of phases, participants, and their motivations.

Studying the specific components of innovation activities in accordance with the chosen focus that was described above allowed suggesting that innovation activities, at least for the purposes of the dissertation research, are interpreted as scientific and technological, as well as organizational and economic, activities of scientific, research and educational organizations, enterprises and government bodies that is aimed at increasing competitiveness of production and reducing costs and comprises research, developments, production, adoption, sales and service of scientific and technological products.

During the evolution of the concepts of innovations the views on different aspects of innovation development of both enterprises and territories on the whole have been repeatedly changed since 1950s. The main concepts are broadly discussed and can be listed as follows to get impression on their development:

- linear: S&T push (circa 1950s – 1960s)
- linear: market pull (circa 1960s-1970s)
- coupling (circa 1970s – 1980s)
- interactive (circa 1980s – 1990s)
- networks (circa 1990s – beginning of 2000s)
- open innovation (circa beginning of 2000s – present)

As it was seen from the dissertation research, the modern views reflect the evolution by tending to take a much closer look at solving resource attraction optimization problems that in particular deal with employing all of the possible sources. On practice this allows to achieve better results while spending less, i.e. better efficiency.

At the same time, the research showed that it is possible to pay more attention, even within open innovation models of innovation activities, to public administration as one of the directions of collaboration in innovation, namely between governments and innovators. This collaboration has to be considered, because stimuli that are created by state innovation policies, as well as state support resources, influence innovation activities directly and penetrate their every phase acting, thus, as a significant activity factor.

Analyzing key arguments concerning the necessity of public administration of innovation activities that can be found in modern Russian and foreign studies made it possible to group them from theoretical and practical points of view and show their correspondence (see tab. 5).

Table 5: Corresponding theory and practice of innovation with regard to issues of public administration (composed by the author based on: Formation and Implementation of Regional Investment Policies, 2007; Nekipelov, 2014; Self-developing socio-economic systems: theory, methodology, forecast assessments, 2011; Todosiichuk, 2010; and others)

Capabilities for innovation (theory focus)	Specificities of innovation (practice focus)
<p>1. Market failures have to be fixed. Market self-regulation to implement innovation is unlikely to take place against the background of poor economic conditions.</p> <p>2. Better quality of economic growth requires more than simply competitive policies.</p>	<p>1. Fields that innovation penetrates weakly (e.g.: low chances of success and practical use cause business to ignore innovating).</p> <p>2. Inharmonious motivations and tasks of participants of innovation activities, non-linear participation.</p>
<p>3. Need for economic capabilities promoting innovation (law, finances, institutions, etc.).</p> <p>4. Modern views on public support as further opportunities.</p>	<p>3. Vague and delayed returns, high uncertainty.</p> <p>4. Business failures in terms of:</p> <ul style="list-style-type: none"> - getting all of the types of innovation input; - their regularity; - their balance between phases

Capabilities for innovation (theory focus)	Specificities of innovation (practice focus)
	and participants.
5. Governments are the only actors to implement and correct strategies for innovation development of territorial entities. 6. Debated challenge of public regulation: need to manage regional innovation activities.	5. Direct impacts on national objectives: country's competitiveness in S&T; social and environment issues. 6. Multiple scopes: regional enterprises implement regional innovation activities as a component of national and world levels.

As a result, the obtained combinations of theoretical and practical arguments made it possible to substantiate that modern innovation activities cause problems that require obligatory participation of the state in order for them to be solved. Furthermore, both contemporary research and practice in the field of designing strategies of territorial innovation development get an integral task to find ways to embrace the growing scopes of collaboration between actors of innovation activities at all levels.

2.5 International collaboration in innovation

Analysis of the world's experience testifies that there are three main strategies of territorial innovation development that are implemented through organizational and economic mechanisms of public administration of innovation activities:

1. "Carrying over" strategy
2. "Catching up" strategy
3. "Building up" strategy

Insufficient internal capabilities to qualitatively develop innovation activities made developing countries, one way or another, to use possibilities to attract resources from the

outside, i.e. borrowing (adapting) and adopting (imitating) innovation products.

Table 6: Strategies of territorial innovation development (composed by the author based on: Polterovich, 2009; Poliancheva, 2007; and others)

Policy variety	Strategy variety and contents	Strategy disadvantages	Strategy advantages
Modernization	Carrying over: using foreign innovation potential and borrowing and adaptation of practical novelties (Japan's experience).	Dependency on highly developed countries and threat to national security; spending resources on unpromising technologies; costs to educate personnel; decreasing rates of designing own developments.	Lower spendings of actors of innovation activities; adoption of new industries; creation of own innovation potential; increased attention to development of favorable innovation environment; large opportunities for growth.
	Catching up: borrowing, imitation of products that developed manufactured before, based on own innovation potentials (Southeast Asian countries' experience).	Spending resources on unpromising technologies; competition with producers of similar products; costs to educate personnel; decreasing rates of designing own developments.	Lower risks of innovation activities; lower terms of implementation of innovation projects; innovation potential development during adoption and improvement of foreign technologies, including: formation of own R&D.

Policy variety	Strategy variety and contents	Strategy disadvantages	Strategy advantages
Innovatization	Building up: use of own innovation potential, attraction of foreign specialists, integration of university basic science and enterprises applied science (highly developed countries' experience).	Large expenditures of actors of innovation activity; need for comprehensive innovation policy; high risks of innovation activities.	Intensification of R&D; increased attention to scientific breakthrough directions; constant building up of own innovation potential.

The “building up” strategy consisting in active design and diffusion of innovations based on the use of own scientific and technological potentials can only be dominant when there are favorable conditions for economic and innovation activities. In that case adoption of innovations in the economy is not blocked due to low technology levels of the industries and, on the contrary, promotes further innovation.

Thus, resources and results of innovation activities of a concrete territory define its options to choose a strategy for innovation development (see fig. 1). Their presence is a reason to concentrate on internal capabilities and their intensive use. The lack of them calls forth a need to attract resources and results that are ready to be used from the outside, which is important for increasing the rates of innovation development of the territory.

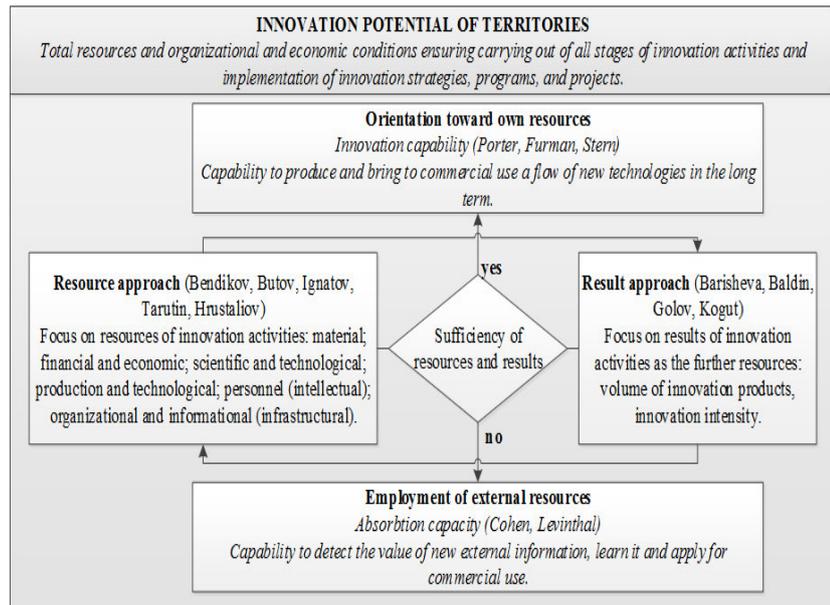


Figure 1: Theoretical bases of territorial innovation potential (composed by the author based on the works of the named researchers; see the literature)

On the whole, modern technologies cannot be developed in isolation with no account of the contemporary reality's global character. Actors of innovation activities, one way or another, face needs to exchange their resources and results.

An important finding of the dissertation research, supported by the conducted analysis of contemporary approaches from both theory (studies) and practice (leading countries' expertise) of territorial innovation development and public administration in this field, showed that the innovation development of modern economies tends to bring the strategies of building up and catching up closer to each other. In terms of public administration this is important with regards to international collaboration in innovation that, according to the finding, is being used as a *form* for stimulation of innovation activities. The reasons for the author to single out international collaboration in innovation as a *form* for stimulation within public administration of

innovation activities is the role that such collaboration plays in the studied context:

- collaboration is a *way* to ensure, on the one hand, faster solving of problems in innovation through borrowing and, on the other hand, accumulation of own innovation potentials
- collaboration provides intensification of territorial innovation activities

In other words, collaboration is a cheaper and quicker *means* to spread innovations, increase product competitiveness, and decrease costs. Nevertheless, getting advantages through international collaboration also requires expenditures, as well as special knowledge and qualifications, so small and medium enterprises face difficulties already in the early phases of collaboration development.

International collaboration in innovation can have a significant impact on innovation development of regions. Research and development results created in one region can be rapidly spread in other areas. Risks for their implementation are lower if efforts, resources and complementary capabilities of the regions are combined. Development of international collaboration in innovation is aimed at creating favorable conditions to carry out innovation activities, develop and commercialize their results, use resources optimally, and gain competitive advantages and synergy effects for national innovation activity actors and their foreign partners.

The analysis of the scientific literature on the topic carried out within the dissertation research testified the lack of interpretations defining international collaboration in

innovation. However, it made it possible to suggest that this phenomenon is understood as a process of interaction of actors of innovation activities of different countries dominated by joint efforts to fulfill common interests in the area of scientific research, developments, adoption, production, sales (on the internal and world markets), and service of innovation products.

For example, in modern research dedicated to innovation activities and public innovation policies the variety of collaboration in innovation, such as innovation cooperation, is widespread. Nevertheless, there is a range of other varieties that, at the same time, are quite closely related and often overlap. Therefore, it is possible to determine universal categories. The type of cooperation appears when actors of innovation activities in countries or regions conduct joint R&D and make commercial and non-commercial exchanges of their resources and results. It includes such implementation measures as programs, agreements, transfer, etc. The type of association is used in order to follow common interests in scientific, technological, and innovation spheres. Its implementation measures cover political, research, commercial, non-profit, as well as other organizations. The type of coordination implies development and implementation of joint policies in the field of innovation activity development. It is manifested in close cooperation of the governments at the international, national, and regional levels, but also between companies, research organizations, universities, etc. Agreements on joint implementation of innovation policies, integration associations, as well as establishment of uniform requirements in the field of innovation activities, can be named among implementation measures for the type of coordination.

In the end, the identified types and varieties of collaboration in innovation were classified, which solved the respective task set out within the dissertation research.

Table 7: Classified types and varieties of collaboration in innovation (composed by the author based on studying the works of Russian and foreign researchers in the field of territorial innovation development; see the literature)

Collaboration category	Collaboration variety
Type	Cooperation
	Association
	Coordination
Scope	International
	National
	Regional
	Corporate
Character	Operating
	Tactic
	Strategic
Commercial aspect	Profit
	Nonprofit
Form (legal ground)	Global treaties
	Program documents
	Agreements

The classification allowed identifying that the high-priority collaboration variety for stimulating regional innovation activities is named to be innovation cooperation. Cooperation in this context was proposed to be understood within the dissertation research as a special form of labor organization in which one or several stages of innovation activities is jointly and directly implemented by their actors. The conclusion about the high priority of this form is a result of seeing it as comprising three directions of international collaboration in innovation corresponding to the three stages of innovation activities in general:

- development of international R&D projects
- realization of innovation products and attraction of resources
- spread of innovation technologies

In conclusion it should be underlined that developing countries are characterized by the discussed above specifics manifesting themselves in that poor economic conditions are the reason for low intensity of innovation activities and vice versa. Thus, the problems of innovation development call forth the need in finding complementary resources in the external environment at all of the stages of innovation activities.

At the same time, ensuring international innovation cooperation is an issue of strategic importance in both developed and developing countries and, therefore, a major task of public administration in innovation. Making weighed managerial decisions in this field, however, requires reliable data on the existing regional background for improving international innovation cooperation.

3 Analysis of international innovation cooperation on the regional level

Studying and defining promising directions to develop international collaboration of regions in the innovation sphere calls forth the need to carry out its assessments. This basis makes it possible to obtain data that allow examining different aspects of the collaboration.

The conducted analysis of the works dedicated to the issues of measuring international collaboration in the innovation sphere in Russian and foreign languages led to the conclusion that at the moment there are no unified views on exploring it. Nevertheless, most of the works contain matching opinions of the researchers indicating that data on its results have practical importance, and, therefore, it is necessary to assess and analyze international collaboration in innovation. The studies of the designed assessment instruments in the field of research of innovation activities testify that scientists consider a so-called scalar approach as the most promising one in terms of such assessment. According to it, the explored phenomenon is assessed on the basis of calculations of a certain integral coefficient, i.e. an indicator consisting of a range of particular coefficients given in comparable mode.

The calculated integral coefficient provides opportunities of comparing regions in terms of how well the explored phenomenon is developed in them and composing the respective rating. In order to understand what methodological technique can be applied to make the corresponding calculations we should address the existing experiences of exploring regional innovation activities and

international collaboration of regions in the innovation sphere.

3.1 Methodological background to explore international collaboration of regions within their innovation activities

The growing topicality of the issues dealing with ways to develop innovation activities has caused different variants of methodological techniques of their assessment to appear both in Russian and foreign research works during the last years. Most of the works on the relevant subjects to some degree reflect importance and increasing significance of international collaboration in innovation under the modern conditions of globalization and regionalization. Nevertheless, assessments of international collaboration results, as a rule, are seen to be indirect, i.e. to be a component of methodological techniques that assess territorial innovation development on the whole. The works that take efforts to give quantitative descriptions to international collaboration specifically are small in number, and the methodological techniques that they apply are highly specialized, i.e.:

- Firstly, they have limited or no possibilities to be applied to research on the regional level
- Secondly, they are focused on a particular direction of collaboration

Quite often this direction appears to consist in preparation of international publications by scientific teams from different countries, and in order to assess results of such collaboration a bibliometrical analysis is used (Terehov, 2012).

The theoretical research conducted by the author while writing his dissertation work revealed existence of several

varieties of international collaboration in innovation. In view of the results of the studies of the statistical data that are available in the collections and databases of the Federal State Statistics Service, as well as in research works, it is possible to conclude that the purpose of assessing international collaboration provides an opportunity of singling out its three aspects that are composed by the existing collaboration varieties and reflected in official statistical data:

1. International R&D projects
2. Commercialization of results of innovation activities and attraction of financial resources
3. Technology exports and technology imports (there are more and less beneficial directions of technology exports and technology imports with regard to socio-economic development of territories. In view of the fact that international collaboration in innovation is oriented toward getting advantages by regions, for the purpose of assessing its level it is necessary to take account of those directions of technology exports and technology imports that are more beneficial for the regions with respect to developing their innovation activities)

Against this background for the purpose of studying the existing methodological techniques each of them was selected according to the principle of whether it was possible to carry out its analysis using the criteria presented in tab. 8. These criteria to analyze the existing methodological techniques were formulated by the author based on the examined theoretical aspects and requirements that are

reasonably expected to be met by the looked-for methodological technique.

Table 8: Criteria to be met by the looked-for methodological technique for assessing international collaboration in innovation (composed by the author)

Number	Criterion
1 Focus	Focus of the methodology on research of international collaboration in innovation or presence of a component dealing with research on international collaboration within the methodology aimed at assessing innovation activities
2 Assessment	Possibility of integral assessment (in particular, possibility of quantitative assessment of international collaboration itself)
3 Initial data	Availability and impartiality (presence in state statistics) of the initial data
4 Level	Applicability of the methodology to studying international collaboration in innovation on the regional level
5 Comparability	Possibility of comparative assessment of regions
6 Scope	Account of all aspects of international collaboration that can be used for assessment based on the data of state statistics (1) international R&D projects; 2) commercialization of results of innovation activities and attraction of financial resources; 3) technology exports and technology imports)
7 Uncomplexity	Uncomplexity of the technique used for the calculations

The used information base included a Russian scientific electronic library, online sources of the EU, as well as a European full text collection of electronic journals on different disciplines via open access to the sources granted by an institution of the Russian Academy of Sciences. As a result it was possible to single out the following existing methodological techniques:

1. Methodological technique for rating innovation regions for the purpose of monitoring and administration (Bortnik et al., 2013)
2. Methodological technique for assessing regional innovation potential (Yegorova et al., 2014)
3. Methodological technique for assessing innovation activities of industrial enterprises (Ivanov et al., 2012)
4. Methodological technique for calculating indices of regional innovation development (Rykova et al., 2012)
5. Methodological technique for quantitative assessment of innovation activity of the territorial entities (Kiselyov, 2010)
6. Methodological technique for calculating regional innovation indices (Regional Innovation Scoreboard, 2014)
7. Methodological technique for rating innovation development of the territorial entities (Innovation Development Rating of the Subjects of the Russian Federation, 2015)

Table 9: Meeting the criteria for assessing international collaboration in innovation by the existing methodological techniques (composed by the author)

Criteria (C)								
C1	C2	C3	C4	C5	C6			C7
					C6.1	C6.2	C6.3	
Methodological technique for rating innovation regions for the purpose of monitoring and administration								
+	+/-	+/-	+/-	+	-	+/-	-	+
Methodological technique for assessing regional innovation potential								
+	+	+/-	+/-	+	+/-	+/-	+/-	+/-
Methodological technique for assessing innovation activities of industrial enterprises								
+	-	-	+/-	+/-	-	-	+/-	-
Methodological technique for calculating indices of regional innovation development								
+	+/-	+/-	+/-	+	n/a	+	+/-	-
Methodological technique for quantitative assessment of innovation activity of the territorial entities								
+	+	+/-	+/-	+	+/-	-	+/-	+
Methodological technique for calculating regional innovation indices								
+	+	+/-	+/-	+	+/-	+/-	+/-	+/-
Methodological technique for rating innovation development of the territorial entities								
+	+/-	+/-	+/-	+	-	+/-	-	+/-

Criteria (C)								
C1	C2	C3	C4	C5	C6			C7
					C6.1	C6.2	C6.3	
Notes: +: the methodological technique meets the criterium; +/-: the methodological technique partially meets the criterium; -: the methodological technique does not meet the criterium; n/a – the data is not available.								

As it follows from the analysis of the strengths and flaws of the methodological techniques, none of them has an opportunity of meeting all of the selected criteria in order to make assessments of international collaboration in innovation to a full extent.

3.2 Developed methodological technique for assessing international collaboration of regions in innovation

Having taken into account the conclusions obtained as a result of the analysis of the data of state statistics, the formulated criteria to be met by the looked-for methodological technique, as well as the advantages and shortcomings of the methodological techniques for assessing innovation activities and, as their part, international collaboration in the innovation sphere, the author proposes his own methodological technique for assessing international collaboration of regions in innovation. It is based on:

- the account of the available and impartial data on all of the aspects of international collaboration that were identified within the research and can

be used for carrying out assessments on the basis of the data of state statistics

- the calculations of a special integral coefficient (index) of development of international collaboration in innovation conducted for every subject of the Russian Federation

In order to make the calculations of integral coefficients of development of international collaboration in innovation of the Russian Federation's regions it was proposed to use the set of indicators presented in tab. 10. The indicator 1 reflects the "international R&D projects" aspect of international collaboration, the indicators 2 and 3 cover the "commercialization of results of innovation activities and attraction of financial resources", and the indicators 4 and 5 have to do with the "technology exports and technology imports".

Table 10: Indicators of state statistics used in the proposed methodological technique for assessing international collaboration of regions in innovation (Rosstat, 2017)

Number	Indicator	Unit of measurement	Indicator characteristics
1	Participation of organizations in joint R&D with foreign countries, calculated per 1000 of enterprises and organizations	Number	Degree of the region's participation in international projects in the R&D sphere
2	Exports of innovation products, calculated per 1000 of enterprises and	Thousand rubles	Intensity of shipping international level innovation

Number	Indicator	Unit of measurement	Indicator characteristics
	organizations		products shown by the region
3	Expenditures on technological innovations and direct investments in research and development obtained from foreign sources, calculated per 1000 of enterprises and organizations	Thousand rubles	Activity of attracting additional resources for innovation activities shown by the region
4	Revenues of technology exports under agreements with foreign countries (beneficial directions: R&D carried out by the country's specialists abroad or in the country and financed from foreign sources; engineering services; patent licenses; utility models; industrial design patents), calculated per 1000 of enterprises and organizations	Thousand rubles	Volume of international level innovation services and technologies offered by the region

Number	Indicator	Unit of measurement	Indicator characteristics
5	Payments of technology imports under agreements with foreign countries (beneficial directions: R&D carried out by foreign specialists abroad or in the country and financed from the country's sources; engineering services; patent licenses; invention patents; unpatented inventions; know-how), calculated per 1000 of enterprises and organizations	Thousand rubles	Volume of international level innovation services and technologies acquired by the region

The methodological technique based on the calculations of integral coefficients was proposed for the purpose of conducting comprehensive assessments of regions in terms of their levels of development of international collaboration in innovation. It is reasonable to apply the multidimensional comparative analysis method when making the calculations, which stems from using the distance method and allows taking account of both statistical indicators and degrees of their derivations from certain reference standards.

The calculation stages:

1. Choosing a reference standard for each of the 5 indicators used in the proposed methodological technique.

The reference standard is understood as the maximal value of the indicator shown by the regions during the studied years, in case of classifying it as a stimulant indicator, i.e. an indicator that raises regional development level when increasing, and as a minimal value of the indicator shown by the regions, in case of classifying it as a destimulant indicator, i.e. an indicator that reduces regional development level when increasing (it should be noted that all of the indicators of state statistics used in the proposed methodological technique are stimulant ones)

2. Subsequently, the comparisons of each region's indicators with their reference standards are carried out for each of the studied years:

$$s_i = \frac{x_i}{x_{\max}}, \text{ or } s_i = \frac{x_{\min}}{x_i},$$

x_i – a region's value of the indicator number "i" out of 5 for a particular studied year;

x_{\max} or x_{\min} – the value of the reference standard (for stimulant or destimulant indicators respectively);

s_i – a region's indicator number "i" out of 5 for a particular studied year compared with its reference standard (in other terms, a so-called standardized indicator number "i")

3. The integral coefficient of development of international collaboration in innovation is calculated for a particular studied year.

It was considered reasonable to use the cubic mean formula for calculating general integral coefficients that allows making more precise assessments of the mean value of all of the used indicators. Using the cubic mean was proposed in connection with that, in case of using a mean value suggesting multiplication of the standardized indicators, proximity of at least one indicator to the zero value will result in that the integral coefficient, in turn, will be close to zero despite of possible high values of all of the other indicators. At the same time, the cubic mean is regarded to be more precise when compared with the simple mean value in this case.

$$I = \sqrt[3]{\frac{\sum_{i=1}^n s_i^3}{n}},$$

s_i – a region’s indicator number “i” out of 5 for a particular studied year compared with its reference standard (in other terms, a so-called standardized indicator number “i”);

n – number of the used indicators;

I – a region’s integral indicator of development of innovation collaboration in innovation for a particular studied year

The conducted research allowed collecting the values of the indicators used in the proposed methodological technique that reflect different aspects of international collaboration of regions in innovation and creating the data base containing the values of each indicator for all of the subjects of the Russian Federation for the period from 2006 to 2013, all in all 3200 indicator values. At the moment the data base is being expanded to include the last years as well.

3.3 Grouping regions and their international collaboration development levels

The collected data were processed and used while applying the developed methodological technique within which the indices of development of international collaboration in innovation were calculated and compared for each studied region, i.e. for every subject of the Russian Federation. By virtue of using the cluster analysis the regions were divided by their levels of international collaboration development as fig. 2 shows it.

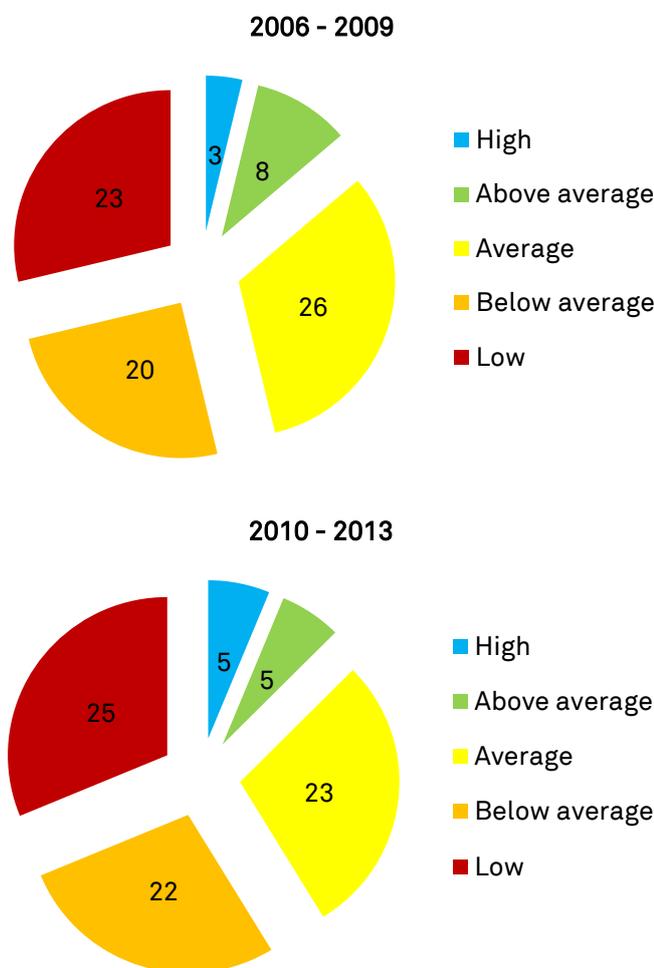


Figure 2: The studied regions in number divided by their levels of international collaboration development (calculated by the author)

The results of the calculations have shown that in the course of the studied period the international collaboration in innovation was characterized by rather high development levels only in 10 studied regions. The positive results achieved by these regions manifest themselves in carrying out collaboration more intensively and extending international scientific and technological relations within all of the directions of international collaboration in innovation identified while conducting the research. On the other hand, even those regions have collaboration development levels adding up to only 40-50% of the ideal one.

In 20 regions the average levels of collaboration development is caused by the lower values of their result indicators, and in a range of the cases they are also considered to be the consequences of the fact that the regions do not implement international collaboration in innovation within all of the possible directions. At the same time, those regions have manifestations of practices and experiences of developing international relations, which is regarded as their advantage. Innovation policies of these regions have a background to improve measures aimed at using reserves of international scientific and technological collaboration as a factor for increasing innovation activity. It may be concluded that the priorities of these regions encompass efforts to ensure conditions for implementation of those directions of international collaboration that are not being employed.

The other territories representing around 50% of the total number of the studied regions showed below average and low levels of development of international collaboration in innovation. The collaboration development indices equaled 0 in the course of the whole studied period in 6 regions. One of

the reasons for the collaboration to be underdeveloped, as the research indicated, should be named as low results of innovation activities in a lot of regions.

Low levels of collaboration development in the regions that have innovation potentials mean that, on the one hand, the actors of innovation activities do not implement collaboration by using own resources and possibilities and, on the other hand, conditions that allow creating stimuli and ensure annual implementation of the region's collaboration within all of the possible directions have not been created or sufficiently effective. In such a situation the collaboration when implemented may concentrate on the certain directions while a range of the directions may be fully absent. Consequently the regions do not use additional reserves and resources of those directions to achieve better results of their innovation activities. Solving these problems will be favored by implementation of regional systems of necessary measures for integrated and comprehensive support of international collaboration in innovation.

The integral coefficients of development of international collaboration of regions in innovation calculated in accordance with the developed methodological technique can be seen on fig. 3.

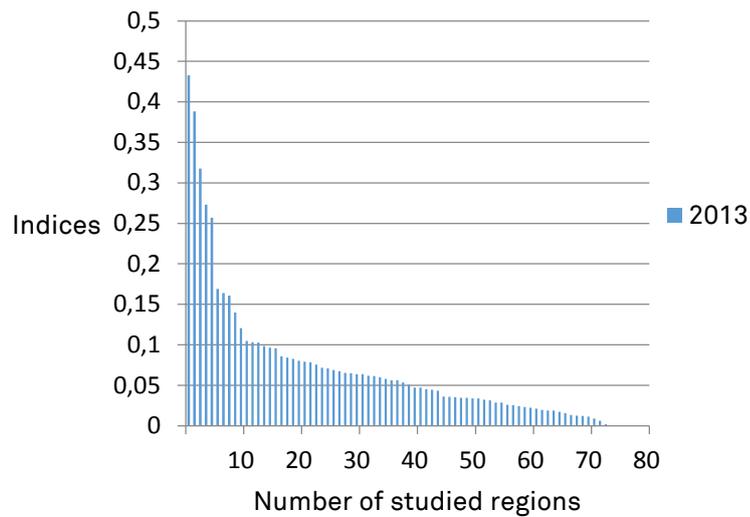


Figure 3: Integral coefficients (indices) of development of international collaboration in innovation of the studied regions (calculated by the author)

The results of the calculations have shown that the majority of the studied regions cannot be classified as regions characterized by development of international collaboration in innovation. Most of the regions have low levels of collaboration development. In seven regions, which adds up to around 9% of the total number of the studied regions, international collaboration in innovation was not being implemented, i.e. those regions were not employing such a direction of developing innovation activities.

3.4 Region typology

On the basis of the calculations in accordance with the proposed methodological technique it is possible to build a region typology in terms of correlation between levels of international cooperation in innovation and regional orientations toward technology exports or technology imports. The proposed typology is presented in tab. 11. It makes it possible to:

1. Provide characteristics of the studied regions in terms of the specifics of their international collaboration
2. Identify their possible long-term and short-term strategies of regional innovation development (the studies conducted within the theoretical part of the author's dissertation suggest that the world's experience testifies the existence of three basic strategies for innovation development: a) "carrying over"; b) "catching up"; c) "building up". Highly developed countries typically use the "building up" strategy that consists in active development and adoption of innovations based on the use of the possessed scientific and technological potential. Developing countries broadly apply the strategies of "carrying over" and "catching up" that imply borrowing (adapting) and adopting (imitating) the products that the developed countries manufactured before)
3. Identify the correlation of the roles between the studied regions in terms of the existing possibilities to develop own technologies and adopt attracted ones

Table 11: Region typology in terms of correlation of levels of international collaboration in innovation and orientations toward technology exports or technology imports, built on the data of the studied regions (developed by the author)

Compared parameters	Low level of international collaboration development	Average level of international collaboration development	High level of international collaboration development
The region's	2 studied	4 studied	0 studied

Compared parameters	Low level of international collaboration development	Average level of international collaboration development	High level of international collaboration development
TE outweighs TI	regions. The region does not get advantages from ICI or those advantages are limited. A technology outflow takes place in the region.	regions. The region gets certain advantages from ICI. The region is oriented toward TE.	regions. The region gets advantages from ICI. The region is oriented toward TE.
The region has both TE and TI that are comparable	5 studied regions. The region does not get advantages from ICI or those advantages are limited.	1 studied region. The region gets certain advantages from ICI.	3 studied regions. The region gets advantages from ICI.
The region's technology exports are inferior to its technology imports	30 studied regions. The region does not get advantages from ICI or those advantages are limited. There is an urgent need	6 studied regions. The region gets certain advantages from ICI. The region is oriented toward TI.	6 studied regions. The region gets advantages from ICI. The region is oriented toward TI.

Compared parameters	Low level of international collaboration development	Average level of international collaboration development	High level of international collaboration development
	to sustain and increase innovation activities.		
The region has no TE and TI	21 studied region. The region practically does not get advantages from ICI.	2 studied regions. The region gets limited advantages from ICI.	0 studied regions. The region gets advantages from ICI, but does not take opportunities of TE and TI.
Notes: international collaboration in innovation (ICI); technology exports (TE); technology imports (TI).			

The built typology allows concluding that regions tend to have orientations toward technology imports while the international collaboration development level is low. However, in such a case, advantages from international collaboration appear limited, which calls forth a need to increase the innovation activity.

Another tendency is that regions with low international collaboration development level may have some other unfavorable features, namely when the international collaboration directions of technology exports and technology imports are fully absent. In that situation

advantages of international collaboration are almost not implemented on the whole. Besides, a region type characterized by prevailing technology exports and low international collaboration development levels has a threat related to a possible outflow of technologies from the region as a particular consequence of the limited international collaboration that, at the same time, is implemented within less beneficial directions.

3.5 Correlation and regression analysis

Within the conducted research it is possible to single out one more direction that has to do with assessing correlations between the international collaboration in innovation and the results of innovation activities. It is possible to apply economic and mathematical methods for these purposes. The research tasks determined to choose and use the correlation and regression analysis.

The information base for conducting the correlation and regression analysis included the data of the Federal State Statistics Service on result indicators of innovation activities and the calculated (also on the basis of the data of the Federal State Statistics Service) integral coefficients of international collaboration in innovation for the studied regions.

The results of the correlation and regression analysis showed the presence of significant correlations between the international collaboration development level of and the results of innovation activities. Examining the parameters of the multiple regression equation led to identifying the dependencies of the result indicator (the volume of innovation products, works, and services) on the level of

development of international collaboration in innovation that are presented in tab. 12.

Table 12: Results of the correlation and regression analysis of the dependence of the volume of innovation production (response) on the level of development of international collaboration in innovation (predictor) (calculated by the author)

Number	Results of the regression analysis		Interpretation of the results
1	Correlation coefficient	$R = 0,4391$	Presence of a significant direct correlation.
2	Determination coefficient	$R^2 = 0,1928$	The predictor explains 19% of the response.
3	F-criterium	$F = 129,9435$; $df = 1,544$; $p = 0,0000$	The dependence of the predictor and the response is statistically significant.

In view of that, on the basis of the interpretation of the results of the conducted correlation and regression analysis it may be concluded that the identified mathematical dependency provides an opportunity of giving a quantitative assessment to the consequences of the international collaboration of regions in innovation. In other words, the conducted studies allows suggesting that international collaboration in innovation that is implemented within the directions ensuring advantages for regions defines 19% (i.e. one-fifth) of the final result of their innovation activities manifested in the volume of innovation products, works, and

services. The identified correlation was direct and statistically significant.

From the theoretical part of the research it was considered that participation of regions in international collaboration intensifies innovation activities in general and strengthens innovation products in new promising markets in particular. Therefore, it was seen advisable to elaborate regional mechanisms that create conditions for collaboration between innovation activity actors and their foreign partners, provide preferences, as well as state support resources for innovation interactions, to participants of collaboration, improve relevant legislative frameworks, enhance infrastructure elements, develop relations with innovation networks and programs of developed countries and their regions, and ensure systematic informational and consulting support for organization and deepening of innovation interactions. As tools of collaboration it is at least possible to use the framework of existing relevant regulatory documents and create regional initiatives to support projects involving development of international innovation cooperation.

Thus, theoretical conclusions about international collaboration in innovation being important get an actual confirmation through conducting the calculations based on the data of state statistics. According to this implementation of measures to develop the collaboration on the regional level evidently is capable of producing significant results.

4 Regional economic and organizational measures of public administration in innovation based on international collaboration development

Sharing experience is one of the key points of international cooperation in the innovation activities. This fact confirms the need to develop cooperation at the regional level, because each region has specific requirements to obtaining and transferring various resources and innovation. The results of innovation activities are not automatically translated to economic success and dynamic economic development of territories. In this regard, it is reasonable to develop measures for intensification of international cooperation of regions in innovation activities.

At the moment holistic mechanisms of international innovation cooperation between regions, according to the results of the analysis of regional innovation policies described further, still have to be formed. In connection with this, there are growing needs to develop and further improve them, which will be aimed at creating favorable conditions to develop, adopt, and commercialize innovations, obtaining competitive advantages and synergy effects.

Practical applications of the developed methodological technique will allow forming priorities and directions of innovation policies to develop international collaboration in innovation for concrete regions. All in all, the proposed methodological tools will provide opportunities of developing and improving organizational and economic mechanisms of regional public administration in innovation on the whole and on the basis of international collaboration development in

particular. The following chapter contains a set of theses from the author's dissertation research to illustrate how the above mentioned needs might be met while using the obtained opportunities.

4.1 Priority measures of regional innovation policies to develop international collaboration in innovation

In order to identify priorities of public administration in innovation dealing with international collaboration development the regional innovation policies were subject to analysis within the dissertation research. The set goal and tasks were a reason to focus, on the whole, on the regulations concerning innovation activities and, in particular, on their parts that are directly related to international innovation cooperation development. This allowed identifying the existing regional public administration opportunities of supporting innovation activities and international collaboration of regions, as well as the implemented and planned relevant measures.

Regional innovation policies, as a rule, postulate importance and needs for international collaboration. However, the regional regulatory and legal bases of public administration of innovation activities:

- concentrate on the aspects concerning investments
- insufficiently specify what measures and means are planned to be used

The region typology developed within the dissertation research in this context allowed getting the idea about the high-priority measures to develop innovation activities on the basis of international collaboration to be taken in the

concrete studied regions (see tab. 13). The analysis showed that the actual implemented measures aimed at supporting international collaboration in innovation are inclined to have a fragmentary character and be underdeveloped.

Table 13: Needs to implement measures for international innovation cooperation development in the studied regions (composed by the author)

Compared parameters	Low level of international collaboration development	Average level of international collaboration development	High level of international collaboration development
$\frac{TE}{TI} \geq 1,5$ or $TE > 0$ and $TI = 0$	Measures: - to develop all of the ICI varieties; - to restructure TE; - to increase the shares of more beneficial TE directions within the total TE volume. Strategies: mid-term: catching up; long term: building up. In relation to other studied regions: the region has a	Measures: - to support the achieved ICI level; - to develop certain ICI varieties. Strategies: mid-term: catching up; long-term: building up. In relation to other studied regions: the region has a background to develop own technologies. In relation to the region:	Measures: - to support the achieved ICI level. Strategies: mid-term: building up. In relation to other studied regions: the region has a background to develop own technologies. In relation to the region: other studied regions can implement the carrying over and catching

Compared parameters	Low level of international collaboration development	Average level of international collaboration development	High level of international collaboration development
	<p>background for developing certain varieties of own technologies.</p> <p>In relation to the region:</p> <p>other studied regions can implement the carrying over strategy.</p>	<p>other studied regions can implement the carrying over strategy.</p>	<p>up strategies.</p>
$0,5 < \frac{TE}{TI}$ $< 1,5$	<p>Measures:</p> <ul style="list-style-type: none"> - to develop all of the ICI varieties; - to develop technologies within the beneficial directions of TE and TI. <p>Strategies:</p> <p>mid-term: carrying over;</p> <p>long-term: catching up.</p> <p>In relation to</p>	<p>Measures:</p> <ul style="list-style-type: none"> - to support the achieved ICI level; - to develop certain ICI varieties; - to increase TE and TI within more beneficial directions. <p>Strategies:</p> <p>mid-term: catching up;</p> <p>long-term: building up.</p>	<p>Measures:</p> <ul style="list-style-type: none"> - to support the achieved ICI level; - to reduce TI; - to develop technologies that are being imported. <p>Strategies:</p> <p>mid-term: catching up;</p> <p>long-term: building up.</p> <p>In relation to other studied</p>

Compared parameters	Low level of international collaboration development	Average level of international collaboration development	High level of international collaboration development
	<p>other studied regions: the region has a background for developing certain varieties of own technologies and adopting attracted technologies.</p> <p>In relation to the region: other studied regions can implement the carrying over strategy.</p>	<p>In relation to other studied regions: the region has a background for developing certain varieties of own technologies and adopting attracted technologies.</p> <p>In relation to the region: other studied regions can implement the carrying over strategy.</p>	<p>regions: the region has a background for developing own technologies.</p> <p>In relation to the region: other studied regions can implement the carrying over and catching up strategies.</p>
$\frac{TE}{TI} < 1$ or $TE = 0$ and $TI > 0$	<p>Measures:</p> <ul style="list-style-type: none"> - to develop all of the ICI varieties; - to restructure TI; - to increase the shares of more beneficial TI directions 	<p>Measures:</p> <ul style="list-style-type: none"> - to support the achieved ICI level; - to develop certain ICI varieties; - to increase TE and TI within 	<p>Measures:</p> <ul style="list-style-type: none"> - to support the achieved ICI level; - to increase TE within more beneficial directions; - to reduce TI;

Compared parameters	Low level of international collaboration development	Average level of international collaboration development	High level of international collaboration development
	<p>within the total TI volume;</p> <ul style="list-style-type: none"> - to develop technologies that are being imported; - to develop technologies within the beneficial TE directions. <p>Strategies:</p> <p>mid-term: carrying over;</p> <p>long-term: catching up.</p> <p>In relation to other studied regions: the region has a background for adopting attracted technologies.</p> <p>In relation to the region: other studied regions can</p>	<p>more beneficial directions;</p> <ul style="list-style-type: none"> - to reduce TI within less beneficial directions; - to develop technologies within less beneficial TI directions. <p>Strategies:</p> <p>mid-term: catching up;</p> <p>long-term: building up.</p> <p>In relation to other studied regions: the region has a background for adopting attracted technologies.</p> <p>In relation to the region: other studied</p>	<ul style="list-style-type: none"> - to develop technologies that are being imported. <p>Strategies:</p> <p>mid-term: catching up;</p> <p>long-term: building up.</p> <p>In relation to other studied regions: the region has a background for developing own technologies.</p> <p>In relation to the region: other studied regions can implement the carrying over and catching up strategies.</p>

Compared parameters	Low level of international collaboration development	Average level of international collaboration development	High level of international collaboration development
	implement the carrying over strategy.	regions can implement the carrying over strategy.	
TE = TI = 0	<p>Measures:</p> <ul style="list-style-type: none"> - to develop all of the ICI varieties; - to develop own technologies within the beneficial TE and TI directions; - to develop TE and TI. <p>Strategies:</p> <ul style="list-style-type: none"> mid-term: carrying over; long-term: catching up. 	<p>Measures:</p> <ul style="list-style-type: none"> - to develop all of the ICI varieties; - to develop own technologies within the beneficial TE and TI directions; - to develop TE and TI. <p>Strategies:</p> <ul style="list-style-type: none"> mid-term: carrying over; long-term: catching up. 	<p>Measures:</p> <ul style="list-style-type: none"> - to support the achieved ICI level; - to develop own technologies; - to develop TE and TI. <p>Strategies:</p> <ul style="list-style-type: none"> mid-term: catching up; long-term: building up.

On the contrary, as a result of the inclinations named above, mechanisms of regional public administration in innovation on the basis of international collaboration development are still unformed and require improving. There are only separate elements of such mechanisms that are being created within

the public administration. Furthermore, they are mostly related to implementation of organizational and informational measures.

Thus, the following advantages of international collaboration of regions in innovation are not being achieved:

- attracting additional financing and sharing high R&D costs
- sharing risks of innovation activities
- achieving synergy effects
- increasing competitive advantages on the world market by virtue of forming partnerships
- expanding realization markets and accessing the markets of the partner countries more easily
- opportunities for specializing on particular “links” of global value chains
- economizing resources compared to the sole building of those chains
- extending opportunities for economic growth

Thus, the research indicated the need to extend the current measures to strengthen international collaboration of regional actors of innovation activities. Priorities in this field include:

- enhancing the role and the share of international innovation cooperation in the overall international collaboration of the regions
- establishing economic mechanisms for international cooperation development

The regions have certain experiences to implement better measures of public administration in this field. Over the past decades they have accumulated reserves for subsequent

intensification of innovation activities with help of appropriate instruments.

4.2 Organizational and economic mechanism of regional public administration in innovation based on international innovation cooperation development

Theses and conclusions formed within the theoretical part of the dissertation research, as well as the regional problems identified in the course of the analysis, allowed the author to develop organizational and economic mechanism for regional public administration in innovation on the basis of international collaboration development (see fig. 4).

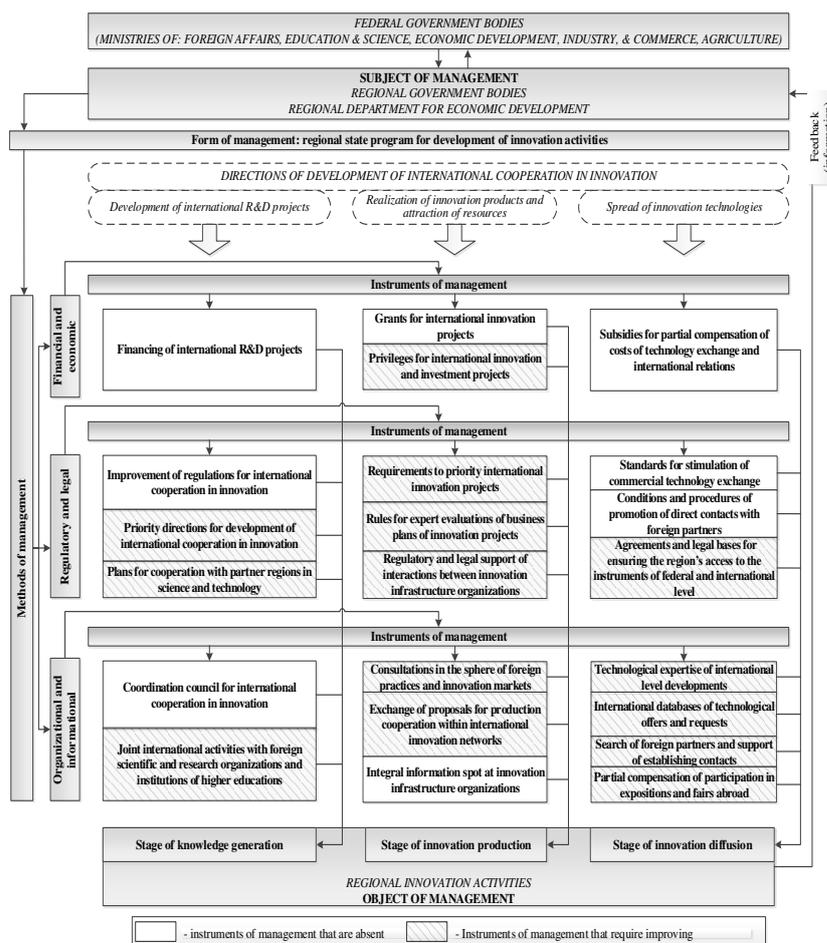


Figure 4: Organizational and economic mechanism of regional public administration in innovation based on international innovation cooperation development (developed by the author)

The practical advantages of the mechanism that are based on it being grounded on a substantiated theoretical base consist in:

1. Development of international collaboration within three specialized directions, each aiming at improving results of a respective stage of the regional innovation activities
2. The whole combination of the public administration methods ensures comprehensive and regular carrying out of each international collaboration direction
3. Opportunities of rapid control and redistribution of the funds to focus on the most important needs of the region in a particular situation when planning specific activities for a concrete period
4. Direct involvement of international leading experiences, resources and results of innovation activities in regional innovation projects as a reserve to intensify them

In view of the fact that the instruments included in the mechanism would require advice on their implementation, the respective suggestions were developed within the dissertation research, which covers the recommendations on the following instruments:

1. Financial and economics instruments (grants; subsidies)
2. Regulatory and legal instruments (regulatory bases of the regional state subprogram's activities)

3. Organizational and informational instruments (coordination council; monitoring; joint activities of infrastructural organizations)

The main regulatory documents of the regions in the sphere of innovation activities (laws, state programs, innovation activity development concepts, etc.) and their provisions concerning international innovation cooperation development were analyzed within the dissertation research, which allowed linking the possibilities of the regional governments to develop international collaboration in innovation with the needs to create and improve a range of important instruments of management.

It was suggested to employ opportunities of a state program dealing with innovation development of the economy by singling out a block within the program aimed at providing subsidies for organization of international collaboration in innovation of regions. In order to practically use this financing it was seen reasonable to adopt a decree at the national level that sets conditions for competitive selection of regions which can receive the budget subsidies for state support of international innovation cooperation.

In the framework of the decree it is necessary to design conditions for the competitive selection in accordance with the following activities:

- financing of international research and development
- ensuring grant support for international projects aimed at production and export of innovation goods

- providing subsidies for partially compensating costs of technology exchange and implementation of international ties

A mechanism for implementation of the activities is as follows:

regions prepare competitive proposals and according to the selection get subsidies to further direct the funding to regional actors of international innovation cooperation.

It is reasonable to suggest, for the purposes of achieving better efficiency of the proposed mechanism, that the budget subsidies are provided on the conditions of co-financing by the regional budgets, which should be no less than 10%.

It was suggested that the developed mechanism is implemented in a form of a subprogram for international collaboration within a regional state program for development of innovation activities. The planned period of the subprogram's implementation consists of 8 years.

The possible sources of the subprogram's financing include:

- regional budgets
- funding within subsidies of national ministry targeted programs

At the same time it was possible to plan that the share of the budget financing of the projects would not amount to more than 12.5% of the total volume of a project's financing.

On the basis of analyzing reported, estimated, and planned indicators and data of the national and regional state programs, regulatory documents, state innovation infrastructure data bases, Russian and foreign practices, and

official statistical data within the dissertation research it was possible to make calculations with regard to the proposed objectives of the studied region's international collaboration in innovation for a period of 8 years.

Table 14: Objectives of the region's international collaboration in innovation for a period of 8 years (calculated by the author)

Objective	Unit	Scenario	Objective's indicator value								
			Reported or estimated	Planned							
				First phase				Second phase			
				2017	2018	2019	2020	2021	2023	2025	
Number of international R&D projects with partners from other countries	Number	inertial	7	11	14	17	20	27	36		
		active	7	20	23	26	29	36	45		
Internal R&D expenditures due to international collaboration	% from 2017 level	inertial	100	107,2	109,6	111,9	114,0	117,9	121,4		
		active	100	119,9	122,4	124,6	126,7	132,7	138,7		
Shipped innovation products due to international collaboration	% from 2017 level	inertial	100	103,5	106,8	109,9	112,7	118,0	122,8		
		active	100	103,7	107,2	110,4	113,5	119,0	123,8		
Technological innovation expenditures obtained from foreign partner sources*	% from 2017 level	inertial	100	117,7	136,7	157,1	178,9	226,5	279,6		
		active	100	351,3	370,3	390,7	412,5	499,1	570,3		

Objective	Unit	Scenario	Objective's indicator value								
			Reported or estimated	Planned							
				First phase					Second phase		
				2017	2018	2019	2020	2021	2023	2025	
Technology export agreements	Number	inertial	4	4	5	5	6	7	7		
		active	4	7	8	10	11	13	14		
Technology imports agreements	Number	inertial	8	9	9	10	11	12	14		
		active	8	12	12	15	16	18	21		
Created and (or) modernized high productivity jobs	% from 2017 level	inertial	100	107,0	117,1	126,5	135,5	154,2	173,8		
		active	100	135,5	143,9	151,7	159,0	173,8	188,4		
Number of actors of innovation activities supported financially within the program	Number	inertial	0	0	0	0	0	0	0		
		active	0	32	32	42	42	46	51		
Patent applications	Number	inertial	119	120	121	122	123	125	128		
		active	119	124	125	129	130	133	137		

Socio-economic effects from implementing the subprogram would, among others, include an increase in the following indicators:

- created or modernized high productivity jobs

- taxes and contributions to the budgets and the state funds

In conclusion, the developed mechanism would ensure the required set of regional public administration measures needed to intensify innovation activities based on international collaboration development.

Implementing the respective mechanism would allow overcoming inconsistency of the relevant regional innovation policies and promoting achievement of the objectives declared within them.

5 Conclusions

Under the conditions of globalization and regionalization an important direction to intensify innovation activities with potential to embrace a significant number of their problems consists in development of international collaboration in innovation. Taking the levels of innovation activities in developing countries into account allows concluding that there are needs to implement measures for improving their own technological bases, as well as to make efforts to strengthen international relations for the purposes of employing leading world developments and practices. Engaging of enterprises in international innovation cooperation creates opportunities of attracting additional financial resources that can be used and aimed at developing innovation activities. In the course of international collaboration own technological bases get strengthened and leading production technologies are attracted, which leads to building up of own innovation potentials for creating such technologies and increasing patent activity. In the end, due to engaging in innovation cooperation the volume of innovation products, works, and services, as well as their export, gets increased. At the same time systematic development of international collaboration of regions requires that they develop it comprehensively, because it is the only way to achieve advantages at all phases of innovation activities. In view of this, there is a pressing need to improve regional mechanisms that allow ensuring and developing international collaboration in innovation of the regions.

The goal of the conducted dissertation research was to theoretically substantiate and design an organizational and

economic mechanism of public administration in innovation based on international collaboration development measures.

The main results that were obtained while achieving the set goal, among others, include:

1. Studied theory, expertise and practices in the field of public administration of innovation activities based on international innovation cooperation (including the respective theoretical conclusions, substantiated positions and resulting theses)
2. A proposed classification of international collaboration in innovation in terms of its types
3. Developed methodological tools allowing assessing international innovation cooperation and comparing regions from different perspectives of their collaboration
4. Identified types of regions characterizing them by specifics of their cooperation and needs within their public innovation policies
5. Mathematically assessed correlations between levels of innovation cooperation and results of innovation activities
6. Comprehensive studies and analysis of international innovation cooperation in regions
7. Systematized data on identified problems that are needed to be considered when developing innovation policy measures
8. Based on this, substantiated priorities of economic, organizational, legal and information instruments combined within an economic and organizational public administration mechanism

aimed at increasing regional innovation activity based on international cooperation

9. The recommendations were formed to develop international collaboration in innovation of the region that include financial and economic measures, regulatory and legal measures, and organizational and economic measures; implementation of the suggested recommendations would allow significantly improving practices of public administration in innovation based on international collaboration development in regions, which would lay a foundation to finalize the forming of the respective mechanisms and, in turn, increase consistency of the implemented measures and ensure obtaining synergy effects within them

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