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**ANALYSIS OF TRENDS IN
DEVELOPMENT OF INNOVATION
INFRASTRUCTURE OF
UNIVERSITIES IN THE CONTEXT
OF INTERACTION WITH THE REAL
ECONOMY**

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Abstract

The article considers the major problems of integration of domestic industry and universities, i.e. the authors have carried out the sampling analysis of data about organizations correlation and usage of the components of universities' innovation structure. In the conclusion the authors provide their offers on the development of universities' innovation infrastructure with the purpose of their most efficient participation in the processes of innovation regional economy.

Keywords: Universities innovation infrastructure, commercialization, industry of Russian regions, innovative solutions, the integration of regional and university industry.

Introduction

Nowadays the role of universities' innovation infrastructure in the region development in the Russian Federation in the long-run is huge. This issue is of vital importance under the conditions of

acute necessity to produce import-substituting and competitive domestic output. That's where the issue of integration of Russian industry with universities to achieve synergic effect is widely discussed. Developed countries rely on innovative economy to pursue strategic perspectives of further functioning, when innovations are not only a means of profit growth but they become the leading factor of the economy growth as well as the advance in living standards. The research has shown that 90% economic growth of developed economies is the result of the introduction of R&D deliverables in the economic turnover. Nowadays Russia is fully aware of the fact that export of raw materials has been exhausted. The usage of export-oriented raw economy model is not able to provide neither economic growth nor meeting the population's needs in the short-run as well as in the long-run. The situation has become even worse due to world financial and economic crises. As a result we are witnessing a sharp decrease of the demand for energy resources and fall in their prices. The decrease in export earnings has led to a breakdown in the amount of foreign direct investments in Russian economy and stagnation in many industries in Russia. Economic sanctions against Russia have contributed to this also.

Thus, we can identify the major problems that must be solved in the near future:

- the gap between the businesses' needs for new technologies and offers of the Russian sector of research and development;
- restriction in using the tools of government support for research and development which impede their effective implementation including the achievement of breakthrough results;
- insufficient level of integration of Russian research and development sector into a global international innovative system as well as clear inequality of the Russian Federation development of scientific-technical cooperation with the leading countries of the world.

One of the solutions of existing problems is the adjustment of state policy in the sphere of science and technology to the given reference directions:

- to form a priority system and mechanisms of its implementation to achieve scientific –technological breakthroughs in certain priority directions;
- to form a single infrastructure to provide for the research and development sector which allows accomplishing complex projects of federal importance and to create mechanisms of its regulation and coordinated development;

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- to contribute to commercialization of science and technological results and new technologies due to the development of innovation infrastructure of national universities.

Materials and methods

According to the received results of the research conducted by the order of Ministry of Education and Science of the Russian Federation in 2015 (project head manager – Doctor of Economic Science, Professor A. Ryakhovskaya, project participants – Candidate of Economic Science, associate professor Y. Gruzina, Candidate of Economic Science, associate professor Kh. Kharchilava, Candidate of Economic Science, associate professor M. Pukhova and others) called “Conducting research and analysis of strategic programs of economic development and regional industries with the purpose of working out a package of measures to include the results of innovative, academic and technological activities of universities in economic activity of the constituent units of the Russian Federation (the implementation of bailout plan of the Government of the Russian Federation)” the authors record a very low dependence of a number of universities’ patents on the amount of financing from economic agreements with regional entities. The described project studied the performance of 42 innovative universities of Russia that characterize scientific engineering potential and the level of penetration of universities innovative activities of into the regional production of the Russian Federation.

Whereby the important indicators of innovative activity of universities are as follows:

- developed innovation infrastructure (components);
- total volume of research, design and experimental and technological projects as innovative inventions and the level of their penetration into the regional industry are connected with the amount of their financing;
- total amount of funds received by an educational establishment from the Department of Intellectual Property Management, total income of an educational establishment. Each university under research possesses supported patents, licences, know-hows, etc. Every year universities have to spend a certain amount of funds to obtain all the above mentioned;
- the ratio of proceeds from R&D to total income of an educational establishment. This indicator characterizes the profitability of research activity and the possibility of developing the components of innovation infrastructure;

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- universities rating of 2015 (rating functional). The methodology of rating creation includes scientific and research potential of universities;

- rating of innovation regions of the Russian Federation of 2015. This aspect analyzed the innovative development of the region where an educational establishment was located.

The analysis of Federal Law “Concerning the Federal Budget for 2013 and for the planned period of 2014 and 2015” showed that aggregate expenditures for research and inventions of non-military nature in 2013 amounted to 342,07 bln. RUB (0,51% GDP), in 2014 — 370,35 bln. RUB (0,52% GDP), in 2015 — 384,78 bln. RUB (0,51% GDP), in 2016 - 316,87 bln. RUB are planned, in 2017 - 302,04 bln. RUB are planned. In prospect this expenditure is subject to reduction due to the number of economic and political reasons including political and economic crisis in Ukraine which will definitely influence innovative activity of the country. At that the terms of providing state funds to support infrastructure elements were clearly stipulated and it was also specified that state support could be provided to those universities whose projects of infrastructure development had passed competitive selection. Universities innovative infrastructure was assessed by the following components: business-centre, business incubator, technology park, innovation and technological centre, common use centre, technopolis, innovation centre, special economic zone.

Results and discussion

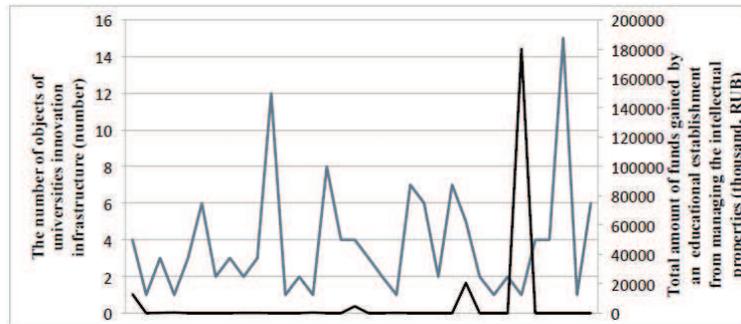
The analysis of indicators of scientific engineering potential of 42 universities provided us with the following data on correlation between the organization and the usage of components of universities innovation infrastructure:

- there is negative low correlation: total amount of funds gained by an educational establishment from managing the intellectual properties, total income of an educational establishment (thousand, RUB) and the number of objects of universities innovation infrastructure (number) (picture 1): $K_k = - 0,146889076$.

The objects of innovation infrastructure can create intellectual properties but a weak side of their development is their implementation and income acquisition from their usage.

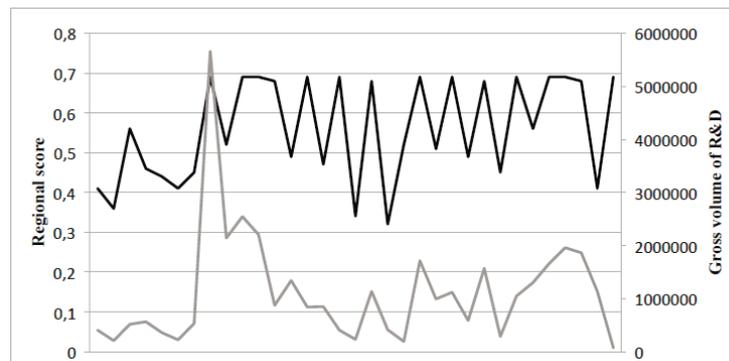
- there is medium correlation: total volume of research, design and experimental and technological projects (thousand, RUB) and rating functional (universities rating of 2015) (picture 2): $K_k = 0,666381737$.

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Picture 1 – the dependence of total amount of funds gained by an educational establishment from managing the intellectual properties, total income of an educational establishment (thousand, RUB) and the number of objects of universities innovation infrastructure (number)

Picture legend: black line - total amount of funds gained by an educational establishment from managing the intellectual properties, total income of an educational establishment (thousand, RUB); gray line - the number of objects of universities innovation infrastructure (items).



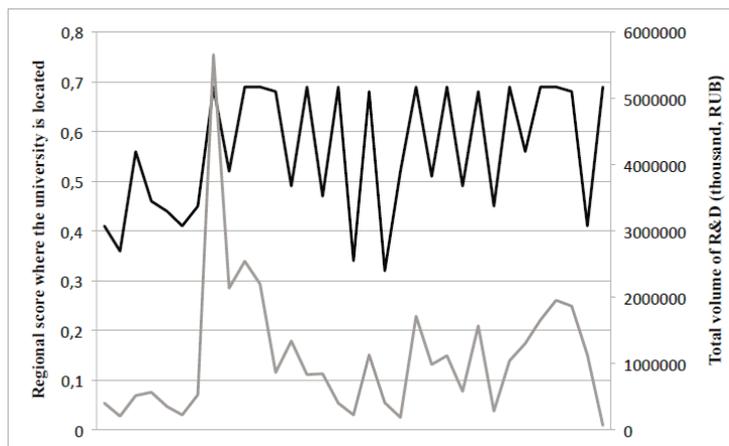
Picture 2 – The dependence of total volume of research, design and experimental and technological projects (thousand, RUB) on rating functional (universities rating of 2015).

Picture legend: black line – regional score where the university is located according to the rating of innovative regions, 2015; gray line - total volume of research, design and experimental and technological projects (thousand, RUB).

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Universities innovation activity directly influences R&D and other qualitative performance indicators of an educational establishment. Efficient innovation infrastructure provides for the development of research activity and integration of universities and regional manufacturing enterprises, for the improvement of education quality, for the attraction of leading national and international scholars to teaching and research activity.

- there is medium correlation: total volume of research, design and experimental and technological projects and the level of regional innovative development (regional score where the university is located according to the rating of innovative regions of 2015) (picture 3): $K_K = 0,515694389$



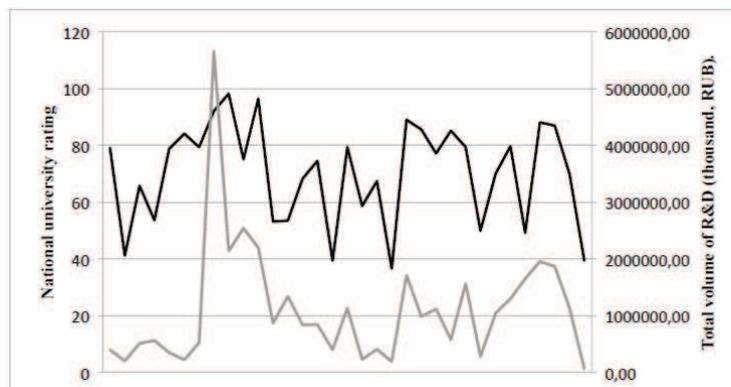
Picture 3 – the dependence of total volume of research, design and experimental and technological projects (thousand, RUB) on the level of regional innovative development (regional score where the university is located according to the rating of innovative regions of 2015).

Picture legend: black line - regional score where the university is located according to the rating of innovative regions of 2015; gray line - total volume of research, design and experimental and technological projects (thousand, RUB).

We should emphasize the role of regional development in the development of innovative infrastructure that allows conducting R&D and introduce the results of innovative activity into production. For instance, R&D and innovative solutions are financed from different regional funds in a number of universities.

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- Medium correlation: total volume of research, design and experimental and technological projects (thousand, RUB) and the position of university in the national university rating of 2014/2015 academic year: Innovations and Entrepreneurship (picture 4): $K_k = 0,519903959$.



Picture 4 – the dependence of total volume of research, design and experimental and technological projects (thousand, RUB) on the position of university in the national university rating of 2014/2015 academic year: Innovations and Entrepreneurship (score).

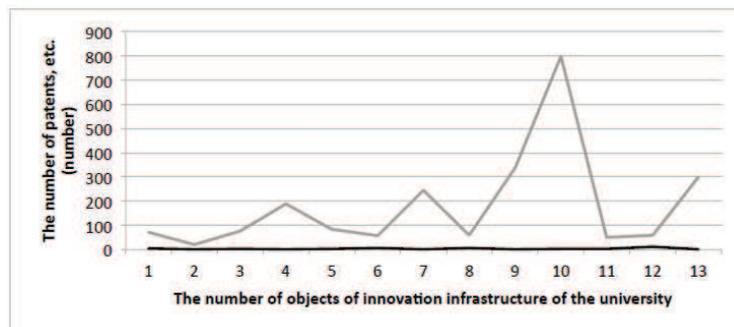
Picture legend: black line - national university rating of 2014/2015 academic year: Innovations and Entrepreneurship (score); gray line - total volume of R&D of 2014 (thousand, RUB).

National university rating includes the following indicators: university earnings from commercialization of developments in the sphere of LS, agreements with targeted enterprises, academic staff involved in small innovation enterprises and students who specialize in the sphere of LS, the availability and development level of infrastructure of technology entrepreneurship of the university in the sphere of LS.

Thus the volume of financing universities in carrying out research activities reflects active innovative policy in the field of cooperation of universities with regional enterprises including the usage of their innovation infrastructure.

Weak correlation: supported patents in universities (number) and the number of objects of innovation infrastructure of the university (number) (picture 5):

$$K_k = 0,285443951$$



Picture 5 - the dependence of the number of supported patents in the university on the number of objects of innovation infrastructure of the university (number).

Picture legend: black line - the number of objects of innovation infrastructure of the university (number); gray line – the number of patents, certificates of registration; databases, etc. in 2015.

The number of objects of innovation infrastructure of the university does not influence the number of patents, certificates of registration, etc.

Correlation data show a very low dependence of the number of patents of the university on the volume of financing from R&D agreements with regional enterprises. Thus we can speak about the problem of commercialization of scientific potential of an educational establishment.

We should note a rather low ratio of income from R&D activity to total income of an educational establishment (%). Only a few researched universities show quite a high ratio, that is 20%. These universities are as follows:

1. Kazan National Research technical University named after A.N. Tupolev – 21,95;
2. Moscow State University named after M.V. Lomonosov – 23,42;
3. Tomsk Polytechnic University – 32,28;
4. National Research University “Higher School of Economics” – 20,45;
5. National Research Nuclear University MEPhI – 50,77;
6. The Mining University – 25,35;
7. National Research University “Gubkin Russian State University of Oil and Gas” – 23;

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8. National Research University “Samara University” – 27;
9. National University of Science and Technology MISIS – 32,32;
10. National Research University of Electronic Technology – 42,62;
11. National research University MPEI – 21,91;
12. Moscow State Technical University STANKIN – 79,23;
13. National Research University MIPT – 36,37;
14. ITMO University (Saint-Petersburg) – 40,92;
15. Southern Federal University – 23,32.

Among the mentioned universities it is necessary to mark Moscow State Technical University STANKIN with the ratio of income from R&D activity to total income of the university of 79,23%. The given indicator characterizes the efficiency of the whole research activity of the university including the development of innovation infrastructure. The measure of the analyzed indicator proves a high level of introduction of results of innovative activity in production.

It is necessary to note that practically all mentioned universities participate in the implementation of RF Government Regulation of 9 April 2010 № 218 (edited 12 February 2015) “On the measures of state support to develop cooperation of Russian educational institutions of higher education, state research institutions and enterprises that implement complex projects to develop high-technology production within the sub-program “Institutional development of research sector” of state program of the Russian Federation “The development of science and technology” for the period from 2013 to 2020”.

It must be stressed that all 42 universities have supported patents, licences, know-hows, etc. However the largest ratio of the funds gained by an educational establishment from managing intellectual properties to total income of an educational establishment (more than 1%) can be observed in the following universities:

1. Irkutsk National Research Technical University – 3,18%;
2. Peter the Great St. Petersburg Polytechnic University - 1,32%;
3. Moscow State Technical University STANKIN – 10,32%.

All the researched universities carry our R&D activity using the objects of innovation infrastructure with regional enterprises.

A number of universities participate in implementing innovation development programs of state-owned companies:

Bauman Moscow State technical University, Tomsk Polytechnic University, etc.

So, we assume that the development of universities innovation infrastructure with the purpose of its maximum efficiency participation in the processes of regional innovative economy (considering correlation ratio) should be implemented on the basis of increasing incomes of universities gained by an educational establishment from managing intellectual properties.

Participation in federal target program provides universities with a substantial income from R&D though it is necessary to activate conclusion of economic agreements with regional enterprises.

We can observe a weak dependence of the total volume of research, design and experimental and technological projects (thousand, RUB) on the total amount of funds gained by an educational establishment from managing intellectual properties in the total income of an educational establishment (thousand, RUB).

$$K_k=0,055219809$$

At that, as it has been mentioned earlier, the ratio of funds gained by an educational establishment from managing intellectual properties in the total income of an educational establishment is rather low. Weak correlation: supported patents (number) and the number of objects of innovation infrastructure (number):

$$K_k=0,285443951$$

Every university is recommended to create a centre of commercialization – technology transfer – that contributes to the patents implementation (other intellectual properties) to economic entities of the Russian Federation. The universities that receive the above mentioned income are: Irkutsk National Research Technical University, Kazan National Research technical University named after A.N. Tupolev, National Research University “Higher School of Economics”, National Research University “Gubkin Russian State University of Oil and Gas”, Saint-Petersburg State University, Moscow State Technical University STANKIN and others. Thus it is desirable to increase the ratio to 0,2-0,3 at the initial stage.

To raise the university income basis from the activity of innovation infrastructure objects in R&D the objects themselves must be efficient in R&D.

There is a weak correlation: the total volume of research, design and experimental and technological projects (thousand, RUB) and the number of innovation infrastructure objects (number):

$$K_k=0,131789166$$

It is desirable to increase K_k to 0,3-0,5.

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Innovation infrastructure objects should take an active part in R&D thus creating the objects of innovation infrastructure, attracting leading national and international scholars, young researchers. It allows creating additional workplaces and conditions for more flexible and efficient integration of universities and regional enterprises.

To raise innovation activity of universities in R&D. The rise in the level of innovation activity reflects positively on the qualitative indicators of the performance of an educational establishment. As it has been mentioned earlier, the developed innovation infrastructure objects form an additional income basis for the universities and provide objects to introduce at regional enterprises.

Medium correlation: the total volume of research, design and experimental and technological projects (thousand, RUB) and rating functional (universities rating of 2015):

$$K_k = 0,666381737$$

To develop mechanisms of integration of regional enterprises and universities in the sphere of introducing the results of innovation activity into production.

There is a medium correlation: the total volume of research, design and experimental and technological projects (thousand, RUB) and the regional score where the university is located according the rating of innovative regions of 2015:

$$K_k = 0,515694389$$

Thus the role of level of regions innovation development in the development of universities innovation infrastructure is absolutely crucial which in its turn allows introducing these developments into production. An important issue is the willingness of enterprises to introduce innovations that's why underdeveloped innovative regions are not ready to integration of universities and production.

The creation of new forms of interaction between universities and regional enterprises to achieve synergy effect in the sphere of innovative development.

For instance, the major forms of interaction between universities and real sector of economy are tailored R&D projects on the basis of economic agreements that are carried out by academic staff of specialized departments. As such the existing system has a very small potential of growth and contributes to "nontransparency" of universities and enterprises because those who haven't participated in the net are excluded; it is difficult to attract resources of other universities; the projects scale is not significant and does not

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influence strategic plans; general planning horizon is not formed and new organizational models are not created as only few employees of university and enterprise are involved in the project.

Let's identify the major barriers for the interaction of universities and enterprises:

1. Endemic problems:

- the dependence of the industry on government orders, operations outside competitive environment;
- significant lag in industrial environment which hinders the introduction of modern innovations;
- the dependence on external equipment suppliers that have to approve of any innovations in the production process.

Operational problems:

- the absence of business-processes of consideration, necessary development and introduction of external innovations;
- the absence of investment resources for the introduction of external innovations;
- the absence of technological policy, roadmaps of technology development.

New forms of interaction must be formed considering the introduction of the objects of universities innovation infrastructure into integration processes. It is possible to conduct interuniversity fundamental and applied research, to carry out the cooperation of universities and enterprises, to attract leading national and international scholars and young promising academic staff using these innovation objects.

The improvement of performance of universities innovation infrastructure.

Nowadays the issue of assessment of the efficiency of innovation infrastructure is not given enough attention in spite of the fact that the development of innovation infrastructure is a key link between the innovators and producers of goods and services which should contribute to the activation of innovation processes in all spheres of activity.

The principles of the development of innovation infrastructure:

1. Measurability of factor system that reflects the development of innovation infrastructure with the purpose to compare the obtained results in the course of time, to identify the sustainability of growth and to forecast the obtained results.

2. Completeness of reflection of all elements of innovation infrastructure by performance assessment.

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3. Depth of performance assessment, i.e. the formation of substantial suite of metrics that includes the most essential indicators to assess innovation infrastructure and the availability of initial data to calculate them.

4. Influence of infrastructure on innovative and economic development of the region.

With the purpose of increasing the resulting indicator and of improving the interaction between universities and regions of Russia we offer the following:

- with the purpose of raising the number of created advanced technologies to enhance the interaction between economic entities and universities in the sphere of production, technical, information and consulting provision by opening new production testing sites and by additional financing of existing spaces;

- the development of programs of providing leasing to renew capital funds of innovatively active universities, innovation centres and programs financing modernization of technological equipment which contribute to the renewal of capital funds of research and production enterprises of innovation infrastructure;

- improvement in service and provision for innovative activity of universities on the regional level considering positions and interests of innovatively active economic entities by creating a consulting centre;

- ensuring the mark-up of financial support of R&D, business incubators and innovation technological centre of universities with the purpose of increasing the number of provided enterprises, etc.

The formation of uniform data bases on all Russian universities in the sphere of innovation infrastructure, research and technology and innovative solutions.

Nowadays there is no single data base accumulating all scope of information about innovative activities of Russian universities. It is necessary to form a uniform data basis that will be available to every enterprise to study and to analyze. We recommend putting all the indicators and components of innovative activity of universities into one uniform table.

1. List of all objects of innovation, scientific, technological infrastructure created in the university structure.

2. Number of academic staff working in the given departments.

3. Income gained from activities of these departments.

4. List of patents, licences, know-hows, etc.

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5. Income from patents, licences, know-hows, etc. commercialization.
6. Priority direction of university research.
7. Attraction of leading scholars to scientific and innovative developments.
8. University participation in different federal target programs including the terms, volume of financing and the obtained results.
9. Performance of the innovation infrastructure objects, etc.

The given list of components and indicators can be extended considering distinguishing features of the university and the region.

Conclusion

The results of the research allowed us to work out the following suggestions on the development of universities innovation infrastructure with the purpose of its maximum efficient participation in the regional innovative economy:

- To raise the income gained by universities from managing intellectual properties. Thus, the created intellectual properties can be used in the processes of the regional innovative economy. Every university is recommended to establish a centre of commercialization, technology transfer that contribute to the patents introduction (other intellectual properties) into the economic entities of the Russian Federation.
- To attract objects of innovation infrastructure to the formation of indicators of scientific engineering potential of the university. Nowadays the indicators of scientific engineering potential of the university largely depend on the indicators of efficient development of the university itself, on innovation activity of the regions where the university is located, on financing volume (predominantly public funding and funding from economic agreements).
- To increase the university income basis from the activities of innovation infrastructure objects in R&D. Innovation infrastructure objects must actively participate in R&D creating intellectual properties, attracting leading national and international scholars, young scientists, etc. At that additional working places are formed, conditions for more flexible and efficient integration of universities and regional enterprises are created.
- To enhance innovation activity of universities in R&D (the formation of efficient innovation infrastructure that is able to integrate into the regional production in the sphere of innovation

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development). The enhancement of innovation activity will contribute to qualitative indicators of the performance of an educational establishment. As it has been mentioned earlier, the created objects of innovation infrastructure form an additional income basis for universities and the objects that should be introduced into regional enterprises.

- To develop mechanisms of integration of regional enterprises and universities in the sphere of introduction of the results of universities innovation activities into production. We highlight a special role of regional innovative development in the formation of universities innovation infrastructure that allows them to introduce the innovations into production.

- To form efficient mechanisms of commercialization of intellectual properties (patents, data bases, software programs, etc.) The role of innovation infrastructure objects is of vital importance in this aspect as they create exactly these innovation infrastructure objects that are demanded by regional enterprises.

To develop new forms of universities and regional enterprises interaction to achieve a synergy effect in the sphere of innovative development. For instance, the major forms of interaction between universities and real economic sector are R&D on the basis of economic agreements, establishment of specialized departments, etc. As such this system has a very low growth potential and leads to “nontransparency” of universities and enterprises as those not involved in the net are excluded; it is very difficult to attract the resources of other universities; the projects scale is not significant and does not influence strategic plans; general planning horizon is not formed and new organizational models are not created as only few employees of university and enterprise are involved in the project. New forms of interaction must be formed considering the introduction of the objects of universities innovation infrastructure into integration processes. It is possible to conduct interuniversity fundamental and applied research, to carry out the cooperation of universities and enterprises, to attract leading national and international scholars and young promising academic staff.

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