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Tendencies of Interaction between Russian Universities and Companies Implementing Innovative Development Programs

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***Abstract**:*

The main aim of this article is to analyze key indicators and trends of global innovative development and their role in development. Attention is given to the consideration of several mechanisms of interaction between universities and state companies, with concrete measures and steps that can be used in economic policy.

The authors analyze the real experience of the Russian economy now. Based on collected data for the total volume of R&D, revenues and the number of patents, regression models were constructed to determine the relationship between the named indicators.

Recommendations and innovative ideas to improve the economic policy are given to achieve the goals and to justify the use of mechanisms of "compulsion to innovate" in state companies for the implementation of more productive development programs.

***Keywords:** State policy, innovative development programs, state participation, research and development.*

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1. Introduction

The purpose of the study is to analyse the trends in the interaction between state companies (hereinafter – state-owned companies, in Russia, companies with state participation, which implement innovative development programs, are the companies approved by the order of the Chairman of the Government of the Russian Federation dated November 7, 2015 No. DM-P36-7563 and currently include 57 societies with state participation, state corporations, state companies and Federal state unitary enterprises that have developed innovative development programs) implementing innovative development programs (hereinafter – IDP) and universities.

The subject of the study is to use institutional forms and quantitative indicators of both innovative development and partnership in the educational and scientific sphere, in which one of the participants is a state company and the other participant is a state university. Based on the results of the study, a regression was built for 48 Russian state-owned companies, which makes it possible to show whether there is a correlation between the costs of research and development (hereinafter R&D), the number of patents and the revenues of state companies. The article also offers recommendations on the further improvement of Russia's economic policy for the long-term period.

The article consists of two parts. The first part studies the key indicators and trends of the global innovative development that explains the interconnectedness of various indicators of innovative development of the national economies, which is reflected in the integral level of competitiveness. The latest world statistical data analyse the R&D sector among the leading countries and the BRICS countries as a universally recognized indicator of their "striving" to achieve scientific and technical superiority. The article notes the importance of orientation of state companies on global competitiveness and the world market, emphasizing the role played by innovation, technology and science in this development. The business sector is the main source of R&D in the world and, at the same time, the consumer.

In the second part, we will answer the question about how to increase the innovative activity of state companies giving a description of the results of implementation of IDP with state participation. In addition, the main issue that must be studied is whether the transformation and the active role that state companies should play can change the traditional view of the inefficiency of state enterprises and whether this can be an alternative to privatization. The article uses statistical research methods, the methods of comparison, clustering and regression analysis.

2. Literature Review

2.1 Key indicators and trends of scientific and innovative development

The level of expenditures on research and development, the global innovation index (Table 1) and the jurisdictions of the largest companies confirms the interconnectedness of such categories as labor productivity, (technology, capital, people), innovative receptivity, the level of per capita income and the development of services in the industrialized and some developing countries (Pastukhov *et al.*, 2016).

Since 2007, INSEAD business school (France) together with Cornell University and the World Intellectual Property Organization have been conducting a global study of the world countries in terms of innovation development index (84 indicators are analyzed).

Table 1. *Global Innovation Index 2016*

National economy	Rating (0-100)	Rank	Income
Switzerland	66,28	1	High income
Sweden	63,57	2	High income
United Kingdom	61,93	3	High income
USA	61,40	4	High income
Finland	59,90	5	High income
Singapore	59,16	6	High income
Ireland	59,03	7	High income
Denmark	58,45	8	High income
Netherlands	58,29	9	High income
Germany	57,94	10	High income
Republic of Korea	57,15	11	High income
Hong Kong (China)	55,69	14	High income
Canada	54,71	15	High income
Japan	54,52	16	High income
New Zealand	54,23	17	High income
France	54,04	18	High income
Australia	52,65	19	High income
China	50,57	25	High income
Russia	38,50	43	High income
South Africa	35,85	54	Moderate income
India	33,61	66	Moderate income
Brazil	33,19	69	Moderate income

Source: *Dutta, Lanvin & Wunsch-Vincent, 2016.*

Studying the rating of 2016, we can conclude that three centres have emerged in the world, which are capable to assume the role of a global innovation leader in the transition to a knowledge-based economy, while three regions compete among themselves in the growth of innovative products (services) in the global commodity turnover. The leaders include Northern Europe and Switzerland. They are the most susceptible to innovations and have a well-established institutional environment. The group of leaders also includes countries of the Anglo-Saxon world with the

fourth place in the rating occupied by the USA, the economy of which is the largest in the world by nominal GDP (17,4 trillion dollars, World Bank, 2015). The third region is represented by Japan and three Asian countries that managed to "move from the third world to the first" (Yew, 2016). In the ranking of 2016 Russia occupies the 43th position (neighbouring with Turkey and Greece), which is comparable with the level of the BRICS group countries. Despite the higher quality of resource and human potential, in the group of large and rapidly developing countries Russia is inferior to China according to the innovation index. The most significant positive changes in the "Global Innovation Index 2016" among the OECD and BRICS countries in the rating of 2016 compared to 2015 are observed in India (15 positions), Russia (5 positions), China (4 positions), Republic of Korea (3 positions), and among the leaders the rating fell by 5 positions for the Netherlands.

The comparison of the countries' positions according to the global research on the development of innovations (Table 1) with the countries' positions regarding their development level as a sphere of R&D (Table 2) as well as the share of global companies on the global markets, shows the interrelations between the ratings examining various aspects of development. In countries with high labour productivity, and, therefore, actively using high technologies in all spheres of the economy, the global innovation index is higher, which forms the environment for the development of international private and state companies. In addition, on the world market, one of the most significant economic phenomena forming the high economic growth is a breakthrough in the services sector (Esfahani and Ramirez, 2003; Osadchy and Akhmetshin, 2015; Akopova *et al.*, 2017).

The concentration of competencies (from idea to product) at one enterprise was replaced by the model of "Open Innovations" that makes it possible for the government to set in motion a whole range of activities that stimulate the innovative activity of enterprises and the transition to a knowledge economy. Information and communication technologies, the network nature of interactions in the new conditions makes it possible for state companies, universities, institutions of the Russian Academy of Sciences and start-ups to be involved in innovative development.

The model of "Open Innovations" is gaining popularity in the most dynamic industries, in which the pace of implementation and the cost of development of new solutions is constantly growing as technologies are becoming more sophisticated. The "suppliers" of innovative solutions are universities and scientific organizations capable of ensuring a constant flow of new solutions and developments with a high potential for commercialization. In the developed countries, the volume of the transfer of knowledge and new technologies created in universities and scientific laboratories is constantly growing.

R&D is the basis of innovation. In this regard, the volume of R&D expenditures and personnel indicators are generally recognized as indicators of innovative

development and the main indicators of the effectiveness of countries' policies in stimulating innovation (Russia and China: Innovation and Entrepreneurship, 2016). The institutional forms and quantitative indicators of interaction between state companies and universities as well as the analysis of the state policy of Russia are highlighted in this article.

According to the data of the Organization for Economic Development and Cooperation (OECD) in 2010-2015 there was a steady downward trend in the volume of state investments of OECD countries in R&D (the Russian methodology Rosstat) uses the term "Internal costs for research and development" - the actual costs of performing research and development in the country (including those financed from abroad but excluding payments made abroad) expressed in monetary terms. Their assessment is based on the statistical data about the costs of performing research and development by organizations themselves during the reporting year regardless of the source of funding. The definition of Rosstat completely coincides with the definition and the methodology used by OECD. In 2015 more than half of them reduced their R&D budgets in real terms by an average of 1,3% (OECD, 2016b).

The data about the gross domestic expenditures on R&D in OECD countries in 2014 in real terms show an increase of 2,3%, but this growth is slower than in the previous year 2013 (+ 3,0%). OECD researchers emphasize that the growth of 2013 in the OECD countries was mainly caused by the constant increase in expenditures on R&D carried out by business (+ 2,8%), but in the system of higher education the expenditures remained unchanged (+ 0,2%). As a percentage of GDP, the internal expenditures on R&D in the OECD countries remain unchanged at 2,38% of the GDP (Table 2) (OECD, 2016a).

Table 2. *Gross domestic expenditure on research and development (The values are given with an accuracy of up to two decimal places) as % of GDP from 2000 to 2014 for the key countries.*

Country/ Year	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14
Brazil	1,02	1,04	0,98	0,96	0,90	0,97	1,01	1,10	1,11	1,17	1,17	1,10	1,16	1,20	..
Russian Federation	1,05	1,18	1,25	1,29	1,15	1,07	1,07	1,12	1,04	1,25	1,13	1,02	1,05	1,06	1,09
India	0,75	0,73	0,71	0,71	0,74	0,78	0,77	0,76	..	..	..	..	..	..	..
PRC	0,90	0,95	1,07	1,13	1,23	1,32	1,39	1,40	1,47	1,70	1,76	1,84	1,98	2,08	2,10
South Africa	..	0,73	..	0,79	0,85	0,9	0,93	0,92	0,93	..	0,74	0,73	0,73	..	..
OECD	2,14	2,17	2,15	2,16	2,18	2,12	2,19	2,22	2,29	2,34	2,30	2,33	2,34	2,37	2,38

Country/ Year	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14
EU (28 countries)	1,68	1,70	1,71	1,7	1,67	1,67	1,69	1,70	1,77	1,84	1,84	1,88	1,92	1,93	1,95
USA	2,71	2,72	2,62	2,61	2,55	2,59	2,64	2,7	2,84	2,90	2,74	2,76	2,70	2,73	..
Japan	3	3,07	3,12	3,14	3,13	3,31	3,41	3,46	3,47	3,36	3,25	3,38	3,34	3,47	3,59

The total volume of gross domestic expenditures on R&D in Russia has increased steadily from $ 16,6 billion US dollars in 1999 to 38,2 billion dollars in 2014 (in constant prices of 2010 in US dollars according to PPP) (OECD, 2016a). However, according to this indicator Russia is currently lagging not only the world leaders, but also BRICS countries as Brazil and China. For example, in China in 2014, gross domestic expenditures on R&D were 344,7 billion US dollars - an increase of almost 10 times since 1999, when R&D expenditures were 31,8 billion US dollars (in constant prices of 2010 in US dollars according to PPP).

The OECD study found out that according to the volume of expenditures on R&D among the BRICS countries, China is the leader in terms of absolute costs, ranking second in the world after the United States according to this indicator. At the same time, China's total investment in R&D increased over 5 years from 0,71 trillion RMB in 2010 to 1,30 trillion RMB in 2014 (which in constant prices of 2010 constituted 213,46 and 344,68 billion US dollars, respectively) (Basic Statistics on Scientific and Technological Activities, 2016).

The share of expenditures on R&D in China's GDP increased from 1,78% in 2011 to 2,07% in 2015 (in absolute terms, the expenditures on R&D in 2015 constituted 1.42 trillion RMB) (Basic Statistics on Science and Technology Activities of Industrial Enterprises above Designated Size, 2016). At the same time, the business sector allocated 1 trillion RMB for scientific research and development in 2015 with an increase of 8,2% compared to the previous year 2014 (Basic Statistics on Research and Development Institutions, 2016), government research institutes – 213,7 billion RMB with an increase of 10.9% (Rajiv *et al.,* 2015), universities - 99.9 billion RMB with an increase of 11.2% (Basic Statistics on Research and Development Institutions, 2016). These data show that the main investment sources of development are enterprises (of all forms of ownership) providing capital for R&D with the aim of converting fundamental and applied developments into new or improved technologies, products, services or business processes.

In Russia, the low volumes of investments from the business sector are explained by the structure of the economy, in which a large part is focused on the export of resources and the low level of processing (redistribution). The consequence of this fact is the low innovation activity of a significant share of the Russian economy, and consequently, low expenditures on R&D. In terms of the size of the state (budgetary)

financing of R&D of the commercial (civil) sector, in relative terms, Russia occupies the first place in the world with a share of 0,4 of its GDP.

Brazil, India, Russia and China have the highest share of state in financing R&D (the methodologies for calculating the costs of R&D slightly differ in different countries) (Figure 1), which indicates a low interest of companies in these countries in making innovate capital expenditures. If Russia reduces the share of budgetary financing to the level of the developed countries and China while taking stimulus measures (without lowering domestic expenditure on R&D), it seems that Russian companies will have completely different results on the international arena.

If we consider the expenditures on R&D by types of research in the countries of the BRICS group, then orientation on the applied research indicates the direction of the state policy towards science-intensive innovations (Table 3).

Figure 1. *Expenditures on R&D financed by the state, billion US dollars (in the current PPP prices) and as a percent of the total R&D expenditures, 2013.*

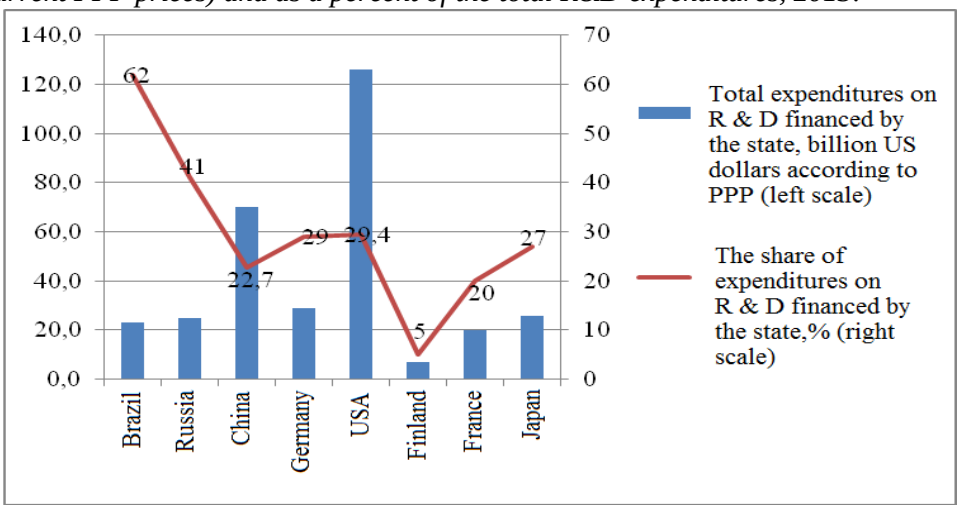


Table 3. *Gross domestic expenditures on research and development by types of research in 2014*, %.*

Countries	Internal expenditures on research and development	Basic research	Applied research	Developments
Russia	100,0	16,4	19,5	64,1
India**a,b	100,0	23,9	33,4	35,1
China	100,0	4,7	10,7	84,6
South Africa	100,0	25,3	46,3	28,4

Source: Gorodnikova, Gokhberg and Ditkovsky, 2016; Rajiv, Gao and Mittal, 2015.
** For India, the data are for the period 2009-2010 (data for later periods are absent).*

*** a) Data for India are given for the public sector of the economy for 2009-2010 due to the lack of data on total investments into R&D, which also consider private investments (data for later periods are also not available). The presented data are representative, because India is characterized by the predominant share of the public sector regarding investments into R&D. Thus, in 2009-2010 the share of state investments into R&D in the total volume of investments was 67%.*
***b) The number of shares for India differs from 100%, since according to the national statistics the structure of investments also includes the costs of supporting (auxiliary) activities, which constitute 7.6% for the studied period.*

Therefore, it is necessary to clarify how to redistribute financing to increase private (corporate) financing in relation to state financing, while not losing the accumulated scientific resources. It should be noted that in China one can observe a tendency of reduction of the state's share in financing of research activities. In the period from 2000 to 2013 this share decreased from 33,4% to 22,7%. In Russia, on the contrary, there is an increase in the share of state funding for research and development.

Based on the collected data about the total volume of R&D performed between 2011 and 2015 by 48 state-owned companies implementing programs of innovative development, for the first time in Russia we have built a regression model to establish the relationship between the volume of R&D carried out by state-owned companies and their revenues in the period 2011-2015, as well as to establish the relationship between the amounts of spending of state companies on R&D and the received patents (presented in Part 2 of the article).

The econometric analysis confirms the existence of a certain trap, in which Russia found itself. On the one hand, it is impossible to reduce the expenditures on R&D since this is an important factor in the development of the economy. On the other hand, in state-owned companies state investments into R&D do not lead to a clear increase in innovative activity and development of such products, services and technologies that would generate a significant increase in revenues. A separate program is needed to change the relationship between the financing of research activities of both civil and military innovations towards corporate (non-budgetary) financing. Because business is a source of R&D financing, it follows that it is also the key subject that generates innovations and consumes the created innovations. There is a continuous cycle of research and production, that is, a continuous process of reproduction.

According to the report of the analytical company strategy, in 2016 the volume of investments of 20 leading companies into R&D amounted to 179.3 billion US dollars (PwC's Strategy, 2017). "Intra-firm science" with the costs of small and medium-sized businesses is approximately 64% of the global volume of R&D (World Bank, 2010).

According to the Director of the Centre for Sociology of Education, Science and Culture of the Institute of Sociology of the Russian Academy of Sciences,

Klyucharyov (2015) said: *"The largest companies create their own scientific centres due to the fact that for them knowledge is becoming an important factor in competition" ... "The main difference lies in the closed nature of research that corporate research centres do, regardless of the subject of research and development" ... "The whole strategy of the company's development is built on its resource base, and the latter is formed on the basis of scientific research".*

In this regard, OECD countries *"prefer to use "soft" policy measures to increase the effectiveness of innovations in the real sector, including, among other things, improving the conditions for doing business, increasing private investments into R&D, demand for innovative products and services"* (Gershman, 2013).

The tendencies of innovative development make it possible to conclude that the state policy and companies both OECD zone and the second largest economy of the world – China are focused on the world market and the global level of competitiveness. Both private and public companies develop programs of long-term innovative development to enhance their own competitiveness. For example, Morris and Jones (199) from the University of Florida have studied the issues of entrepreneurship in the public sector, drew attention to the similar nature of private and public corporations; formalized hierarchies, heterogeneity of stakeholder groups, established procedures and organizational cultures, inflexible systems of financial control, budgeting and stimulation of employees. They note the changed nature of the external environment characterizing it as turbulent. Therefore, not only the private, but also the public sector require a rapid reaction to market signals.

An example of the science-intensive industry with a high degree of state participation in both research and production is the space sector. According to the 2016 State of Innovation Report, Russia and France are the most active in terms of the number of inventions and the introduction of space technologies in the European part of the continent, and in Asia – China. The study summarizes that the aerospace sector on a global scale has demonstrated significant progress in 2015 compared to 2014 in terms of the number of patents. The biggest increase is typical for such industries as spacecraft and satellite technologies (23% growth compared to 2014), technologies for the production and operation of equipment for the aerospace sector (19%), engine building (15%).

The aerospace industry is one of the branches in which Russia has significant scientific, technical and industrial achievements. For many years higher education programs have been functioning providing the industry with highly qualified personnel. Since the advent of the space industry in the Soviet Union it has been characterized by a high concentration of significant initial investments, which only the state is able to implement. Given the low attractiveness of the space industry for private investors and a long cycle of the invested capital, the system of state financing has allowed the industry to survive after the collapse of the Soviet Union and have several achievements. At the same time, the drawback of the existing

system is that it does not allow a rapid introduction of innovations in the production and introduction of innovative products to the market.

In our view, the increased role of private aerospace companies, which is already being observed in the United States, can eliminate this shortcoming (for more details see: Space Exploration Technologies Corporation (SpaceX), which developed and launched into space a light spacecraft Falcon 1, created a private spacecraft (the Dragon project), launched a satellite (SES-8) to the geostationary orbit, etc.). In order not to lose competitive advantages in the aerospace industry, Russia needs not only to intensively develop the infrastructure, but also to establish cooperation with newly created private aerospace companies, future national leaders in Russia, in 2011, a private Russian space company Dauria Aerospace was developing and manufacturing small spacecraft of the new generation as well as offering components for small space vehicles; service systems, sensors, executive bodies. The company operates in Russia, Germany and the USA. In its field Dauria Aerospace is one of the fastest growing companies in the world with a focus on the global market and international cooperation, which are more flexible than state companies and can introduce innovations into production and bring them to the market.

We believe that Russia also needs a reorientation of the strategies of state companies with a focus on global cooperation and the world market. So far, the Russian legislation only mentions the need for state companies to develop international cooperation.

2.2 Interaction of universities and state companies in the scientific and educational spheres on the example of Russia

Since 2010, the growth rate of the economy has significantly decreased and it has became obvious that the previous growth model conditioned by high prices for traditional export goods, capital inflows into the country and rapid growth in household consumption (the volume of lending was growing from 2002 to 2007 at an average of 40% per year, and from 2008 to 2013 the growth of the lending volumes amounted to an average of 10% a year), had exhausted its capabilities (Nikitin, 2016). In 2013, the internal factors hindering the growth were compounded by restrictive political and economic measures containing the inflow of credits and investment capital as well as international exchange of technologies by the OECD countries.

The need to implement incentive measures emerged a long time ago (Gorodnikova *et al.*, 2016; Latyshev and Akhmetshin, 2015). In the last 5 years in the period from 2010 to 2015 no more than 10% of Russian enterprises implemented innovations, and only 8,3% of industrial enterprises implemented technological innovations. At the same time, the share of innovative products in the total amount of goods, works and services in 2015 did not exceed 8,4%, (Kokueva and Tsertseil, 2016), and in

2014 it was 9,7% (Abdrakhmanova *et al.,* 2015). In the cycle from R&D to product, state companies (and not only them) are both ordering customers and consumers of innovation. However, the demand for innovations is possible only in the competitive struggle both on the domestic and international markets. Investments in R&D are, first of all, advancing the future competitiveness. This is done only by those companies that understand the threats related to the competition.

Since in the competitive environment investments into R&D come from the companies' own profits, the R&D efficiency is higher than with public funding. Such behavior of state-owned companies leads to an increase in the overall innovation activity in the country (e.g., China), which can be clearly seen in international ratings that take into account various factors. In Russia, there is a weak relationship between investments into R&D by state-owned companies and revenue growth.

Given the prevalence of state investments into R&D in Russia and the impossibility of changing this ratio in a short time, an increase in the effectiveness of state companies in the sphere of innovation is an important step towards increasing the efficiency of Russia's innovation policy along with the development of proposals to stimulate private investments. To develop measures aimed at increasing the effectiveness, we will analyze Russia's policy in the field of interaction of universities and state companies in the scientific and educational spheres in order to identify the strong features of the chosen model of interaction and develop recommendations for overcoming weaknesses.

The indicators characterizing quantitative assessment of the development of interaction between state companies and universities and scientific organizations recommended by state bodies for inclusion into the innovative development programs include:

- the number of employees of state companies, who have been retrained in universities (people);
- the number of employees of state companies, who have undergone advanced training in universities (people);
- the volume of funding for research and development works (hereinafter - R&D) carried out by scientific organizations on the order of the state-owned companies (million rubles);
- the amount of funding for retraining of employees of state companies in universities (million rubles);
- the amount of funding for improving the qualifications of employees of the state-owned companies in universities (million rubles).

In 2016 - 2017 the authors analyzed the dynamics of the planned indicators of interaction between 42 state companies and universities from 2016 to 2020, which

makes it possible to understand the trends and directions of development of interaction in the scientific and educational spheres in Russia. On the whole, all indicators have a positive trend.

The volumes of financing of R&D, retraining and advanced training of employees carried out by scientific organizations and universities, the indicators of the number of employees of state companies that have been retrained and/or improved their qualifications in universities are shown in Table 4.

Table 4. *Standard volume of indicators of interaction between universities and companies in the period from 2016 to 2020*

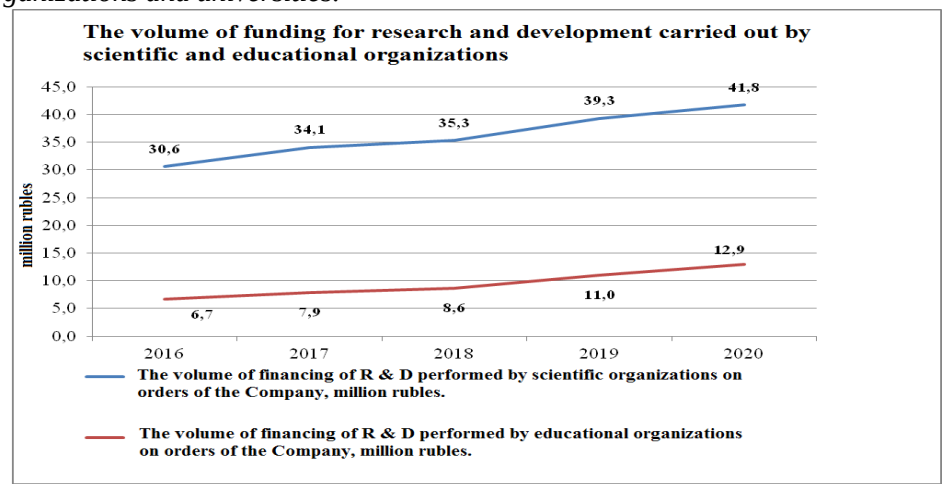
Indicator/Period	2016	2017	2018	2019	2020
The number of employees of the Company, who have been retrained in universities (people);	3 052	3 263	3 481	3 617	3 810
The number of employees of the Companiy, who have undergone advanced training in universities (people);	17 577	18 024	18 538	19 018	19 650
The volume of funding for research and development carried out by scientific organizations on the orders of the state company, million rubles	30 596,2	34 096,9	35 291,5	39 342,5	41 801,5
The volume of funding for research and development carried out by universities on orders of a state company, million rubles	6 720,4	7 863,4	8 600,4	11 014,5	12 931,6
The amount of financing for the retraining of the Company's employees in universities, thousands of rubles	217,4	232,0	245,2	256,1	278,0
The amount of financing for improving the qualifications of employees of the state-owned Company in universities, thousand rubles	392,4	419,4	445,3	463,0	486,0

The planned volume of financing of research and development carried out by scientific organizations on orders of state-owned companies is growing by 36,6% from 2016 to 2020, the amount of funding for research and development carried out by universities is growing from 2016 to 2020 by 92,4% (Figure 2). The volume of orders for R&D carried out by universities is growing year by year faster than the volume of orders for R&D performed by scientific organizations. The demand for the scientific potential of higher educational institutions is growing at an accelerating pace in relation to scientific organizations, which indicates the growing competence of universities in the scientific and production fields.

Regarding the indicators of costs for retraining and advanced training, it can be concluded that the planned amount of funding for improving the qualifications of state employees in universities is increasing from 2016 to 2020 by 23,9%, the amount of funding for retraining of state employees in universities is growing from 2016 to 2020 by 27,8% (Figure 3). As aggregate indicators for the personnel policy in the innovative development programs of state-owned companies the following indicators have been selected.

The number of employees of state-owned companies to undergo advanced training in higher educational institutions is increasing from 17,577 people in 2016 to 19,650 people in 2020 (Figure 4). Advanced professional training is the training of employees with the purpose of deepening and improving the existing professional knowledge of the employees, which are necessary for a certain type of activity indicating that the demand for professional development is stable. This indicator slightly increases from 2016 to 2020 (by 10,5%), which is primarily caused by the consistent planning by state-owned companies of the transition to new technologies and the training of personnel for these purposes.

Figure 2. *The planned volume of financing of R&D performed by scientific organizations and universities.*



The number of employees to be retrained in educational institutions of higher education increases from 3,052 people in 2016 to 3,810 people in 2020 (Figure 4).

As a rule, this retraining is associated with the acquisition of a new specialty. Regarding the indicator "the number of employees of the Company retrained in universities", it can be noted that this indicator is growing insignificantly, but at a faster pace than the indicator of the advanced training of employees. From 2016 to 2020 the growth was 24,8%.

Figure 3. *The planned volume of financing of retraining and advanced training of company employees in universities*

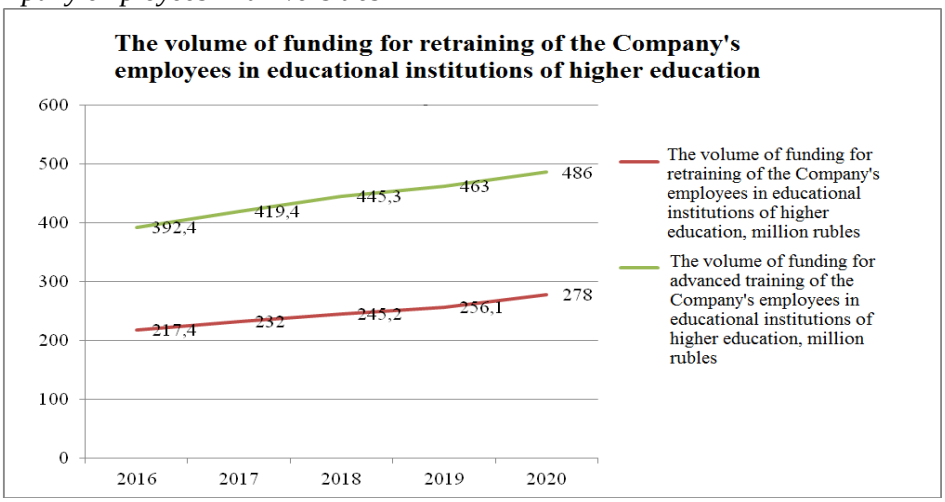
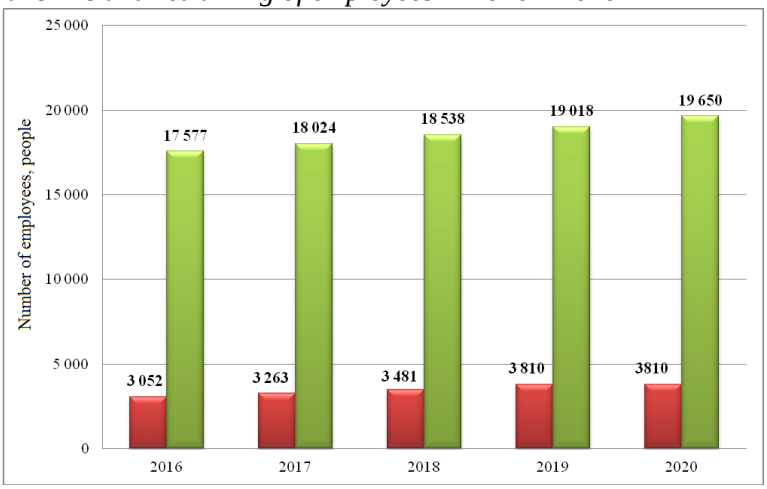


Figure 4. *Natural indicators of state companies regarding the improvement of professional skills and retraining of employees in 2016 – 2020*



Dynamic growth is demonstrated by the financing of advanced training of employees of state-owned companies in universities, which also indicates the demand for this type of training, the existence of demand on the market for continuing education.

One of the characteristics of the planning of expenditures of state companies on additional professional training of their employees is a unit cost of training (Table 5).

Table 5. *The costs of retraining and advanced training of one employee of the state company in universities*

Indicator, unit of measurement	2016	2017	2018	2019	2020
Number of employees of the Company who have been retrained in educational institutions of higher education, people	3 052	3 263	3 481	3 617	3 810
The amount of funding for retraining of the Company's employees in educational institutions of higher education, million rubles	217,5	232,0	245,2	256,1	278,1
The cost of retraining of 1 employee, thousand rubles	71,2	71,1	70,5	70,8	73,0
The number of employees of the Company who have undergone advanced training in educational institutions of higher education, people	17 577	18 024	18 538	19 018	19 650
The amount of funding for advanced training of the Company's employees in educational institutions of higher education, million rubles	392,4	419,4	445,3	462,9	485,9
The cost of advanced training of 1 employee, thousand rubles	22,3	23,2	24,0	24,3	24,7

In the period from 2016 to 2019 the standard average cost of retraining of one employee for the Company remains practically unchanged and amounts to 71,2 thousand rubles per person in 2016 (Figure 5), and in 2020 – 73,0 thousand rubles per person.

The total number of employees of state companies to be retrained in educational institutions of higher education during the program period is increasing (Figure 5). In 2016, the value of this indicator, considering the plans of all the analysed state-owned companies, is 3,052 people. In 2016, the cost of advanced training of one employee will be 22,3 thousand rubles, increasing insignificantly until 2020 to 24,7 thousand rubles (Figure 6). The analysis shows that the cost of both retraining and advanced training of one employee increases slightly from 2016 to 2020, which, on the whole, demonstrates a real decrease in financing (taking into account inflation and other factors) per employee of a state-owned company.

In the scientific sphere universities and scientific organizations are executing R&D on orders of state companies. Quantitative indicators are provided to make a quantitative assessment of the planned activities.

Figure 5. *The cost of retraining of one employee of a state company*

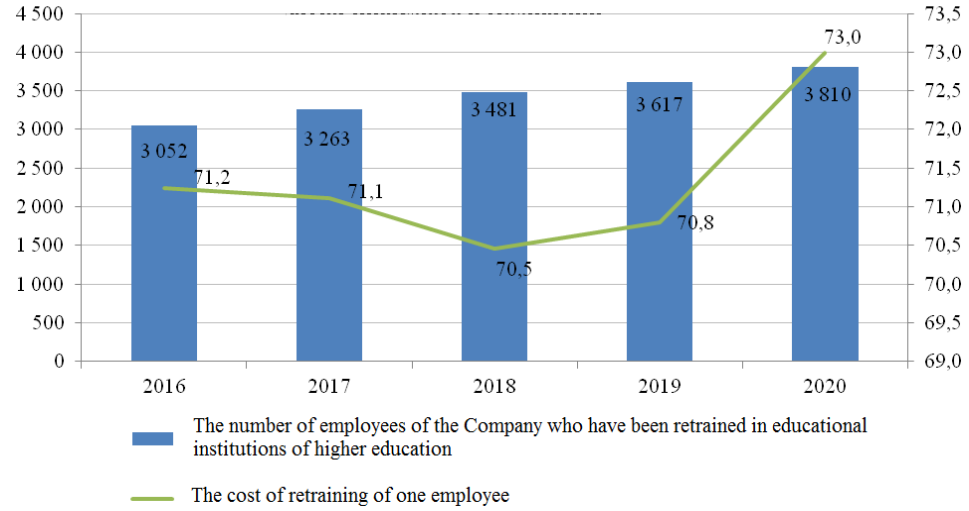
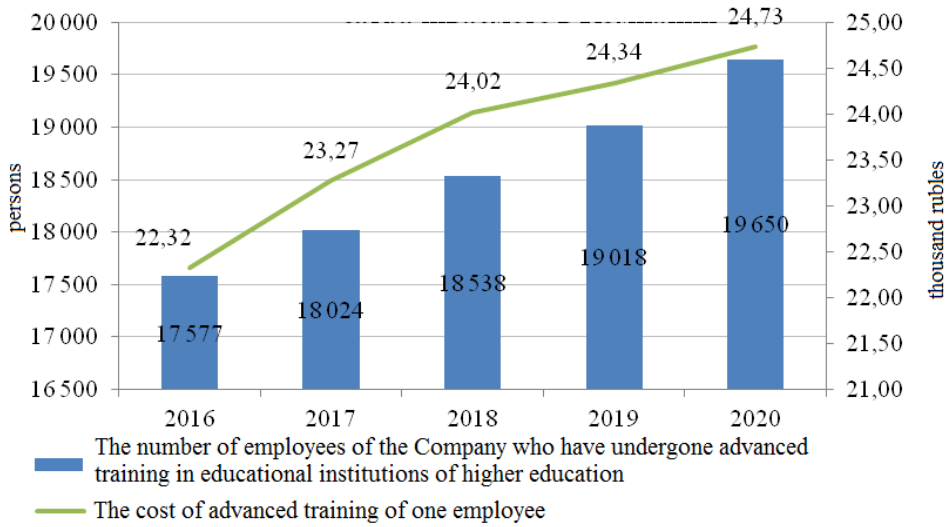


Fig. 6. *The cost of advanced training of one employee spent by a state company.*

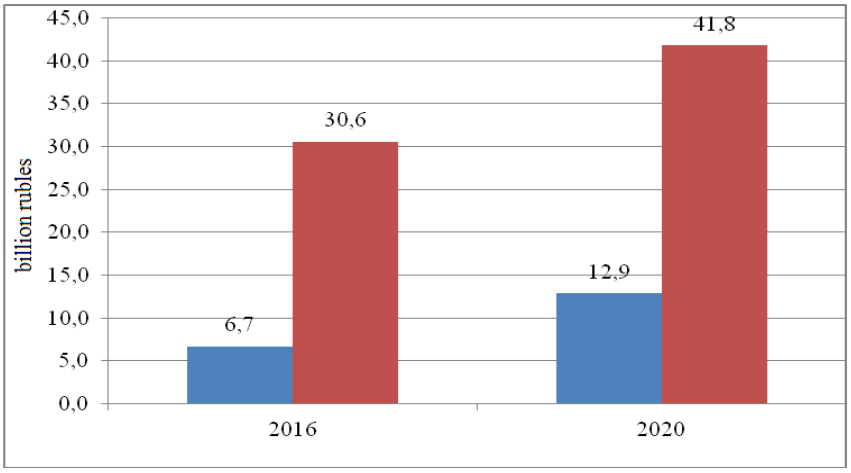


The biggest expenditures of state companies are planned for works carried out by scientific organizations. The orders of state companies for R&D conducted by scientific organizations are to be increased from 30,6 billion rubles in 2016 to 41,8 billion rubles in 2020.

A dynamic growth is characteristic for indicators of the volume of financing of R&D carried out by both universities and scientific organizations on orders of state companies. There is an annual increase in financing, which indicates a stable

demand of state companies for such services. In 2016, the total amount of funding for research and development carried out by universities on the orders of state companies is 6,7 billion rubles, in 2018 it will increase to 8,6 billion rubles, and by 2020 the amount of financing is expected to reach 12,9 billion rubles (Figure 7).

Figure 7. *Dynamics of R&D performed by educational and scientific organizations in 2016-2020*



The analysis of the peculiarities of interaction between universities and state companies in the scientific and educational spheres leads to the conclusion that the strengths of such interaction are the increased demand for the scientific potential of higher education institutions among state-owned companies, which proves the growing competencies of universities in the scientific sphere. The demand of state-owned companies for the improvement of qualifications of their personnel is stable with insignificant growth during the analysed period, which relates to the plans of state companies in the field of personnel training for the transition to new technologies. Based on the results of the conducted analysis it is expedient to recommend to the state companies to increase the unit cost of training of their employees to improve the efficiency of training compared with the current versions of innovative development programs submitted for analysis (it can be noted that considering the inflation factor, the unit cost of employees training even decreases by 2020 in comparison with 2016).

The plans presented by state-owned companies regarding innovative development programs include an increase in R&D funding. To determine whether this increase in funding will raise the efficiency of innovation activities of state companies, it is necessary to establish whether there is a correlation between R&D expenditures and indicators reflecting the effectiveness of innovation activities. The determination of such interrelationship will make it possible to plan the necessary increase in R&D expenditures sufficient to achieve the target performance indicators of innovation

activities of state companies. As an indicator of effectiveness, we use the revenues of state companies and the number of patents.

3. The Results of Modeling

Based on the collected data on the total volumes of R&D performed by 48 companies implementing innovative development programs, a regression model was built to determine whether there is a relationship between the amount of expenditures of state companies on R&D and their revenues for the period from 2011 to 2015. Presented below (Table 6) are the data for 2015 - a linear relationship between R&D expenditures and revenues in 2015 (and in 2011-2014) is not observed.

Table 6. *Data for linear relationship between R&D expenditures and revenues in 2015 (and in 2011-2014), R Square - 0,040866262; Adjusted R Square - 0,020015528; F - 1,959943603*

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	3232257,692	1938799,34	1,667144003	0,102281061	670342,9049	7134858,288
X Variable 1	0,012869101	0,009192347	1,399979858	0,168227981	0,005634134	0,031372336

The regression model shows that an increase in spending on R&D by 1 conventional unit increases revenues by 0,012 units with the presence of other constant factors, which means a weak relationship between R&D and revenues in state-owned companies. Probably, this can be explained by the negative macroeconomic situation and sanctions in which Russia found itself in 2013. As noted: *"... in 2014-2015 Russia faced simultaneous manifestations of three crisis components – structural, cyclical (internal situation) and external"* (Mau and Ulyukaev, 2015).

We conducted an analysis to determine the relationship between the number of registered patents (objects of intellectual property) and expenditures of the state companies on R&D.

According to the Oslo Manual (2010): *"A patent is a legal property right over an invention, which is granted by national patent offices. A patent provides to its owner a monopoly for exploiting the patented invention (with limited duration) as a counterpart to invention" ... "Patent statistics are increasingly used in various ways as indicators of the output of invention activities. The number of patents granted to a*

given firm or country may reflect its technological dynamism. Examination of the technologies patented can give some hints on the directions of technological change".

We have analysed the available data on 30 companies for 2 years. Based on the analysis, the dependence in the general case looks as follows:

$$y = 6069045{,}76 + 35567{,}56 * x,$$

where the resultant variable y is the value of the company's annual expenditures on R&D, and variable x – the number of patents registered by the company in the reviewed year. The statistical dependence is supported by the following indicators (Table 7).

Table 7. *Indicators, that were used*

	Coefficients	Standard Error	t Stat	P P-value	Lower 95%	Upper 95%	Lower 95,0%	Upper 95,0%
Y- Intercept	6069045,766	1789889,69	3,390737318	0,001283886	2483465,884	9654625,649	2483465,884	9654625,649
X - Variable 1	35567,56752	12919,56266	2,753000892	0,007945713	9686,573729	61448,56132	9686,573729	61448,56132

The second model established the relationship between the volume of R&D conducted by state-owned companies and the number of patents received (at the same time, innovative development programs in state-owned companies include: the number of intellectual property objects, the number of patents received in the current year and the previous two years, the number of patents used, the number of international applications, the number of the registered intellectual property items, etc.

The values of the number of patents used in the regression model can contain many types of intellectual property. A hypothesis about the existence of relationship between the number of registered patents (objects of intellectual property) and expenditures of a state company on R&D was confirmed at the level of significance of 95%. The model turned out to be significant.

4. Conclusions

The amount of expenditures on R&D and the indicators on the personnel engaged in research and development are the generally recognized indicators of innovative development and the main indicators of the effectiveness of countries' policies in stimulating innovation. High rates of labor productivity make it possible to ensure a high level of social and economic development. The latter is achieved through state policies aimed at the development of human capital, in particular, the financing of education and science. The sector of R&D in the developing countries continues to grow very rapidly mainly through public investments, however, in the developed economies the growth is caused by private (corporate) investments.

In Russia the revealed regularity suggests that investments into R&D play an important role regardless of the sources of financing, but private capital, which is both the customer and the consumer of innovations, is the most effective source of investments into R&D. One of the factors contributing to the low volumes of investments into research and development by the business sector in Russia is the structure of the economy focused on export with a low level of processing (redistribution).

However, many Russian state-owned companies implementing innovative development programs operate in science-intensive industries with high added value, which makes it possible to conduct international comparisons and to compare the generally accepted development criteria. To increase the role of the business sector in financing R&D in Russia it is necessary to actively use "soft" state policy measures that improve the investment climate, to improve the legislation in the area of innovation and investment cooperation and to refocus the innovation development strategies/innovative development programs on the global cooperation and the world market (A mere description of some joint projects in government documents is not sufficient). A purposeful system of measures is required that makes investments into R&D attractive from internal sources of state-owned companies facilitating the creation of intellectual property.

The results of the analysis aimed at verifying the existence of relationship between the number of registered patents and the expenditures of state-owned companies on R&D, some of which are carried out by universities, confirm the hypothesis. However, more efficient is the financing of R&D from the companie’s own sources as seen in China. An active role of the state, which sets the model for the development of state companies, changes the traditional notion of the inefficiency of state enterprises and may be an alternative to privatization.

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