

## **Analysis Of Scientific And Technical Activity Resourcing In Russia\***

I.A. KABASHEVA, A.G. KHAIRULLINA, I.A. RUDALEVA

Kazan State Federal University

**Abstract.** *The article analyses the resourcing of scientific and technical activities in the Russian economy. We identified the influence of crisis phenomena of 2014-2015 on the state of scientific and technological potential, which manifested itself in the following: the outflow of highly skilled specialists abroad and the reduction in the number of personnel engaged in scientific research and development, which reduced the provision of scientific and technical potential with human resources; the decline in the number of advanced technologies used by Russian researchers and scientific organizations, due to increased tensions in the geopolitical situation affecting the trade relations of the countries; the increasing risk of lagging by the Russian science development from the rest of the world's scientific community; the reduction in the volume of financing of scientific and technical activities in real terms, etc.*

**Key words:** scientific and technical activity, scientific and technical potential, resources, scientific research, development, science.

### **Introduction**

There is a rather wide variety of interpretations of the "scientific and technical potential" category in the scientific literature. For example, a large economic dictionary defines it as "...a set of personnel, material, technical, information and organizational resources designed to solve the tasks of scientific and technological development faced by the society".<sup>1</sup>

In many respects, a similar but more detailed definition is presented in the scientific works of Krayukhin and Proskuryakov, where the emphasis is on the general definition of the "potential" concept as a set of resources, stocks, means and sources that can be used for various purposes.<sup>2</sup>

In addition, there are more recent studies that determine the scientific and technical potential as a level of development of the country's scientific and technical system. In general, the scientific and technical potential is considered from the point of view of the development of specialized institutions that support the functioning of the scientific and technical system and the interrelations between them in this approach. In particular, the researchers, who determine the scientific and technical potential as a feature of the level of science development, include Zaitsev N.L., Gorfinkel V. Ya.<sup>3</sup>

In our study, the scientific and technological potential will be considered from the point of view of the first approach, since the scientific and the scientific and technical activity, like any kind of human activity, consists in the use and transformation of a set of resources.

### **The main part of the study**

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\* The work is performed according to the Russian Government Program of Competitive Growth of Kazan Federal University.

<sup>1</sup> A.N. Azriliyan, *Large Economic Dictionary*, Moscow, Institute of New Economics, 2007.

<sup>2</sup> G. A. Krayukhin, *Economic Problems of the Scientific and Technological Progress*, 3<sup>rd</sup> edition, Moscow, 1986; V. M. Proskuryakov, *Economic Statistics*, 3<sup>rd</sup> edition, Moscow, 1986.

<sup>3</sup> N. L. Zaitsev, *Economics of an Industrial Enterprise*, Moscow, 1998.

Let us take a resourcing analysis of the scientific and technical potential in Russia in the following classification: human resources; material and technical resources; informational resources; organizational resources; financial resources.

Table 1. The number of personnel engaged in research and development, by categories (persons) (6)

|                                 | 00     | 00     | 00     | 00     | 00     | 01     | 01     | 01     | 01     | 015    |
|---------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
|                                 | 0      | 2      | 4      | 6      | 8      | 0      | 2      | 3      | 4      |        |
| The number of personnel - total | 87,729 | 70,878 | 39,338 | 07,066 | 61,252 | 36,540 | 26,318 | 27,029 | 32,274 | 38,857 |
| including:                      |        |        |        |        |        |        |        |        |        |        |
| researchers                     | 25,954 | 14,676 | 01,425 | 88,939 | 75,804 | 68,915 | 72,620 | 69,015 | 73,905 | 79,411 |
| engineers                       | 5,184  | 4,599  | 9,963  | 6,031  | 0,218  | 9,276  | 8,905  | 1,401  | 3,168  | 2,805  |
| support personnel               | 40,506 | 3,263  | 23,356 | 13,579 | 94,769 | 83,713 | 75,790 | 75,365 | 73,554 | 74,056 |
| other personnel                 | 46,085 | 48,967 | 44,594 | 38,517 | 30,461 | 24,636 | 19,003 | 21,248 | 21,647 | 22,585 |

As can be seen from Table 1, the total number of personnel engaged in research and development decreased by 16.77%, while the number of direct researchers decreased by 10.93% from 2000 to 2015.

If we follow the dynamics by years, it becomes obvious that the number of personnel in this area has gradually decreased from year to year, and gradually increased in the next three years from 2000 to 2012. At the same time, in recent years, an increasing concern about the low indicators of the country's publication activity in the global flow of publications, which have undoubtedly objective reasons, is expressed in the Russian publications: a low proportion of domestic publications in the international indexes of the cited literature, the inclusion of references in English, the intensive reduction of productive researchers of the older

generation, etc.<sup>4</sup>) Thus, Russia accounted for 2.11% of articles in the world in 2014, 2.28% of articles - at the beginning of 2016 indexed in the Web of Science.<sup>5</sup>

Table 2. Movement of personnel involved in research and development, within the Russian Federation (persons)<sup>6</sup>

|      | availability at the beginning of the reporting year | Increased |                                     |            |       | Decreased  |  |                   |       | at the end of the reporting year |
|------|---|-----------|-------------------------------------|------------|-------|------------|--|-------------------|-------|----------------------------------|
|      |   | total     | including:                          |            |       | total      | including:                             |                   |       |                                  |
|      |   |           | from other scientific organizations | from other |       | designated | in connection with the staff reduction | for other reasons |       |                                  |
| 2011 | 90,718  | 32,757    | 4,122                               | 1,549      | 7,086 | 37,932     | 3,587                                  | ,542              | 0,803 | 85,568                           |
| 2013 | 67,456  | 20,298    | 3,777                               | 0,702      | 5,819 | 29,284     | 9,513                                  | ,917              | 3,854 | 58,470                           |
| 2015 | 26,007  | 09,973    | 3,495                               | 5,618      | 0,860 | 22,773     | 1,623                                  | ,598              | 4,552 | 13,207                           |

<sup>4</sup> T. I. Volkova, I. A. Usoltsev, "Inventive Activity of Researchers: Intercountry Rating Assessments," in *Economy of the Region*, V (2017), no. 1, p. 290-307.

<sup>5</sup> \*\*\*, "Is activity growing?," in *Search. Weekly Newspaper of the Scientific Community*, VII(2016), p. 2.

<sup>6</sup> Official Web-Site of the Federal State Statistics Service. URL: <http://www.gks.ru> accessed. 01. 03. 2017.

|            |        |        |       |       |       |        |       |      |       |        |
|------------|--------|--------|-------|-------|-------|--------|-------|------|-------|--------|
| <b>007</b> | 14,329 | 05,758 | 4,150 | 9,778 | 1,830 | 18,952 | 0,536 | ,617 | 3,799 | 01,135 |
| <b>009</b> | 45,978 | 3,526  | 3,235 | 3,529 | 6,762 | 7,071  | 8,295 | ,776 | 3,000 | 42,433 |
| <b>011</b> | 41,183 | 4,939  | 3,725 | 1,881 | 9,333 | 00,849 | 2,848 | ,973 | 5,028 | 35,273 |
| <b>013</b> | 25,591 | 4,550  | 1,075 | 3,210 | 0,265 | 3,112  | 9,214 | ,015 | 1,883 | 27,029 |
| <b>015</b> | 37,210 | 00,290 | 1,662 | 4,026 | 4,602 | 8,643  | 8,285 | ,238 | 6,120 | 38,857 |

It is clearly seen from Table 1 that the number of persons employed has less than the number of retired employees, which created a decline in their total number until 2012. At the same time, it can be noted that the number of employees taken after graduating from the higher educational institutions has steadily decreased from year to year (except for 2015). Each year, the largest share of retired employees was represented by those who were resigned. It follows the conclusion that the scientific and the scientific and technical activity loses its attractiveness as a whole: fewer graduates with higher education apply to it, and many workers leave this sphere (the reasons for this can be dissatisfaction with wages, working conditions, obstacles in the way of career ladder, etc.).

An important problem in the staffing issue is the so-called "brain drain", which is reflected in the outflow of highly qualified specialists to the foreign countries, where they have more opportunities to implement their ideas and developments, better working conditions and higher wages. Unfortunately, it can be said that the scientific activity in Russia does not withstand competition with many foreign countries.

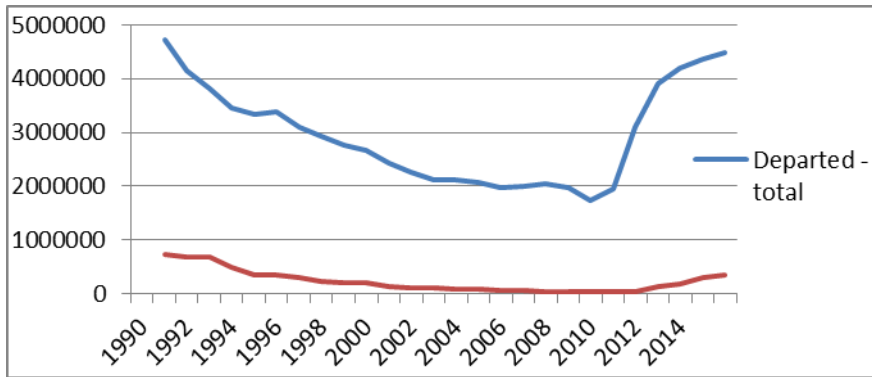
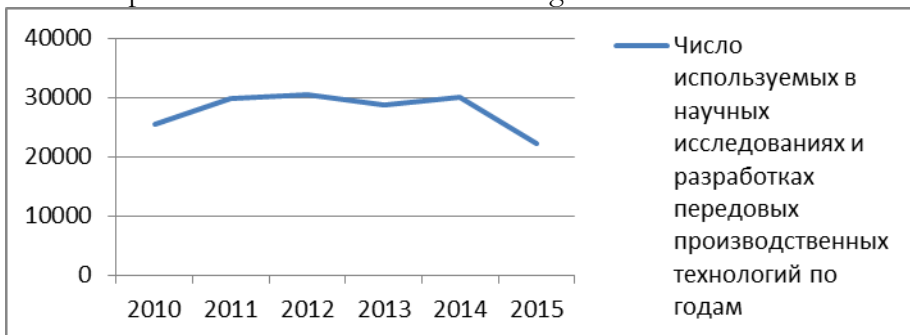


Fig. 1 Results of emigration in the Russian Federation by years (persons)<sup>7</sup>

Fig. 1 shows that the number of citizens, who have left the Russian Federation and have settled abroad, has dramatically increased in recent years. This phenomenon could be explained by a manifestation of the country's economic crisis, which led to inflation, a reduction in real wages of the population, a decline in living standards, a reduction in financing many sectors of the economy, etc. These factors led to the outflow of highly qualified specialists from the country (including from the sphere of scientific and scientific and technical activities).

If we trace the dynamics of the number of advanced production technologies used in the scientific research and development, then we can see weak fluctuations in the period from 2010 to 2014 and a significant decline in 2015.



|   |   |
|---|---|
| Число используемых в научных исследованиях и разработках передовых производственных технологий по годам | Number of advanced production technologies used in the scientific research and development by years |
|---|---|

Fig. 2. The number of advanced production technologies used in the scientific research and development as a whole of the Russian Federation by years<sup>8</sup>

<sup>7</sup> Official Web-Site of the Federal State Statistics Service. URL: <http://www.gks.ru>, accessed 01. 03. 2017.

<sup>8</sup> Official Web-Site of the Federal State Statistics Service. URL: <http://www.gks.ru>, accessed 01. 03. 2017.

Such a sharp decline in 2015 can be explained, firstly, by the crisis phenomena in the country that has adversely affected the financial situation of the subjects of scientific and technological activity, and, secondly, the increased tension in the international relations that has led to restrictions on foreign trade. Due to these factors, the access of domestic researchers and institutions to advanced technologies and developments proved to be difficult.

It is difficult to express the information resources in the quantitative terms, unlike other types of resources. The information exchange and access to it, including in the scientific field, is much easier and faster due to various communication means (especially the global Internet network) in the modern world.

The Government of the Russian Federation ensures the creation of federal information funds and systems in the field of science and technology that collect, register, analyse, store and deliver scientific and technical information to the consumers, promote the publication of scientific and technological products, etc. However, at the same time, there is the problem of information security, especially when it comes to copyright or development, classified in accordance with the state, official or commercial secrets.

Patenting as a necessary condition for the market circulation of scientific and technical products is comprehensively analysed in the studies of foreign scientists.<sup>9</sup> Patent protection excludes illegal use of inventions by third parties and provides an opportunity for the inventor to recoup the costs incurred by him and receive some rent. Without going into the analysis of this, it should be noted that the effectiveness of patent protection requires the creation of appropriate institutional conditions, that is, the development of the market of intellectual products and venture capital in the country.<sup>10</sup>

It should also be noted that the scientific and other organizations that carry out scientific research and development can be considered particularly important subjects for the formation and implementation of the scientific and technological potential, since they are actually the units that carry out direct scientific and scientific and technical activities.

The number of such organizations can be judged from the data provided in the official state statistics.

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<sup>9</sup> O. Granstrand, *The Economics and Management of Intellectual Property: Towards Intellectual Capitalism*, Cheltenham, Edward Elgar Pub, 2000; E. Kaufer, *The Economics of the Patent System*, New York, GmbH Harwood Academic Publishers, 1989.

<sup>10</sup> W. Bygrave, M. Hay, J. Peeters, *The Venture Capital Handbook*, London, Financial Times-Prentice Hall, 1999; V. Ya. Gorfinkel, *Economics of the Enterprise*, 2<sup>nd</sup> edition, Moscow, 2000; P. Gompers, J. Lerner, *The venture capital cycle*, Cambridge, Massachusetts, USA: MIT Press, 1999; Z. Griliches, "Issues in assessing the contribution of research and development to productivity growth," in *Bell Journal of Economics*, X (1979; no. 1, p. 92–116; T. Hellmann, L. Bottazzi, M. Da Rin M., "Who are the active investors? Evidence from venture capital," in *Journal of Financial Economics*, LXXXIX (2008), p. 488–512.

Table 3. The number of organizations, having performed research and development, by types of organization within the Russian Federation (units) <sup>11</sup>

|  |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|--|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
|  | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 01   |
|  | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 1    | 1    | 5    |
|  | 0    | 1    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 0    | 1    | 2    | 3    | 4    |      |
| the number of organizations - total        | ,099 | ,037 | ,906 | ,797 | ,656 | ,566 | ,622 | ,957 | ,666 | ,536 | ,492 | ,682 | ,566 | ,605 | ,604 | ,175 |
| including:                                 |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| research organizations                     | ,686 | ,677 | ,630 | ,564 | ,464 | ,115 | ,049 | ,036 | ,926 | ,878 | ,840 | ,782 | ,744 | ,719 | ,689 | ,708 |
| design organizations                       | 18   | 89   | 57   | 28   | 94   | 89   | 82   | 97   | 17   | 77   | 62   | 64   | 38   | 31   | 17   | 22   |
| design and design and survey organizations | 5    | 1    | 6    | 8    | 3    | 1    | 8    | 9    | 2    | 6    | 6    | 8    | 3    | 3    | 2    | 9    |
| ilot plants                                | 3    | 1    | 4    | 8    | 1    | 0    | 9    | 0    | 8    | 7    | 7    | 9    | 0    | 3    | 3    | 1    |
| higher education                           | 90   | 88   | 90   | 93   | 02   | 06   | 17   | 00   | 03   | 06   | 17   | 81   | 60   | 71   | 02   | ,040 |

<sup>11</sup> Official Web-Site of the Federal State Statistics Service. URL: <http://www.gks.ru>, accessed 01. 03. 2017.

|  |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |    |  |
|--|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|----|--|
| ional<br>institu<br>tions  |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |    |  |
| ndustr<br>ial<br>organi<br>zation<br>s,<br>havin<br>g had<br>the<br>scienti<br>fic<br>resear<br>ch<br>design<br>and<br>engine<br>ering<br>subdi<br>vision<br>s | 8<br>4 | 8<br>8 | 5<br>5 | 4<br>8 | 4<br>4 | 3<br>1 | 5<br>5 | 6<br>5 | 3<br>9 | 2<br>8 | 3<br>8 | 8<br>0 | 7<br>4 | 6<br>6 | 7<br>5 | 71 |  |
| ther   | 0<br>3 | 8<br>3 | 6<br>4 | 6<br>8 | 5<br>8 | 3<br>4 | 1<br>2 | 5<br>0 | 8<br>0 | 5<br>4 | 5<br>2 | 8<br>8 | 5<br>7 | 3<br>2 | 3<br>6 | 4  |  |

According to the table presented, we can make a conclusion that the number of organizations under consideration is not constant in the country and is subject to varying degrees of fluctuation. However, there has been a generally upward trend since 2012, and the figure has even reached its peak for 16 years in 2015. If we look at the structure of the aggregate of these organizations, we can see a clear predominance in the total number of specialized scientific research organizations, as well as the higher educational institutions. It is worth noting a relatively small share of industrial organizations (less than 9%), which can be considered a problematic issue for the country.

The structure of the organizations under consideration can also be considered in the context of the activity sectors, in which they function.



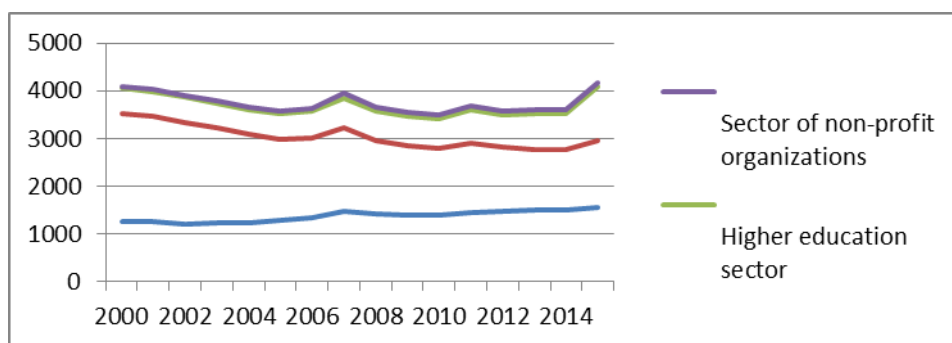


Fig. 3. The number of organizations, having performed research and development, by activity sectors (units)<sup>12</sup>

This table shows that the largest share is occupied by the state organizations, accounting for more than 37% of the total number of organizations in the country (not taking into account the state higher educational institutions). This again confirms the exceptionally high role of the state in forming and implementing the scientific and technical potential of the country.

There is a table below, showing the amount of state funding for science at the expense of the federal budget for 2011-2015.

Table 4. Science financing from the federal budget (Official Web-Site of the Federal State Statistics Service. URL: <http://www.gks.ru> (access date: 01.03.2017)

|  | 2011          | 2012          | 2013          | 2014          | 2015          |
|--|---------------|---------------|---------------|---------------|---------------|
| Expenditures for civil science from the federal budget, mln. roubles | 313,89<br>9.3 | 355,92<br>0.1 | 425,30<br>1.7 | 437,27<br>3.3 | 439,39<br>2.8 |
| including:   |               |               |               |               |               |
| for basic research   | 91,684.<br>5  | 86,623.<br>2  | 112,23<br>0.9 | 121,59<br>9.5 | 120,20<br>3.8 |
| for applied research   | 222,21<br>4.8 | 269,29<br>6.9 | 313,07<br>0.8 | 315,67<br>3.8 | 319,18<br>8.9 |
| in percentages:  |               |               |               |               |               |
| to the federal budget expenditures                                   | 2.87          | 2.76          | 3.19          | 2.95          | 2.81          |
| to the gross domestic product  | 0.53          | 0.53          | 0.60          | 0.56          | 0.54          |

This table allows tracing the dynamics of state expenditures on science. There was a consistent increase in funding in both absolute and relative terms up to 2013: it was not only an increase in the nominal volume of expenditures on science,

<sup>12</sup> Official Web-Site of the Federal State Statistics Service. URL: <http://www.gks.ru>, accessed 01.03.2017.

but also their share in the total expenditures of the federal budget and in the gross domestic product.

In 2014-2015, the volume of science funding continued to increase, but it slowed down significantly, as a result of which a very small increase was observed in comparison with the previous years. It is worth noting that the basic research funding has been reduced. The shares of public expenditures in the GDP and the aggregate expenditures of the federal budget demonstrated an obvious downward trend in the same period. These processes can also be explained by the already mentioned crisis phenomena in the Russian economy and the aggravation of relations in the international arena.

However, the federal budget expenditures constitute only a part (albeit significant) of the total internal costs for the research and development, the amounts of which are presented in the following table.

Table 5. Internal costs for the research and development in Russia <sup>13</sup>

|   | <b>011</b>   | <b>012</b>   | <b>013</b>   | <b>014</b>   | <b>015</b>   |
|---|--------------|--------------|--------------|--------------|--------------|
| Internal costs for the research and development, mln. roubles |              |              |              |              |              |
| in actual prices  | 10,42<br>6.7 | 99,86<br>9.8 | 49,79<br>7.6 | 47,52<br>7.0 | 14,66<br>9.1 |
| in constant prices of 1989                                    | .75          | .09          | .23          | .57          | .58          |
| in percentages to the gross domestic product                  | .02          | .05          | .06          | .09          | .13          |

Here we can trace a fairly similar picture: the volume of costs has been increasing at a moderate pace until 2013, but the growth has slowed significantly since 2014. Of course, in the nominal terms, that is, in actual prices, the financing volumes have been growing approximately equally throughout the five years. However, if we translate these costs into the constant prices of 1989, it becomes obvious that the financing has actually remained approximately at the same level, and the nominal increase could be explained by the price increase due to inflation in 2014 and 2015. An increase in the share of costs for the research and development in the gross domestic product is due to the GDP decline to a greater extent.

Nevertheless, it is important to note that the Russian Federation lags behind many other countries in terms of relative weight of domestic expenditures for the scientific and technical activities in the gross domestic product. For example, this indicator reached 4.29% in 2015 in the Republic of Korea, 4.11% - in

<sup>13</sup> Official Web-Site of the Federal State Statistics Service. URL: <http://www.gks.ru>, accessed 01. 03. 2017.

Israel, 3.59% - in Japan, 3.17% - in Finland, 3.16% - in Sweden, while the internal costs for the research and development amounted to only 1.13% as of 2015 in Russia, as can be judged from the table above.

The data of the last two tables make it possible to calculate the share of state expenditures in the total amount of expenditures for financing the scientific and technological activities as a ratio of the corresponding indicators. This share was about 51.42% in 2011, 50.86% - in 2012, 56.72% - in 2013, 51.59% - in 2014, and, finally, 48.04% - in 2015. We should not forget that these figures reflect the share of the federal budget expenditures, without taking into account the amount of funding from the budgets of other levels of the budget system of the Russian Federation.

Obviously, the state ensures the receipt of more than half of the financial resources received by the subjects of the scientific and the scientific and technical activities. In itself, this fact is not a negative factor, but it implies that the scientific and the scientific and technical sphere attracts a very small amount of private capital (especially in comparison with the developed countries), which indicates a low investment attractiveness of this sphere.

### **Conclusion**

Thus, summarizing the data on all the above indicators characterizing the formation of the scientific and technological potential (or the resource availability of scientific and technological activities) in Russia, one can come to the following conclusions. Firstly, there is a fairly strong impact of the crisis of 2014-2015 on the state of scientific and technical potential, as it has had the following consequence: the outflow of highly skilled specialists abroad and the reduction in the number of personnel engaged in scientific research and development, which reduced the provision of scientific and technical potential with human resources; the decline in the number of advanced technologies used by Russian researchers and scientific organizations, due to increased tensions in the geopolitical situation affecting the trade relations of the countries; in this regard, it has emerged the risk of lagging by the Russian science development from the rest of the world's scientific community; the reduction in the volume of financing of scientific and technical activities in real terms, etc.

Secondly, among the organizations engaged in the research and development, the share of state participation is significantly dominated, since most such organizations are state-owned or dependent on state funding or co-financing of their activities. This is also evidenced by the fact that the largest share is occupied by state expenditures, in particular, the federal budget expenditures, in the structure of state expenditures on the scientific and the scientific and technical activities in Russia.

Thirdly, the total state expenditures on the scientific and the scientific and technical activities in Russia represent the insignificant share of the gross domestic product, and Russia lags far behind this indicator from many developed countries.

