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SCIENCE IN RUSSIA: FACTORS OF MODERNIZATION AND RESOURCES FOR DEVELOPMENT

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Abstract

One of the most strategic resources of a country is its science and technology complex. To be productive, scientists need excellent conditions for doing research. Consequently, they choose such place where they can work efficiently, they even leave their motherland for researching under better conditions.

The study describes the key indicators of efficient research activity. To characterize the science of a country, we distinguish two groups: indicators of scientific and technological capabilities and indicators for assessing the impact of scientific productivity. We use statistical data of reports published in Russia from 2003 to 2014. We did the comparative analysis of performance indicators of research activity in some European and Asian OECD member countries. That provides an overview of the main trends of development and the state of world science. Using data analysis presented in Science Watch, Web of Science and Scopus databases, OECD STAN database, ANBERD, the data published by National Science Foundation and the RAND Corporation, we identify key indicators of research activity in the world. We point out the negative tendency of emigration of Russian scientists and highlight the main reasons of this process. In conclusion, we outline the main reasons of the crisis in Russian science.

1. Introduction

The science and technology complex is one of the most important strategic resources for every country. It defines a national country identity, gives a chance to get out of the economic crisis and takes rightful place in the current millennium. Losing it would be a cause for a lag of high-tech branch of science and technology, national safety and protection against dangerous man-made and nature disasters.

Nowadays, Russia has scientific and technological and human resources for generating and implementing scientific ideas. To modernize and to develop the Russian scientific and industrial potential, the priority should be given to formulating new knowledge and innovation ideas based on the basic and applied research. Universities, especially scientific-research ones, are the points for attracting highly skilled academic staff and an advanced foundation for improvement and development of science of any country and Russia, in particular. However, under the existing circumstances, we cannot but refer to the issue of scientists' and engineers' migration, when best and prospective specialists leave their home countries to do research in host countries, as one of the key factors is more attractive conditions for research activity. Nowadays, one of the best and most sought-after specialists leave Russia for this reason.

It is obvious that to solve existing problems, transformation is necessary not only in funding research, but also in organizing scientific environment for research activity.

1.1. Effective scientific environment as the main factor of the modernization of Russian science

Over the last ten years, some indicators of the Russian sector of research and development, such as funding, internal costs and the number of patents, have shown a positive tendency and steady growth. However, some basic indicators, such as the publication productivity, the number of citations and the number of staff involved in the research process, shows a clear decrease. All this demonstrate that there is a certain dis-balance of input and output parameters of the Russian science. Such dis-balance will lead to the deficiency in the Russian scientific sector.

During the last decade, the Russian government has been implementing a consistent policy, which aims to support science. From 2002 to 2012, the funding of science from the federal budget has increased from 31.05 billion rubles to 355.92 billion rubles - more than tenfold. The total cost of the research process and development increased from 135 billion rubles up to 699.9 billion rubles by the end of 2012. As for the average wages in the public sector, there are also positive changes: the increase from 9700 rubles in 2006 up to 32 540 rubles in 2012.However, it should be noted that despite some positive changes, there is still a negative dynamics in the Russian sector of research and development (Kiselev, 2014).

Considering the indicators which characterize the science of a country, we distinguish two subgroups:

1) indicators of scientific and technological capabilities, which include factors such as funding, the number of employed population, the number of highly qualified researchers, etc.;

2) indicators for assessing the impact of scientific productivity: number of publications, patent statistics, technology balance of payments, etc.(Kabanova, 2013; Karpova, et al., 2015)

As for the first group of indicators, it should be noticed that at the end of 2014, internal costs for research and development, and science funding from the federal budget tend to increase, but such indicator as the number of R&D employment in the Russian sector tends to decrease. The indicators of the age structure of the staff engaged in research have a positive trend of expansion in the number of young scientists under the age of 29 for the last decade. However, there is also a dramatic, more than two fold in crease in the number of research scientists over the age of 70 years (Rosstat, 2015).

Indicators of publication productivity, including the percentage of Russian publications in the world volume, ranking, the citations number per article and others, are the main indicators used to compare the

performance of the research process in the world. Reducing rates of publication productivity reflects the decline in the efficiency of the entire research sector in Russia. According to the statistics, there is a noticeable decrease in the number of researchers as well.

Considering the statistical data of the second group of indicators – scientific research productivity, we can state the following:

• The publication productivity over the period covering 1996-2014, i.e. the total number of Russian scientific publications, had increased from 31 482 to 50 430;however, the number of citations had decreased markedly from 247 578 to 15 155,as well as the number of self-citations from 71 253 to 6 892 (Dezhina, et al, 2015).

• The indicator value of the "number of citations per article" had dropped off from 7.86 to 0.3. The number of cited articles, which in 1996 was over half of all publications (17 899),had decreased almost threefold (6867)by 2014 (Dezhina, et al, 2015).

• The total share of Russian authors' publications for the indicated period worldwide decreased from 2.75% to 1.94%, and among the countries of Eastern Europe - from 45.23% to 30.57%.(SJR, 2015) (Dezhina, et al, 2015).

All this demonstrate that there is a certain imbalance of the funding increase and the efficiency decrease which is shown in the international publication productivity decline within an increase in support from the federal budget.

2. Methods

2.1. Comparative analysis of the research effectiveness indicators

The main sources that publish regular data reflecting the structure, efficiency and funding of Russian science, are the following: Science Watch, SCImago Journal and Country Rank (SJR), bibliographic and abstracts databases SCOPUS and Web of Science CC, publications of the Organization for Economic co-operation and development (OECD), including the OECD Main Science and Technology Indicators (MSTI), OECD Science, Technology and Industry Outlook, Technology and Industry Scoreboard, databases STAN, ANBERD. Such credible organizations as the US National Science Foundation and the RAND Corporation also publish reviews on major trends and the state of world science.

The most complete information in the context of comparing the performance of Russian science with other countries is provided by the STAN database and the publication of OECD Main Science and Technology Indicators.

The Russian sources that have been used include the annual statistical compilation "Russian Science in Figures", Federal State Scientific Institution "Research Institute - Republican Research Scientific-Consulting Centre for Expertise" of the Ministry of Education and Science, as well as the publication of the Higher School of Economics "Science Indicators".

Comparing key performance indicators of scientific activity in Russia in comparison with the other countries of the world, we can distinguish the following indicators:

1) Costs for research and development

Financing of science in Russia is inferior to all leading countries of the world and is1.13% of GDP.

The best indicator in 2013 had Korea (4.15%of GDP), Israel (4.09%of GDP), Japan (3.47%of GDP), Sweden (3.3%of GDP), Finland (3.39%of GDP), Denmark (3.06%of GDP). (OECD, 2013) This indicator clearly illustrates the attitude in the countries to the research, technical and innovation policy (Dezhina et al., 2015).
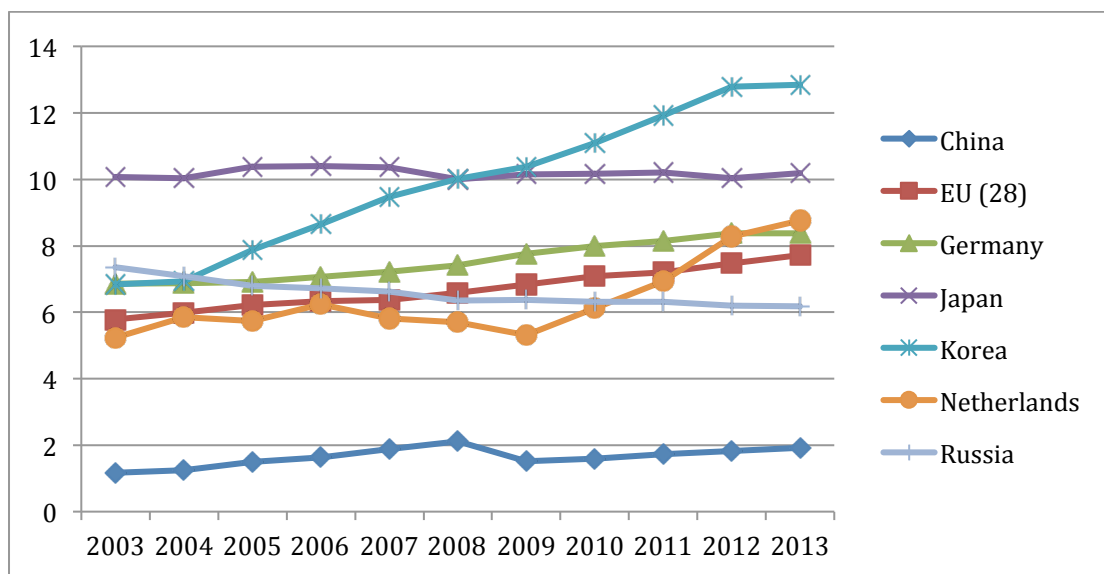

Fig. 1. Changes in the number of researchers in some OECD countries and Russia in 2003-2013.(Per 1 000 employed).

2) Human resources

According to the data of the OECD, during the period from 2003 to 2013, such index as the total number of researchers (full-time equivalent) in almost all OECD countries had a tendency to rise or did not change as in Japan.(OECD, 2015) In Russia, this index tended downward: from 840 thousand in 2004 to 727 thousand in 2013. The share of researchers in the total number of employed people in the economy is an indicator of the knowledge economy as a whole. According to this indicator, Russia is not in the leading position and markedly inferior to other countries. In 2003, the value index in Russia was almost 8 people, in 2013 – 6 people. (OECD, 2015)

3) Publication productivity

One of the main sources of data for evaluating publication productivity of different countries is SCImago Journal and Country Rank (SJR, 2015). The number of publications amounted to: US authors - 552 690, China - 452 877, United Kingdom - 160 935, Russia - 50 430. Thus, Russia lags behind the United States ranking leaders more than 10 times, from China - nearly 9 times.

Considering the number of citations ― the main indicator of the quality of the studies and their results ― in 2014, the number of citations in scientific journals indexed by SCOPUS for the United States was 352 934, China - 152 140, UK- 111 107, Russia - 15 155. According to this indicator, Russia lags behind the US more than 23 times, and more than 7 times ― behind China and the UK.

Analyzing such figure as the h-index, Russia also lacks in leadership positions. In 2014, the US publications got number 1648, while Russian― only 390. Consequently, only 390 Russian authors'

publications of out of 50 thousand published papers were cited more than 390 times each.

The effectiveness of applied research.

Considering the effectiveness of applied research, we turn to such indicators as patent activity, which is calculated on the basis of information about the registration of the results of scientific activity in the form of inventions, new technical solutions and others.

According to the OECD initiative indicators, triad patent families (OECD, 2015) are used for statistical analysis and evaluation of the international patent activity of countries. According to this indicator, Russia was on the 20th place in 2013, lagging behind many developed countries. The Russian Federation by the number of patents is behind nearly 146 timesfrom the ranking leader Japan, and17 times from China. However, it is worth noting some positive growth in the number of registered patents from 2008 to 2013.

Assessing trends in the import and export of Russian-made technologies, we can note steady growth of export-import operations in 2006-2008. However, the economic crisis of 2008-2009 had a negative impact on implementation of technology. Since 2010, operations for technology imports have started rising, but export remains low (Kiselev, 2014).

In total, the results of comparative analysis have led to the following conclusions:

•   there is anegative tendencyin such key indicators as publication productivity and proportion of researchers in the total number of employed people in the economy;

•   there is a problem of quality of the research carried out in Russia, which primarily depends on the human resources.

2.2. Human capital - the main resource of science development

Today, the scientific and research talent is one of the most valuable resources in the field of scientific activity (Riazantsev, 2015). The level of human capital largely determines the level of innovative activity: the more educated and experienced professionals are engaged in research and development, the higher innovation activity and the generation of new ideas are.(Ledeneva, 2005). Thus, staff mobility, promoting knowledge transfer and improving research quality, is an essential characteristic of the research process. In the Russian federation, we can observe the mobility of academic staff, but in this context, mobility turns to the concept of labor migration.

Considering the labor migration in general, and the migration of academic staff in particular, it should be noted that thisprocess is bilateral. The same country is both a donor and the recipient. In context of developing countries, the process of for the most part a one-way migration acquires the features of a phenomenon called "brain drain". This process seriously threatens the problems in the social and economic spheres of the state. Russia, like most post-Soviet countries, suffers from a similar phenomenon.

From 1989 to 2004, about 25 thousand scientists left Russia. In 2012,this number was 30 thousand of scientists working on temporary contracts abroad (Artyunov, 2003). According to the recent sociological studies, only a quarter of all students studying abroad plan to return home, and 45% have a specific intention to stay in host country (Ledeneva, 2006). When scientists emigrate abroad, Russia loses not only the unit of the population, but new discoveries, research and development as well. We do not

mention the financial side of the issue.

In the USA, one scientific expert in the field of high technology produces a profit of about $ 300,000 a year on average. It is not uncommon when these professionals are progressive Russian scientists. According to the USA National Research Council (NRC), only 52% of the total numbers of industrial patents that are registered in the United States belong to Americans. The rest 48% are registered by foreigners (Tomberg, 2005).

3. Results

There is a negative trend of our time: young, professionally trained, economically active academic staff goes abroad. Low salaries, uninteresting work, the lack of clear prospects and low demand make young people try their hand abroad, where talent and ability are valued higher than the acquaintanceship and status. Despite the complexity in organizing life in a foreign country and difficulties in communication at work, the majority of immigrants quite easily adapts and stays for permanent residence.

We have identified the main reasons of emigrating Russian scientists abroad:

1. There are many small and pointless restrictions, such as the law on compulsory tenders for R&D and purchasing scientific equipment and others.

2. The high level of corruption in connection with excessive bureaucratization of administrative and governmental structures.

3. Inadequate procedures for research projects examination.

4. The imperfection of science management system, which is closely related to the Academy of Sciences. In most cases, all decisions are made by people-functionaries, who are not associated with science at all. They pursue an objective to preserve existing foundations and organizational structures instead of receiving unique scientific results and increasing research efficiency.

5. The lag of the Russian science from the modern world scientific community, isolation from the global community of information and ignorance of the latest foreign publications, inability and unwillingness to participate in international research teams.

6. The low level of English language proficiency.

7. Nonflexible Customs and visa system do not consider specifics of work with research equipment and interfere with Russia's interaction with the rest of the world.

All of these earlier mentioned problems denote a lack of a well-established science and technology policy, promoting the development and support of actively working scientific staff, supporting and ensuring the implementation of R&D and joint research projects. Going up to a higher level, we can witness the absence of a strategy, a comprehensive plan of action and the real working mechanism to rebuild Russian science.

4. Conclusions

The issue of providing Russian scientists with appropriate conditions for effective research work and dignified life is quite urgent today. Considering the conditions existing nowadays, it should be noted that the scientific infrastructure is almost completely destroyed in Russia. Certainly, we cannot state that such

situation is ubiquitous (Ignatov, 2013). On the other hand, engineers are required to be culturally, socially and communicatively skilled, they should be able to act in constantly changing socio cultural environment (Galanina, et al., 2015, 2016). In the last few years, various organizations, cooperation makes efforts to modernize scientific and technological environment, but these are single elements that can change the system fundamentally.

The annual increase of government subsidizing on science is not the main factor of science modernization, as financing research activities effectiveness as well as academic performance, is "only proportional to the logarithm of the appropriation, but is directly proportional to the degree of science organization " (Artyunov, 2003). Consequently, we can conclude that the presence of an inefficient organization of scientific activity and the absence of effective research environment, the increase in costs is less warrantable expense for spending state funds in the current environment. The crisis of Russian science is not financial, but that of the system.

Activities in the field of restoration and formulation of necessary conditions for the effective research process should be intensified. The issue on the global consequences of the science degradation and science modernization in the ever-changing world remains unclear.

Acknowledgements

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