

Digital technology research of the number of scientific diaspora

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Abstract– The article presents the technology of forming the database of the scientific diaspora on the example of Russia, as well as the approach to its verification - a survey of scientists included in the database. The analysis allowed to get the information not only about the causes of migration, interest in interacting with Russian science but also information about the awareness of tools for attracting foreign scientists to interact with Russian science and promising major research projects that can have a significant impact on the development of science and attract foreign scientists.

Key words – *scientific diaspora; analysis of the number of scientific diasporas; brain drain; circulation of scientific personnel; promising research projects.*

I. INTRODUCTION

"Brain drain" has a negative impact on the development of any country, manifested in the inability to re-industrialize the country, reduce the technological gap with the leading countries. Tracking the emigration of Russian scientists according to official statistics is difficult due to the fact that Rosstat publishes data on migration flows without regard to citizenship. Thus, the compilation "Number and migration of the population of the Russian Federation" [1] provides data on the number of migrants with academic degrees, but does not take into account the fact of change of citizenship of migrants. As a result, migration flows of candidates and doctors of science are observed between Russia and the CIS countries (Ukraine, Kazakhstan, Uzbekistan), both in the case of a visit to Russia and in the case of departure, which is explained by periodic scientific interactions, after which scientists return to their country of origin. In fact, this fact is a reflection of the circulation of scientific personnel. The emigration of Russian scientists to foreign countries, according to Rosstat, is insignificant, and Russia has an annual increase in scientists (160 people in 2017).

Besides official statistics, another tool is necessary to determine the number of the Russian scientific diaspora - emigrated scientists entrenched in science and continuing their scientific career in the leading scientific institutions of the world.

II. LITERATURE REVIEW

A. Study of the number of the scientific diaspora.

The number of the Russian scientific diaspora has a significant variation in values: from a few thousand to over a million people [1-3]. This is due to the lack of a calculation methodology, as well as the possibility of distinguishing between highly qualified specialists and scientists, therefore the number is estimated. The Web of Science database was used to track, on the basis of affiliations, the participation of Russian scientists in foreign research in several scientific organizations [4]. However, the number of scientific diasporas was not determined by this method.

Abroad, estimation of the number was carried out on the basis of statistical data of the countries to which migration is carried out [5]. However, this approach does not allow an assessment of the scientific diaspora, since the scientist, having left the country, could not integrate into the scientific field of the host country, which does not allow him to be considered as a member of the scientific diaspora and establish interaction with him or involve him in scientific research. Or, it is not the scientific diaspora that is being investigated, but the diaspora of highly qualified specialists, which erodes data on the number of scientists who successfully integrated into the science of the host country [6]. There are studies of the scientific diaspora based on the NSF database, however, due to the source used, the study is limited to the diaspora of scientists who emigrated to the United States [7].

B. Diaspora polls

Surveys of representatives of the diaspora, both Russian and others, were aimed at determining the reasons for emigration [8-11] job satisfaction abroad [12], possible options for returning to the country of origin [12] and areas of cooperation with science in the country of origin [13]. The reasons for the migration of scientists are identical for scientists from different countries: career opportunities, wages and research prospects. At the same time, only a quarter of Russian scientists do not intend to return to Russia [12], while in India these figures turned out to be 41% [9].

III. RESEARCH METHODOLOGY

In the framework of this study the scientific diaspora refers to fellow scientists who left the country and integrated into the science of the host country. Integration in this case represents participation in scientific research with the corresponding scientific result in the form of scientific publications. Studies of the size of the diaspora were carried out using the Web of science database, which contains information about the affiliation of the authors with the scientific organizations of the respective country. The study was conducted on the example of the Russian scientific diaspora for the period 2008-2017. Until 2008, the information contained in the database regarding affiliations is incomplete, which makes it impossible to use it for earlier periods of time as a source of information.

Unloading of scientific publications of scientists with affiliations with Russian and foreign organizations was made from the Web of science database; duplicate records were removed. Russian affiliation indicates that the author worked in Russia, and the foreign one is the country of emigration. The facts of the change of Russian affiliation to a foreign one were also tracked. In the resulting list, the authors with foreign affiliations are selected according to the principle of having a last name ending in "ov" or "ova". However, the list is supplemented by the authors with foreign affiliation, if the co-author has Russian affiliation. This is explained by the fact that, while maintaining professional ties with colleagues in Russia, joint articles are often published. For a foreign co-author by last name, the possibility of the origin of a scientist from Russia was verified. At the end of the database formation, foreign authors were excluded from it (selected by last name) employed in Russian scientific organizations.

As a result, a database of Russian scientists was obtained, including information on the directions of the author's research (in accordance with the Web of science classifier), the author's e-mail, country of emigration and place of work. The total number of entries was 3000 units.

In order to verify the records, a survey was conducted of scientists included in the database. This approach allows you to:

- Evaluate the accuracy of the applied research method, including clarifying the fact of belonging to the scientific diaspora;
- To update the place of work of the scientist and his position, which allows to evaluate the success of the researcher's incorporation into the foreign scientific environment;
- To identify scientists willing to contact with the representatives of the scientist's country of origin;
- To conduct a survey on prospective studies for the country of origin, as well as identify problems that were the cause of emigration;

The questionnaire consisted of the following questions:

- The questions about the respondent (current and previous jobs, position, age, areas of your research interests, age at the time of emigration);
- The reason of choosing this country for emigration;
- The scientist's awareness of Russian initiatives to attract foreign scientists to work in Russia;
- Frequency of visits to Russia;

- Questions about the possibility of participation in Russian scientific projects (in what capacity, the expected income);
- To identify possible major scientific projects that would attract leading scientists to Russia, as well as lead research directions, the concentration on which would allow Russia to become one of the world's scientific leaders;
- To assess the impact of state initiatives on Russian science.

In contrast to other surveys, in this study, in addition to analyzing the causes of migration and the conditions for returning to Russia, scientists also studied the existing initiatives of the state to reform science, including suggesting an increase in interaction with foreign scientists and representatives of the diaspora, promising large-scale interdisciplinary projects have been identified, the results of research on which can give a complex effect for various fields of science. An assessment was also made of the level of wages that scientists are counting on in the event of their return to Russia.

IV. RESEARCH RESULTS

A. The number and structure of the diaspora

184 scientists took part in the survey, which corresponds to the minimum sample for 95% reliability and a confidence interval of 7%, which makes it possible to consider the sample representative. It should also be noted a more significant number of responses received in the framework of this study, compared with other studies: 150 people in the Russian diaspora. (However, the study was conducted in 1994) [8], 43 in the work [13]. The number of surveyed representatives of the Indian diaspora was 50 people. in the study [9] and 26 in the work [10].

This result is associated with a large amount of contact information obtained due to the database formation method, which allows you to poll quickly a significant number of respondents.

The distribution of scientists by countries and areas of research is shown in Fig.1 and Fig.2. Most scientists emigrated to the United States and Germany (22% and 18%, accordingly). 7% went to France and the UK.

Most of the emigrating Russian scientists conducted research in physics (36%), mathematics - 16%, chemistry 18%. The distribution corresponds to the strengths of Russian science, which has always focused more on the natural sciences.

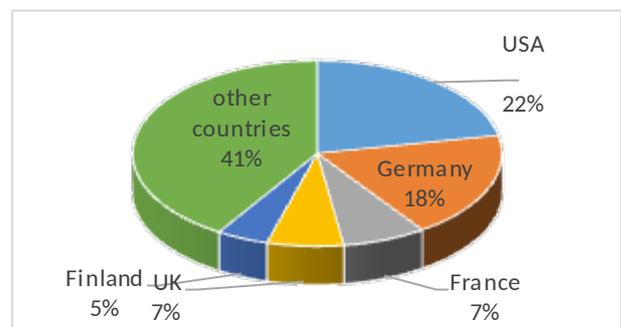


Fig.1 Structure of migration of Russian scientists by country

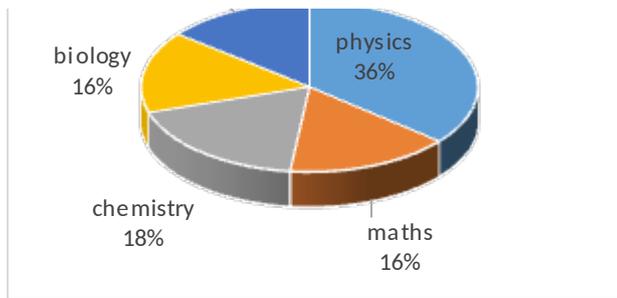


Fig.2 The structure of the fields of science of the Russian scientific diaspora.

The age composition of the diaspora is as follows: over 50 years old - 62%; 30-50 years old - 33.7%; younger than 30 - 4.3%.

B. Reasons for emigration

The main reasons for emigration include participation in prospective studies (60.8% of respondents answered) and a high level of research funding abroad (60.2% of respondents). Many respondents also talked about the need for complex, systemic changes, including increasing of the demand for scientific research in the country, raising the social status of a scientist, reducing bureaucratization, creating long-term programs for the return of scientists, etc. These reasons correspond to those previously revealed in other papers [12–13]. However, the availability of the necessary scientific equipment is highlighted: 43.2% of the respondents.

C. Possibilities for engaging with the diaspora

Since individual scientists periodically visit Russia several times a year (30% of respondents) or more than a month each year (22.9%), the prospect of involving fellow scientists to work with Russian science was analyzed. However, the most significant factor is the level of payment - from 5 to 8 thousand dollars per month (34.6% of the respondents). The salary of 2-4 thousand dollars suits 26.5% of the respondents. Only 4% agree to have a main job in Russia with a salary of less than 2 thousand dollars.

The returning of Russian scientists should not become an end in itself. Perhaps remote interaction can be more useful and convenient, especially since representatives of the diaspora are ready to participate in such projects. The respondents supported particularly the following forms of participation:

1. Over half of the respondents (63.4%) agree to participate as a paid expert in projects of Russian research funds and federal targeted programs, including remotely.
2. As a teacher for a Russian undergraduate / postgraduate studying abroad (48.3%), including scientific review (43%).
3. 43.6% of respondents are ready to teach in Russia.
4. 42.4% of respondents are ready to interact with Russian science in the format of a “mirror” laboratory as a manager or an employee.

D. Evaluating the effectiveness of government initiatives in the field of science

Representatives of the diaspora note that among Russian projects aimed at interacting with foreign scientists, including the most famous people who emigrated (85.9% of scientists indicated that they are aware of the existence of such a program) use the “Megagrants” project, which attracts foreign scientists to create laboratories in Russia. 75.3% of the polled are known to the international competitions of the RNF. The project to improve the competitiveness of universities (the project "5-100") is known to 46.5% of the respondents. At the same time, an assessment of the effect obtained from government actions to raise the level of Russian science showed that on a 5-point scale, the greatest effect was obtained from the creation of the RNF (66.2% of respondents gave 4 and 5 points). About half of the respondents also indicated the importance of the “MegaScience” projects. Russia's A participation of Russia in large projects of the “MegaScience” class has a positive effect on a level of Russian science. So, international projects (the Large Hadron Collider, ITER) indicated 64% of respondents, Russian (PIK, NIKA) - 50%. The national technology initiative received a rather negative assessment: 39.5% gave 3 points, 32% - less than 3 points. Conflicting scores received the approval of the Science and Technology Development Strategy (the answers were distributed approximately equally for each score). The use of indicators of publication activity in journals indexed in the Web of Science and Scopus databases was noted as 52.9% of the initiative that did not have a positive impact (1-3 points), and 47.1% of respondents had a positive effect.

E. Promising research area

A survey of representatives of the diaspora on the subject of research that may have a significant positive effect if they are implemented in Russia, including able to attract foreign scientists, showed that for this it is necessary to implement large projects aimed at solving significant scientific problems. Scientists attributed to such projects the following:

- creation of a quantum computer and the development of artificial intelligence (18.2%);
- research on aging issues, personalized medicine (18.2%);
- response to threats related to climate change, research in the field of renewable energy sources (17.2%);
- landing on the surface of Mars, which involves the development of appropriate engines, life support technologies for the crew, new materials and communication systems, research in the field of robotics (13.1%). At the same time, the scientists who have indicated this option note that, despite the conduct of such studies abroad, Russia has a competitive advantage in the form of cheaper resources for conducting research than leading countries;
- a brain research and the creation of relevant models, including for use in creating artificial intelligence (10%). It is noted that such projects are being implemented abroad (for example, the Human Brain Project), but all respondents who have indicated this option note that there is a strong mathematical school in Russia, which provides a competitive advantage.

Separately, it should be noted scientists pointing to the need to create a knowledge-intensive industry in order to

increase the demand for the results of scientific research, which, in turn, will stimulate the development of science in Russia.

F. Scientific novelty

In the course of this study, the following results were obtained:

- A technology for estimating the size of the scientific diaspora was proposed;
- An algorithm for the formation and verification of a database of emigrated scientists who continued active research activities abroad was proposed;
- A database of scientists-members of the scientific diaspora was formed, including contact details of scientists, place of work, country of emigration, area of research, and also allowing to track the fact of the return of scientists to Russia;
- A group of experts ready to cooperate with representatives of the country of origin has been formed;
- The results of a survey of fellow scientists, indicating the need to implement major interdisciplinary research projects in Russia, which are also able to attract foreign scientists. Among such projects, a complex of studies on the creation of a quantum computer, artificial intelligence, which can be combined with a large-scale study of the human brain, is highlighted. The importance of finding a solution to the global climate change problem is noted, as well as the need for a flight to Mars. The results of research on these projects will provide new technologies in several areas: artificial intelligence, new materials, robotics, medicine and biology, engine-building, microelectronics, and others.

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