

Brain Drain and New Mechanisms of Funding in Russian Science

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Russian science is currently in crisis, internal and external « brain drain » process is one of its manifestations. Since the disintegration of the USSR three waves of “brain-drain” may be distinguished. Before observing this process in historical perspective it is important to give some definitions.

The term “brain drain” was defined in 1962 by the British Royal Society in a report on the emigration of scientists and technicians from the country towards the United States ¹. In 1972 at the Third Meeting of the United Nations Conference on Commerce and Development, it was defined as a problem of “reverse transfer of technology”.

In Russia the structure of such phenomenon as a brain drain is very complicated and besides obvious includes some “hidden” forms. The main forms of outflow of intellectual resources from Russian science are the following :

- emigration which means permanent residence abroad ;
- contract-based employment abroad which may become the first stage to actual emigration ;
- leaving science for another type of activity ;
- work for foreign firms and organizations on the Russian territory. This is a specific form of brain drain for countries with undeveloped laws in the science and technology spheres (for example, with poor regulations of intellectual property rights) and cheap science and engineering workforce ;
- so called “informational emigration”. This is also a specific form of intellectual emigration for Russia. Foreign publications are inaccessible to the majority of Russian scientists, and in this way publications of Russian researchers abroad is in fact lost information for their colleagues at home.

All official assessments of brain drain process in Russia are not reliable because of scarce and inadequate statistical basis. Then, there exist some forms of poor formalised processes which actually are types of “brain drain”. For example - part time job outside scientific sector. According to some expert data, about 90 % of personnel in R & D sector in Russia have part-time job in other branches of the economy (*Nezavisimaya gazeta*, 1994). As a result the main trends of the brain drain process from Russian science may be traced only on the basis of *different statistical samples and sociological surveys*. This information helped to reveal the historical “waves” of brain drain. The suggested lower chronology concerns mostly the actual and contract emigration. Internal emigration, i.e. leaving science for other types of activity, is hardly separated on “periods”. This process is permanently developing without any notable splashes. Other forms of brain drain named above are not studied enough yet.

The first wave of “recent” emigration may be dated between the end of 80s and the beginning of 90s. That time was in some sense transitional, because it began before the disintegration of the USSR. In the years prior to the Soviet Union’s eventual dissolution, Soviet leaders had little reason to be concerned about a possible emigration of scientific personnel because of tight controls over travel abroad. That is why the first wave of “scientific” emigration was not very

large. For example, during 10 years -from 1982 till 1992- the number of those who have emigrated to USA was 4962 persons, from which 15 % (738) were researchers ².

At that period *scientific elite* was the main contingent among researchers who left the country. These scientists were well-known in the international scientific community. Surveys have shown that scientific elite found its place abroad : about 70 % of those who left the country at this period of time found job at universities and R & D organizations.

The other significant flow was by the channels of ethnic emigration. But those who left for abroad because of ethnical reasons usually did not continue to work in the science sector in the new country of residence.

The second wave of emigration was in 1992-1993. That was the period of the most intensive emigration abroad and, correspondingly, the time of the greatest attention of mass media to this problem. The second wave was partly connected with new legislation. In January 1, 1993 the Law on the procedures of Exit from the USSR and Entry to the USSR for Citizens of the USSR was enforced. The measure was designed to allow freer travel abroad for Soviet Union's citizens and was passed by Supreme Court Soviet on May 30, 1991.

During 1992-1993 the first official data on the scientific migration were collected and aggregated. Estimations on the basis of the official statistical data showed that in 1992 about 400 scientists emigrated abroad for permanent residence, in 1993 - 426 scientists. It means that in 1992-1993 the rate of emigration of R & D personnel was more than for all 10 previous years.

According to expert data *contract emigration* was higher in 4 times. In general, the share of external brain drain was at the level of 5 % from the total outflow of specialists from the science sector (Kitova, G. Kuznetsova, T. Kuznetsov, B., 1995). Furthermore it was estimated that only 20-40 percent from the total number of those who left for abroad obtained positions in the science sector.

At the same time the decreasing percentage does not mean real decrease of those who stayed in science abroad in comparison with the previous years. The scale of the second wave was larger than of the first one, so the values counted in numbers were close to each other and the number of those who continued to work in science sector abroad stayed stable.

The "generalized picture" of brain drain in 1992-1993 looks as follows. Typical emigrant - a man at the age of 31-45 years old, having Ph.D. and engaged in theoretical research. In most cases the researcher had a large number of publications. According to different surveys physicists and mathematicians were leaders in disciplinary structure of emigrants, taking together more than 50 % of total number of emigrants, followed by biologists (about 30 %) and chemists. The biggest share of emigrants was from Moscow, S.-Petersburg and Novosibirsk - the main Russian scientific centers. Country contributions was not stable from year to year (see Table 1).

Table 1. The distribution of emigrants from science sector by new country of residence

Country	The share of emigrants, % to the total number of the emigrants from science sector :	
	1992	1993
Germany	60.48	66.9
Israel	25.44	21.0
USA	10.43	8.6
Greece	0.94	1.6
Canada	0.22	0.4
Australia	1.09	0.3
Other countries	1.40	1.2
TOTAL	100	100

Sources: Nikipelova, E., Gokhberg, I. Mindeli, I. (1994); O. Ikonnikov (1993),

Different sample surveys revealed that *the proportion between the number of emigrants on the permanent residence abroad and the number of those researchers who left science for another activity inside the country was 1 : 10* (S. Egerev. Poisk, 1996), i.e. on one scientist who left for abroad there were ten researchers leaving science for another sector of the economy inside the country.

At that period of time the dominating number of young researchers under age 30 who left science found themselves in private enterprises inside the country. At the same time the intensity of youth emigration began to grow : *in 1993 thirteen thousand of graduates left Russia for abroad* (S.-Petersburg vedomosti, 1994). The study of emigration moods among students (Radaev, V. 1995) showed that 10 % wanted to leave Russia, and about 60 % would like to work abroad on the basis of long-term contracts. From those 10 % who was ready to emigrate the predominant number did not want to work in science. The greatest number of potential emigrants were from Moscow and S.-Petersburg regions and belonged to "student elite". They had good computer education and knowledge of foreign languages.

The third wave of emigration started in 1994 and is continuing at the present time. The important sign of this period is the increase of those who were ready to leave the country with guarantee of any job, not always in the science sector. But some surveys revealed that the share of those who not only wanted but also could leave the country was only about 4 % (Mirskaya, E., 1994). These are mostly science leaders and young researchers from the laboratories and institutes with international connections. The typical representatives of potential emigrants continued to be physicists, mathematicians, specialists in computer sciences, genetics, biotechnologists, virologists. All these specialists who provide the social and technological development of the country.

The main feature of this wave became the growing share of graduates and young researchers among those who leave science. *Today the "main body" of emigration consists of undergraduate students and graduate students, and young researchers at he age up to 35 years old.*

In 1994 the share of *potential emigrants among students* was already about 40 % (Morozov, A. 1994). Then, potential young researchers not only have high emigration moods, but they also began to see their future out of science sector. From this point of view specially dramatical situation turned out in those discipline which were very prominent in Russia : for example, in theoretical physics up to 80 % of students are not going to work as physicists and some of them, even in science at all.

A characteristic sign of the contemporary situation *is the increasing outflow of students and graduate students* who are potential R & D workforce for Russian science. The most popular for continuation of education are different American universities and colleges (see Table 2). While the share of the students who receive their education in the U. S. is slightly decreasing, the total number of former Soviet Union students in this country has increased in 19 times during the last 5 years. The prevailing number of young people wishing to enter foreign university can not pay for their education. The level of competition for those who need financial support is the highest. It means that only the best become graduate students in foreign universities. That is the main difference between this contingent of "brain drained" and other scientist-emigrants. For the last group the "real quality" of scientific personnel leaving the country is uncertained. After studies abroad, specially graduate, a very small share of graduates return home.

Although the number of graduate students from Russia is considerably large and is permanently increasing, the total number of those who earned Ph.D. is still very insignificant. According to the U.S. National Research Council who provides annual surveys of earned doctorates, the number of doctorate recipients from U.S. universities who reported that they were citizens of Russia was zero from 1979 to 1992. In 1983 there were research doctorate awards to 5 Russian citizens, in 1994 18, and 45 in 1995. It is great increase, but in comparison with

the number of graduate students - not so much. In 1995 it was only 0.3 % of all doctorate awards. One of the explanations is that thesis is prepared during several years, so those who received Ph.D. in 1995 entered graduate school in 1990 or around this year. It was a period with more closed borders than after the disintegration of the USSR. Today the number of graduate students in the U.S. universities is increasing dramatically. In some universities there appeared entire Russian communities. The outburst of the number of Russians with Ph.D. should be expected in 2-3 years. Those who, today, go to study abroad may be divided into two main groups : those who immediately are looking for possibility to stay abroad forever ; those who try to keep in touch with their colleagues in Russia - mostly through joint projects supported by different science foundations, and through contracts.

Table 2. The distribution of students from the former USSR among leading Western countries

Host country	Number of students/percent				
	1990/91	1991/92	1992/93	1993/94	1994/95
USA	167/39.5 %	387/55.6 %	1081/76.4 %	2094/68.9 %	3159/65.4 %
France	83/19.7 %	144/20.7 %	136/9.6 %	388/12.8 %	613/12.7 %
Germany	108/25.6 %	92/13.2 %	92/6.5 %	417/13.7 %	746/15.4 %
Great Britain	61/14.3 %	63/9.1 %	71/5.0 %	75/2.5 %	120/2.5 %
Canada	4/0.9 %	10/1.4 %	35/2.5 %	667/2.1 %	193/4.0 %
TOTAL for 5 leading countries	423/100 %	696/100 %	1415/100 %	3041/100 %	4831/100 %

Data were counted on the basis of the sources :

1. UNESCO Statistical Yearbook 1990, table 3.15, pp III381-439.
2. UNESCO Statistical Yearbook 1991, table 3.15, pp III398-423
3. UNESCO Statistical Yearbook 1992, table 3.16, pp III390-415.
4. UNESCO Statistical Yearbook 1993, table 3.14, pp III363
5. UNESCO Statistical Yearbook 1994, table 3.16, pp III433.

The USA still give the largest possibilities for employment in the science and technology sphere. Data for the USA (see Table 3) shows that the situation with inflow of Russian scientists was not very dramatical. First, because the average « quality of Russian researcher » is rather good ; second, because Russians do not take the largest share of R & D immigrants. According to Immigration and Naturalization Service data ³ China and India take together 37.9 percent of all S & E immigration (20.44 % and 17.5 % respectively).

Table 3. The distribution of scientists and engineers from the former USSR admitted to the U.S. on permanent visas, by occupation and labor certification

Occupation	1991	1992	1993
Engineers	494	468	725
Natural Scientists	73	93	211
Math Scientists and computer specialists	64	67	113
Social Scientists	37	36	51
Total S&ES	668	664	112
From total :			
<i>Certified</i>	5	15	96
Non Certified	663	649	1031

Note : Data present only those S & Es who had USSR as a country of last residence.

Sources : 1. Immigrant Scientists, Engineers and Technicians : 1991-1992. Detailed Statistical Tables. NSF 95-310, Tables b-5, B-19, B-20. 2. Immigrant Scientists, Engineers and Technicians : 1993. Detailed Statistical Tables. Unpublished NSF data, Tables B-4, B-11.

Data from Table 3 show that emigration of former Soviet Union researchers remains spontaneous, because the number of certified immigrants is still very low, the highest share was 8.5 % (for 1993). At the same time the rate of increase of this category is impressive -from 0.7 % in 1990 till 8.5 % in 1993- about 12 times increase. Certified workers are those who already had agreement about future place of work before they left the country. It means that these category of researchers definitely stayed in the science sector abroad.

As a result of these three waves of emigration today from 100 Russian researchers who have the highest indicators of science citation index more than 50 researchers live and work permanently abroad ⁴.

At the present time the number of scientists in total number of employed in the economy of the country became twice as less in comparison with 1991.

Aggregating the data of different sociological surveys one may distinguish the main *motivations for science emigration* during the past 5 years. These are the following :

- 1) economic and political situation in the country ;
- 2) low level of prestige in the society, uncertain perspectives ;
- 3) the absence of necessary conditions for research : low level of salary, unadequate equipments and instruments, poor informational support of research ;
- 4) undeveloped rights on intellectual products ;
- 5) for researchers from regions - difficulties in access to big scientific centers with better conditions for research ;
- 6) for young researchers, impossibility to receive dwelling, specially in special "science cities".

For those who leave science for other types of activity or for abroad the predominant factor is the low level of personal income. Those who leave the country on the basis of long-term contracts, a very significant factor is the possibility for professional realization which includes work in good equipment, access to foreign informational resources, professional contacts with colleagues.

From the other hand there was a number of *obstacles*, both objective and subjective, such as :

- 1) "immigration capacity", i.e. the possibility of the western science and technology market to accept foreign specialists ;
- 2) the difference in qualification standards, habitual conditions of research work and in organization of scientific process ;
- 3) uncertainty in future job placement.

Unfortunately all motivations for emigration keep being true at the present time.

If we analyze the process of brain drain in correlation with the financial situation in Russian science the picture will be much darker. To evaluate the real state of science in Russia means to look at the evolution of research and development (R & D) financing. Federal funding is still the dominant domestic source of support for Russian science. Its volume is permanently decreasing. For normal science development the presence of some "critical mass" of scientific personnel is necessary. Usually its actual value correlates with the share of the expenditures on science in Gross National Product (GNP). According to expert data, the destruction of national scientific potential may happen if the share of expenditures on science in GNP during 5-7 years will be lower than 1 %. In Russia during the past 4 years this share was under 1 % (see table 4).

Table 4. The dynamics of the expenditures on science in GNP and emigration of the specialists from the economic branch "Science and education"

	1992	1993	1994	1995
The share of expenditures on science in GNP, %*	0.69	0.52	0.44	0.29
Number of emigrants	4572	4088	5171	5500**

* In 1991 the share of expenditures on science in GNP was 1.03%.

** Preliminary data.

Table 5. International R&D expenditures as a percent of GNP

Country	1992	1993	1994	1995
United States	2.7	2.6	2.5	2.4
Japan	2.8	2.7	na	na
Germany	2.5	2.5	2.5	na
France	2,4	2.4	na	na
United Kingdom	2.2	2.2	na	na
Italy	1.3	1.3	1.2	na
Canada	1.5	1.5	1.5	na

na = non available.

Source : Science % Engineers Indicators, 1996, appendix Table 4-33, p. 154

In 1996 the dramatism increased. Science was not financed from the federal budget at the beginning of the year and during three summer months. It was a new crisis of financing. Until August 1996, the science sphere received as budget only 50.8 % of the expected and planned level. As a result today only 17 % of researchers in Russia have salary which exceeds the official level of poverty ; the level of income in "science" taken as a branch of economic activities occupies the 10-th place among 11 branches as counted in statistics ⁵.

The science budget planned for 1997 is even lower than for 1996 : 2.65 % of the expenditures from Federal budget (in 1996 -2.7 %). It shows that science in the list of federal priorities still has low rating. As a result the problem of brain drain may become extremely actual again, and in 1996 there even appeared a new definition, "organized emigration of scientists", which means that the whole laboratories from R & D institutes are ready to leave the country.

Russian government structures which are responsible for S & T in the country try to resist the outflow of scientists. In 1994 there was created an Interagency Program for Regulating the Migration of Science and Technology Specialists. The program contained urgent measures to prevent brain drain and long-term issues aimed to coordinate and monitor this process. Urgent measures were for period till the middle of 1995. They included the development of legislative basis which help to prevent the outflow of researchers, and some economic measures such as implementation of a contract system in the science sphere. These two main directions have not been put into practice till today. Long term initiatives included the development of the alternative to federal budget sources of support for science, the creation of science foundations, the stimulation of international contacts. Some long-term measures are under implementation at the present time.

Today a number of initiatives aimed to support science and to prevent the brain drain process exist. These are : grant system of support, selective federal support of the best scientific collectives and schools, and institutions. Additional funding at the level of certain organization is provided for those R & D institutions who received the status of *Federal Research Center (FRC)*. In 1995 there was started a program of support for leading scientific schools and the best 100 young researchers (up to 40 years old) with doctorate degrees. Unfortunately these two initiatives are conserved because of the lack of federal money. Some other initiatives were more successful.

Federal Research Centers appeared in 1993. The idea was to preserve the leading directions of research through special support from federal budget. Today there are 61 such Centers, about 1.5 % of total number of scientific organizations in Russia. In 1995 they received about 6 % of the entire federal allocations on science.

Researchers and research teams may receive support applying for grants from the federal foundations. In 1993, the first Federal Russian foundation - Russian Foundation for Basic Research (RFBR) - began its activity, in 1994 Russian Science Foundation for Humanities (RSFH) started its work. These foundations are assigned 4 % and 1 % respectively of all federal budget allocations for science. Therefore the Russian foundations represent one more form of distribution of federal support and at the same time they constitute new institutional and motivational mechanisms and in this way may have an influence on the mobility of the scientific community.

During the same period of time there appeared a new and very influential source of financing for Russian science - *foreign grant-awarding foundations*. Since opening their offices in Russia, a number of these foundations have developed special programs to support natural and social sciences, and humanities. In 1994-1995 these foundations' share in supporting basic research was equal to the share budgeted by the federal government for this purpose. This is the reason why the foundations' selective influence on the social behavior of the scientists may be considerable.

Foreign foundations and emigration of Russian researchers for abroad

The evaluation of different foreign foundations' activity from the point of view of their influence on the brain drain process showed that there is a strong connection between the level of mobility and different mechanisms of grant awarding procedures. The level of impact of the foundations' programs is tied to such parameters as :

- 1) type of grant award (scholarship abroad or implementation of research project in Russia) ;
- 2) for scholarships abroad, type of research (basic or applied) and duration of grant ;
- 3) grant size, conditions and regulations of award.

Empirical data demonstrate that *scholarships and fellowships abroad* are still in many cases the first stage to actual emigration. In opposite, *grant awards for conducting research in Russia* keep researchers at their home institutions. A good example here is International Science and Technology Center (ISTC). It is one of the most successful initiatives aimed to help the conversion of weapons scientists and engineers. ISTC projects are funded by the United States, the European Union and Japan, as well as Finland and Sweden, which joined the ISTC before acceding to the European Union. Since March 1994 ISTC made awards on \$82 million for civilian projects to promote a reorientation of the defense research. Today ISTC provides its support to 11500 researchers that is about 17 % of all specialists who have access to special secrets.

Its activity helped to prevent emigration what is especially important for defense-related scientists. All researchers continue to work under projects, and they have not to look for another sources of support : first, grant size is large, and second, according to ISTC regulations no less than 50 % of a grant must go to the salary. That is quite opposite to the situation in Russian science foundations - RFBR and RSFH. The salary must not be more than 50 % of a grant and grant award itself is not very large. Then, the duration of ISTC projects is three years. It permits to do qualified research without seeking for additional financing every year. The similar rules prevailed at the International Science Foundation (more popularly known as Soros foundation by the name of its sponsor). The researchers were free in determining how to spend their grant award. And the duration of the grant was of 2 years. Three years grant duration is also a practice at USA National Science Foundation (NSF) International Projects Division. They also permit to apply for grant extension. *Grant size and duration are very actual for Russian researchers because in current economic situation grant in general serves as a replacement of actual salary.*

Some foundations have special - direct and indirect - regulations aimed to prevent brain drain from Russian science. An example of *indirect regulation* is given by NSF. International grants for Russian scholars are based on the model "receiving side-pays costs", which means that a Russian scholar receives only living expenses during his visit abroad. It stimulates most of researchers to spend short period of time abroad, because in that case it is not a way to earn on leaving. The practice shows that in average Russian researchers spend no more than one year abroad during a three-year grant period.

Direct regulations are constituted at the Civilian R & D Foundation (CRDF) - a new USA foundation established to support cooperative grants program in civilian environment in Russia. According to its rules, a Russian researcher is permitted to stay no more than three months in the U.S. during a two-years grant period.

In fact, the same direct regulations exist in Russian science foundations - Russian Foundation for Basic Research and in the Russian Science Foundation for Humanities. According to these Foundations rules, if the principal investigator works abroad more than 3 months, the funding of the project can be terminated.

Scholarships and fellowships as well as awards to conduct joint projects abroad form another type of support. In that case, the influence on research mobility factors depend on the type of supporting activity (basic or applied research) and the duration of the grant size. It may be illustrated by the results of the activity of two U.S. programs - CAST (Cooperation in Applied S & T) and COBASE (Cooperation in Basic Science & Engineering). A survey among American recipients of these programs revealed that there was some number of Russian researchers who emigrated abroad after completion of these programs grants. The rate of emigrated researcher who participated in CAST program was much higher than from COBASE : 35 % against 14 % respectively. The duration of CAST program is one year, while COBASE - up to six months. During one year a researcher has more possibilities to find a new position. Then, the CAST program, providing support for applied research helps to find contacts in the U.S. industry. The same survey showed that 85 % of Russian researchers had developed contacts with U.S. firms. In a context of emigration problem it means that probably it became also their potential new place of work. Chances to receive position in the industrial sector are in average higher than in academic sector. The distinctive feature of CAST program was also the age of Russian participants : about 50 % of them were younger than 40 years old. And that is a bad sign for Russian science.

An interesting detail in the COBASE program was the specialization of emigrated researchers : 2/3 of them were chemists. And for half of them ethnical motivation predominated. That is not an accidental result. According to data from the Siberian Branch of RAS ⁶ there was an abnormal growth in the number of emigrated chemists especially those who worked in the technology applied spheres. The explanation of this fact may be found in the character of the chemical community and in the peculiarities of the jobs in this sphere. It means that the chemical scientific community, specially in the USA, was comparatively closed for newcomers, in comparison with physical or biological communities. They started to accept foreign researchers later than in another disciplines. Then, in chemistry there is a much bigger variety of simple applied tasks than in physics or biology, and a lot of works with dangerous materials (for example with radioactive materials). These positions are not very attractive for permanent residents of the country. In the situation when from one hand the foreign market is tough, and from the other, the conditions in Russia are not improving, Russian researchers began to accept jobs which demand low qualification or are dangerous for health.

A separate position occupy the foundations and programs awarding grants for studying abroad. For example, Edmund S. Muskey fellowship program provide scholarships for Master's-level study in the United States universities. In Russia this program is provided through "funder-driven" organizations -IREX, ACTR, "Open Society" Institute. The rate of returned back participants in this program is 95 % -97 %. The rest 3 % -5 % are staying in the U. S. to continue their education in Ph.D. programs. One of the measures which prevent from an effective brain drain in this program is the strict order to return after completion of the grant or to return the cost of education.

Long term joint projects implemented abroad are still considered as a hidden possibility to escape. They permit to work with foreign colleagues, and to be tightly involved in scientific life abroad. All these helps to find a new occupation. Unfortunately, that is still indication of a bad situation in Russian science. In current economic environment the best types of support from the foreign foundations are short-term fellowships abroad and support of research activity in

Russia. "Shuttle" visits are preferred in both directions. The popular concern that it is impossible in Russia to conduct research because of out-of-date equipment not always keeps true. CAST survey revealed, for example, that in several cases Russian researchers brought abroad with them the unique equipment for collaborative research in the U.S.

It is important to note that not only above mentioned types of support are preventive for brain drain. The foundations themselves, as forms of support, influence more positively (i.e. resist) than negatively the brain drain from Russian science. A sociological survey conducted among Russian scholars in 1995, showed that, in average, foreign foundations and programs provide a positive influence on the sustenance of the scientific sector in Russia. Conducted among researchers from different parts of Russia Federation (Emilianov, E, Iaroshevskii, M., Urevich, A., 1995), it revealed that the majority of them (55.5 %) do not see any connection between the grant from foreign foundation and the wish to emigrate (see Table 6). But at the same time only 10 % of all respondents think that grants increase the wish to emigrate. This survey showed that foundations do not influence much on *internal brain drain to another sectors of the economy*. More than a half of all respondents supposed that there is no relation between these two factors, but only 25 % thought that grant reduced the wish to leave science. In general the most common position was that grants do not prevent leaving science for those researchers who already strongly made this decision.

Another sample survey, provided at the end of 1995 among researchers from all sectors and regions of Russia, helped to reveal to what extent foundations and foreign support as a whole open new possibilities for professional growth at home country and, accordingly, diminish brain drain ⁷. Foundation help to improve professional skills abroad only for 33 percent of researchers in natural sciences, for young researchers this percentage is a little higher -30 percent. The possibility to work abroad temporarily is open for 33 percent of researchers in natural sciences. This data shows that foreign support for science is sufficient only for one third of researchers, mostly from big science centers, Moscow and S.-Petersburg, who have scientific degrees and work in fields which have perspectives abroad. Young scientists are in a beneficial position, because a number of foundations develop special programs to support young researchers or to help them to obtain a degree. That is important from the point of view of modern tendencies in the brain drain process.

Foundations also helped to reveal *comparatively new tendency* : the reestablishing of network between Russian researchers and those who emigrated abroad. This tendency is tracked by a number of foundations which provide support for joint projects : NSF, CRDF, CAST, COBASE. For example, for CAST program in 1996 11 percent of all applications were sub-

Table 6. Grant from foreign foundations and brain drain process :
the assessments given by different categories of Russian researchers
(in percent to the total number of respondents in each category)

	Researchers who have grants	Researchers who do not have grants	Average assessment for sample
- reduce to emigrate	16.2	13.5	15.0
- do not influence	56.8	53.9	55.8
- increases the wish to emigrate	9.0	12.4	10.5
<i>The influence of grants on the process of internal brain drain</i>			
- do not influence	55.0	52.8	54.0
- increase the wish to leave science	4.5	3.4	4.0
- reduce the wish to leave science	27.0	23.6	25.5

mitted by emigrated Russian researchers. The growing number of green-card keepers and even those Russian researchers who are temporarily affiliated with foreign institutions and are eligible to apply as non-Russian researchers try to create joint projects with colleagues in Russia. For example, in 1996 in CAST program 11 percent of all applications were submitted by emigrated Russian researchers. For COBASE the share of grant awards to the former Russian researchers is comparatively stable : 13 % in 1993, 18 % in 1995, 14 % in 1996. The latest example is given by the CRDF competition : 7 % of awards are given to the collaboration projects between Russian researchers and former emigrants. The greatest number of such awards is in physics (50 %) followed by biology (25 %) and mathematics (17 %). And that is a good indication. At the same time that tendency just reflects the existing mentality in Russian scientific network all over the world. For example, according to a sociological survey done among immigrant Russian scientists in Israel (Toren, N. 1996), over one half (52.2 %) percent of them consider that the most influential and authoritative for them are Russian researchers followed by USA scholars (18 %), Western Europe (12 %) and Eastern Europe (3 %) scholars.

Now there is a process of development of strong communities of Russian researchers who live and work abroad. The analysis of INTERNET networks shows that if in 1991 the list users of special "Russian pages" in INTERNET included in average up to 30 addresses, today there are more than 1200 addresses. People try to stay in touch, to inform each other about possible grants and joint programs with Russian researchers, to help newcomers with better orientations in their new environment.

Another situation is with those students and young researchers who leave abroad to obtain a Ph.D. degree. They usually do not have scientific background and research experience in Russian science and as a result they are more strongly incorporated in foreign scientific communities, following its traditions, mentality and culture. For them there will be weaker motivation for collaboration with Russian researchers, and that is the source of future problems.

At the same time this tendency is restrained by the internal situation on Western markets of S & T workforce. Now it is more and more true for the largest one, the U.S., that in the S & T sphere, the possibilities for foreign researchers to find occupation are becoming worse.

New context of R&D sphere in USA and employment possibilities for immigrants researchers

Main changes are connected with financial situation in the USA R & D sector. According to forecast estimations, to 2002 the federal expenditures on R & D will be reduced on 25 % in comparison with 1996. At the same time during the last three years there has been some reduction of R & D in the industry sector. Besides, the Senate is discussing a bill to reform immigration law. An issue is a complex tapestry of visa categories and requirements. Today if the prospective employee from abroad falls into an "Outstanding Professors and Researchers" category, the door is open immediately. For the researchers from former Soviet Union there was the special Soviet Science Emigration Act (1993) which gave preferential emigration status to those Russian scientists who would like to emigrate. Under this act 740 Russian researchers have emigrated to the U.S. The current initiative in Congress is to eliminate the fast-track route to the green card for "outstanding researchers". Now it must be proved that a prospective employee cannot be replaced by an American one, and that the immigrant will be paid the "prevailing wage", a requirement designed to ensure that American worker will not be displaced for foreigners willing to take lower pay.

In current conditions the new U.S. policy in connection with the cooperation issues towards Russian science is selective support of different regions and directions of research *on the territory of Russia* in combination with issues to reduce the number of those researchers who work in the USA. For that purpose some regulations concerning time presence abroad are introduced in a number of foundations.

The comparatively big share of support will continue to be provided to defense-related research so as to stimulate conversional research. The example is ISTC activity with permanently growing number of financing projects. CRDF program is also based on a half on “defense money” from Department of Defense’s “Nunn-Lugar” program to promote demilitarization in the former Soviet Union.

Concerning the possibility to emigrate now the U.S. policy get closer to West European model, according to which only *scientific elite* will be invited and accepted.

European Community policy towards “brain drain” from Russian science

In opposite to a not very evident U.S. policy, the European Community has taken a number of initiatives to promote the mobility of Russian researchers with a view to develop their scientific potential while at the same time preventing a brain drain. The mobility is a key word in European policy towards brain drain process. It is proved that working with people whose way of thinking is different (and that is the case for scientific culture in another country) is a stimulus for research. Thanks to mobility, scientists can diminish the distance and linguistic barriers between them and establish the best “selling points” for their most important work (Martin-Rovet, D. 1996). Mobility is thus a mean to progress in a career. That is an interesting phenomenon that American hardly put into practice. Their acceptance of foreign scientific labor remains passive.

There is a number of EC initiatives aimed to support science in Russia and to prevent outflow of researchers. These are INTAS, COPERNICUS, TEMPUS and TACIS programs. INTAS and COPERNICUS point projects just started in full in Russia (first call for proposals was at the beginning of 1996). The demand of these programs is the presence of at least two partners from European Community. That is aimed to develop networks and communications among Russian and European scholars.

Another specificity of the European type of initiative is the twinning of laboratories. This is particularly common in France (Tanguy A. de and Wenden, C. de), which has been doing it for 6 years. For example, a dozen researchers from Landau Institute in Moscow specialising in math and physics work in Paris under twinning arrangements with the Ecole Normale Supérieure. And that is also an example of the way how the scientific elite from Russian science is selected and accepted.

It must be also mentioned that European Community “suffers” from brain drain from Russian science much less than the United States. This problem is not so actual there. For example, the number of those from Russia who worked at CNRS (Centre National de la Recherche Scientifique) in 1993-1995 was respectively 110, 122 and 81 with average duration of stay 4.2 months, 4.1 months and 4.5 months. These “shuttle” visits may have also promoted mobility, but not brain drain.

At the same time there is some new tendency in emigration routes of Russian researchers. Having emigrated initially to the U.S. they begin to search for possibility to find a job in scientific sector in Europe. The explanation of this phenomenon may be the following. Russian and European science have much more in common in terms of scientific approaches, culture and scientific behavior. So for Russian researchers it is easier to adapt in European environment.

The other more evident factor is that in Europe Russian researchers in average have more chances to receive a salary equal to the level of European researchers, without restrictions. Till present time it was not the case for Russian researchers in the USA, specially in industrial R & D sector.

Financial transitions at the institute level from brain drain prospective

Two statistical sample surveys complemented by interview with the administrative and scientific staff conducted by the author in 1995 among 26 R & D physical and chemical institutes located in Moscow, S.-Petersburg, Novosibirsk and Nizhny Novgorod, helped to understand some correlations between brain drain process and new financial and organizational elements in Russian science as well as to reveal some new tendencies of the brain drain.

The distribution of the researchers by the type of activity abroad reveals that a large majority of scientific personnel goes abroad for short-term training : in average 57 % of those who worked abroad in 1995 were there during period up to three months. 19 % visited foreign countries so as to conduct joint research projects, about 14 % left for post-graduate study, and 3 % - to obtain Ph.D. The geography of visits abroad depends on the purpose of visit. For short-term business-trips scientists prefer Western Europe (Germany, Italy, France, UK) while they chose USA for post-graduate study and to obtain Ph.D. Joint research projects are actively conducted in Germany, France, USA and UK ⁸.

The most interesting were qualitative results of the survey. It helped to understand some latest tendencies in the brain drain process.

1. Among researchers who leave for abroad on the basis of contracts the number and share of those who are involved in experimental research is permanently increasing. In 1995 the share of experimenters varied from 65 % to 100 % of those who left for abroad on the basis of long-term contracts. Leaving abroad experimental researchers are in the most productive age - around 35-40 years old ⁹. The loss of these categories of personnel leads to the break in the training of the next generation of experimental researchers. In three-four years it may result in irreversible fall of qualification in methodes and technics of experimental work. That is first. Second, if theoretical-researchers having returned back may enrich science at home, experimental researchers cannot apply their new knowledge in Russia, because they return to out-of-date equipments. According to the opinion of the scientific administration from the Institute of Solid Physics RAS, today modern experiments can be provided only abroad.

2. Another new tendency : those who left abroad try not only to maintain connections with their home institution ¹⁰, but also help to get in touch with foreign colleagues. Some prominent researchers organized joint laboratories abroad. In fact that structures are foreign branches of Russian R & D Institutes. This tendency can be considered as positive from the point of view of world science, because the best researchers continue to contribute to the development of scientific knowledge.

3. For young researchers the situation changed as well. If 2-3 years ago young researchers left science for another sectors of the economy inside the country, now they try to leave abroad. Most institutions have point out that the main reasons for young researchers to leave abroad are not only the level of salary, material and informational conditions of research work, but also such a pure economic reason as inability to receive dwelling. Possible ways out from this situation, work abroad on the basis of 2-3 years contracts, after which it could be possible to improve living conditions ; or leaving science for business for the same period of time. Each possibility is not a good decision : in the first case it usually leads to brain drain, in the second, to loss of scientific qualification and to inability to continue career in science.

Today, it becomes common place that the most talented young scholars try to continue their education abroad. For example, Institute of Spectroscopy RAS is a basic institute for the chair of quantum mechanics of the Moscow Engineering and Physical Institute. The chiefs of the institute indicated that during the last three years all graduating students from this chair have left abroad. So young researchers not only leave science, the worst is - they do not come to work in science. As a result the share of young researchers at these institutes is permanently decreasing. For instance, at the Institute of General Physics RAS among 1025 researchers only 24 are of age under 30 ; at the Institute of Spectroscopy RAS among 11 researchers who left abroad all are under the age of 35.

4. Both researchers and administrative staff consider grants from Russian and foreign foundations as a factor which prevents the outflow of specialists especially in its "hidden" form, when researchers have part-time job outside of the science sector. At the same time grants is a form of individual support. As a result some researchers and research team become more successful, some less. The financial position of different laboratories inside one institute begins to differ as well. In some institutions it leads to desorganization of an institute as a whole organism. Sometimes institutes continue to exist as a formal structures while each laboratory in fact is a small independent institution. In such situation grants influence much on the subject orientation of each laboratory. It becomes difficult for the institute to provide the common science policy

Such measure as grant support can not compensate the lack of federal support, from a financial and from a general point of view. Usually there are more chances to receive grant support for those directions of research which have good background and the results of which are easy to forecast. At the same time today, according to assessments of the chiefs of some institutes, grants cover about 10% -20% of expenditures which are necessary for implementation of a given research project ¹¹. As a result, the effectiveness of grant system as a measure for preventing brain drain is less than it could be.

Some economic conditions in fact favour the brain drain process. That is taxation and custom policy of the government. According to rules currently in force import duty for scientific equipment is very high. So institutes cannot afford to import equipment temporarily so that to conduct research in Russia As a result, institutes have to send researchers to work for some period of time abroad. Especially dramatical situation is in the institutions with predominant share of experimental works.

6. In modern economic environment in Russia the predominant number of the institutes consider work abroad during short periods of time as the most acceptable form of survival for researchers, on the one hand, and as the means of preserving the national scientific potential, on the other hand. According to the results of the survey, the optimal duration for a work abroad is 3-4 months. At some institutes (for example, at the Institute of Hydrodynamics Siberian branch of RAS) according to internal regulations the chiefs of laboratories are prohibited to work abroad more than 3 months. Practice showed that if the chief of laboratory is abroad more than 9 months the level of governing is dramatical decreasing. Finally it influences on the quality of research work.

7. Another interesting example is given by the Institute of Applied Physics of RAS in Nizhny Novgorod. On the basis of this Institute in 1994 a new organizational structure, the International Center-Foundation for Advanced Research was created. The novelty of this organizational form is in *attracting foreign researchers and lecturers to Russia on the basis of grants*. Sponsors of this Center-Foundation are ISF (George Soros) and local administration. They financed in equal portions (\$45.000) the first year, 1995, of the Center's activity. Financial support may be received on the basis of competition for conducting joint projects in the fields of mathematics, physics, chemistry, biology and economics. The joint research team *must* include young researchers and/or graduate students. The scale of activity of this Center is local, oriented on the needs and the demands of Nizhny Novgorod region. But it is extremely important, as for the development of regional science, as for the preventing brain drain process and specially the outflow of young researchers. During the first year grants were awarded in physics, chemistry and biology (medicine). In every project, from the Russian side there were undergraduate and/or graduate students. The Center influenced the situation at the institute : the mobility became positive, and there was no increase of the share of those who left abroad on the basis of long-term contracts.

Statistical data collected during these sample surveys showed that some organizational and financial forms influence positively the reduction of the brain drain. Such centers of international cooperation and financial support in the form of grants in the territory of the Russian Federation. In most cases such structures appear spontaneously.

At the same time the status of Federal Research Center does not influence much on the mobility of scientific personnel. The situation in each Center depends mostly on internal conditions at each institute, its specialization, directions of research, etc.

Long-term contracts still remain the first step to the emigration of researchers as well as catalyst of "informational" emigration.

In conclusion it may be said that the problem of brain drain from Russian science remains very actual and should not be left to develop "naturally", i.e. without any regulations at government level. All federal measures which can influence the outflow process are uncoordinated at present time. The way out is not only in the increase of the level of financing of science but also in stimulation of the variety of the sources of support for science and in the transformation of the system of indirect regulations in the economy.

The brain drain situation from Russia is unique. Russia had a large and strong science sector and now the level of research continues to be high and the level of the economy is inadequate. Real "brains" will be demanded by the economy in a very long perspective when positive changes happen in all economic environment in Russia.

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¹ IMO, 1990

² Social Dynamics of Modern Science. Nauka, 1995, p. 54.

³ INS, 1993 Statistical yearbook of the Immigration and naturalization Service

⁴ *Vestnik RGNF*, N2, 1996, p. 74.

⁵ *Liternatunaya gazeta*, no 33, 14.08.1996, p. 13

⁶ *Science in Siberia*, no 12, 1996, p.9.

⁷ *Informatsionnyi biulliten monitoringa VTSIOM*, N1, January-February 1996, p. 26-27.

⁸ All countries are listed in descending order by the number of researchers who visited a given country in 1995.

⁹ In general there is no "average age" of those who leave for abroad. In most number of institutions which participated in the surveys the most mobile are researchers at the age 31-40 and 42-50 years old. It is not a good indicator : it shows that now Russian science is losing "the middle link" in the structure of scientific personnel and in this way there is forming a gap between youngest and oldest.

¹⁰ Almost the institutions participated in the surveys indicated that 100 % of those who leave for abroad on the basis of contracts stay in touch with their home institute.

¹¹ That is an assessment of the institutes which have grants from ISF, INTAS, ISTR, Russian Foundation for Basic Research.