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Science and technology in restructuring of Russian economy

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Abstract

This paper, written in 1999, is concerned with the adjustments in Russian society at the end of the 20s century to growing importance of knowledge for economic performance, for industrial modernisation, and for international competitiveness. Russia was hit at this phase of restructuring by an innovation failure, by loss of specialists and entrepreneurs through job shifts out of scientific or technology activity and emigration. It was important for policy making to judge the market introduction in all spheres of economy - as creator or distracter of S&T, of skills and of development potential. First, I give details on the specificity of the Russian scientific and innovation systems. Second, some indicators for evaluation of demand side and of the offer of Science and Technology (S&T) in Russian societal and politic context are estimated for clarifying the potential efficiency, from social point of view, of market mechanisms into innovation sphere.

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Science and technology in restructuring of Russian economy

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1. Introduction

It seems that modern Russia is hit by an innovation failure. Why? How to judge the market introduction in all spheres of economy - as creator or distracter of S&T, of skills and of development potential?

Recently the interaction between science, technology, industrial and commercial activity – innovation processes - became the purpose of analysis. Notion of innovation is different than S&T and has its proper rules and determinants. Innovation is an affair of entrepreneurs who use the researchers' work, adapting market mechanism and public structures. The reforming of institutions, in question with innovation in Russia, is at the analogous trajectory as in the main European and North American countries and in some sense the transformations are more rapid and radical than in any of them. The urban consumer's demand shifted in this country definitely to information and communication technology. But why Russia has taken a turn economically for the worse after fifteen years of transformation effort? What is the basis of economic and political actions in Russia? How to enhance public awareness of the benefits of innovation? What government should be doing for enforcement of national knowledge economy?

1.1. Economic sphere and dominant social forces

The economic slow-down of Russia until the 1998 was determined by the loss of markets and by substitution of Russian goods and services on national market area. To master this unfavourable economic trend the development of inventions of USSR period and the utilisation of new and high technologies seems to be vital for assuring the production of goods and services corresponding to Russian and world demand.

How to order the priorities among social, economic and S&T needs? And who, what forces might assure the respect of the ordering? The social and politic groups, on which the government policy may to lean, are not sufficiently structured or constituted. The states' own economic foundation is fragile, as the informal sector is too large. The survey of 500 firms, realised in 1997 (Tambovtsev (1998)), shows that the existence of informal sector in Russia is related to the intentional choice of industrial firms. The 28% of respondents declare that they choose themselves to effectuate shadow transactions, 65% affirm to be indebted to transact by this way and 7% do it from habit. In Russia the persistence and enlargement of shadow economy may be explained (Dolgopiatova (1998)) by some backgrounds of long and short terms. Traditionally, citizens defy the state. The behaviour out the frontier of lawful is not morally condemned by societal consideration or by authorised social groups. A special push for informal sector development was given by the deposition of the communist party and the soviet state, which caused the slacking of legal protection of state ownership and of contracts between state and enterprises. New legislation was long to be implemented and the carrying out of laws, of decrees and of instructions was lost. But the more important factor for informal economy rise is probably the state inclination to eroding the small private property. The small business is not sufficiently protected and certainly not supported in fact. The disorders of economic nature that followed the price liberalisation in 1992 encouraged the shadow activity at personal and at firm levels.

On the one hand, informal economy allows the enlargement of competitiveness of firms involved in shadow activity, the rise of certain strata of population revenue and the decrease of real unemployment. Conceptually these factors may favourably change the S&T asset. In practice the small share of firms in 1998 seeks to develop (less than 25%) comparatively to the share of firms that try to stabilise (nearly 40%) or survive (almost 35%). That is why the technological development appears at the fifth place among their priorities, after the maximisation of sells, the maximisation of profits, the sustaining of the level of employees revenues and the increase of market share. The investment utilisation of hidden resources by firms is complicated in comparison with their consumption use or personal appropriation. Indeed, the purchase of new equipment depends on the liquidity of assets and this fact constrains the scale of investment and limits the firms' expansion. The shadow funds prevent the possibility of external investments into the firm and bank credit acquisition, as in both cases the interlocutors possess a false underestimated information in regard to the firm performance. New businessmen didn't work up a good habit of sciences' patronage. They are convinced that the ideas of Russian researchers are unusable and that the technological realisations of developed countries are cheaper and effortlessly adaptable. Part of informal activity, hidden from legal and statistical observation, is a criminal one. It is developing in the forbidden zones. It is difficult to conceive that in these zones some S&T promotion might exist.

On the other hand, the state budget has dropped because of firms' tax shirking and consequently the state monetary support of S&T is usually reduced as well as other public expenditures.

1.2. Research sector

By thirties the Soviet Union had given birth to about one thousands research institutes, employing tens of thousands of scientists in a co-ordinated programme designed to meet the needs of the entire society. The Soviet Union presented its strategy for the development of R&D, based on centralised planning in 1931 at the international congress of the history of science and technology in London. This form of management was very audacious. The subject matter for scientific work in institutes was given beforehand. The state organised the complete cycle: funded the researches and was the consumer, educated the specialists and guaranteed their employment. In other countries the knowledge production was often the state prerogative, but innovation was always a sphere of private sector.

After the WW II the state anticipated the magnitude of technology requirements. Within a very short time a large number of new research institutes were created at the Academy of sciences and at defence related ministries in consideration of the Cold War economy and international isolation of the country. The military and technological safety was in need of basic and applied sciences, as well as in their transferring into industry. The institutes revamped their research programs to meet military demand.

The first state administrative agency of science was precisely the State Committee for Introduction of Advanced Technology into National Economy of USSR Counsel of Ministers, created in 1948. Some large technological programs initiated by this committee were done such as: the switching of railway transport into electric and heat-engine locomotion and large diffusion of welding, which revolutionised the national shipbuilding. This Committee was transformed into the State Science and Technology Committee of the USSR Counsel of Ministers in 1957. The achievements performed from 1957 to 1960 concerned nuclear physics and thermonuclear energetic, the large scale Antarctic exploration and opening by the USSR of the cosmic exploration epoch. At the middle of the sixties the scientists replaced the engineers at the head of the Committee and the links with the Academy of science were enforced. Both of them participated in the elaboration of the first “Complex program of scientific and technological progress of the USSR for 20 years”. A large interest was dedicated to the perfection of programming and objective method of planning, as well as to long run energetic program, in 1980’s. Both programs were stopped by “perestroika”, signalling the end of centrally organised S&T administration. The Ministry of Science and of Technological Policy of Russian Federation was instituted in 1991.

This brief description of administrative transformations shows that the principal effort of the state since WW II was directed at applied sciences and at technology transferring.

The USSR system had many advantages of realisation of big strategic achievements that were beyond the powers even of very large Western firms. Guaranteed funding allowed to develop carefully and quietly for many years and decades the same research area. It was conductive to the development of Russian specificity (Efremov (1997), Demikhov (1997)); so-called schools' phenomenon, when the continuity of scientific tasks remains; the knowledge, the approach and the know-how are transmitted personally. In the Soviet period the scientific school was institutionalised by the research hierarchy group structure.

Soviet scientists enjoyed life, as each year their institutes were funded. The funds usually were restrained, but guaranteed and uncontrollable. The results were not secured, but sometimes they were outstanding. Ideally, only public research allows developing the knowledge independent on economic interest and ideologies. It is important to distinguish among industrial stakes, societal ones and stakes of knowledge. Precariousness of contractual research as well as the reappraisal of economic repercussions by authorities led the scientists to refuse to make an attempt in risky domains.

The defaults of centrally planning were accumulated. The research sector suffered mainly because of secrecy and isolation, which caused the general inferiority of scientific level. The ideology was powerful even in natural sciences, and public character of S&T could not protect against its negative effect. The national economy had the hard task to maintain the military industry and the role of the research sector here was important.

Professor Andrei Sakhorov considered in 1986 that it would have been easier and cheaper for the Soviet Union to follow what was already being done in the West, rather than do everything from scratch itself. But even if the sufficient technological information exists in the world, how can any nation assimilate and apply it without its own science? For Alfimov (1997) the way of development by acquisition of foreign licences is too expensive for Russia. This way is also inefficient, as Russia possesses yet a developed system of industrial knowledge and qualified scientists.

Accordingly to V. Letokhovs' point of view (Letokhov (1999)) many of institutes had not scientific traditions, and no possibility of evaluating the quality of their research because of total secrecy. Sometimes the secrecy was artificial in order to hide from the scientific society how poor the research results were. The 1987 "program of scientific and technology progress in USSR for 1991-2010" acknowledged that "scientific potential of the country exhausted its capabilities and in its actual aspect will not assure the crucial necessities of national economy even with substantial increase of investments into the science" (cited from Shardiko (1998)).

However, many observers are astonished that the large majority of Russian scientists and teachers continue in our days their activity over and above the drastic cut of their wages and of all privileges. Certainly the professional mutation is not an easy personal decision, but it is simple truth that these sections of the population conserve certain creative exertion. The document "Conception of Russian science reformation" elaborated in 1997 by the Guild of science managers (see journal "Socialisticheskaia Rossia", December 3-9) signifies the striking fact that Russian science has not collapsed till now. The authors explain it by "selfless devotion of scientists of elderly and intermediary generations".

In 1992 Russian State withdraws the function of science management and effectuates the radical step, choosing the sharpest variant of reforms. The funding of the applied sector in science was removed, and the majority of sector institutes disappeared or was transformed into joint-stock companies.

1.3. Methodological aspect of the paper

Analytical scope of the paper is restricted to the description of government and firms action in the field of science, technology and innovation policy, taking account of the current economic and political constrains. It takes a selective look at the framework of innovation system, examining institutional arrangements and efficiency in performing innovation activity, linking science and industry. Scientific specialisation is characterised by measuring the relative weight that selected scientific disciplines occupy in the Russian science system. Technological specialisation is evaluated as usually on the basis of patenting activity and of S&T intensity.

Lack of pertinent data on the past period and complexity of causal factors obliges us to referee, more then economist usually ventures, to opinion surveys and to scientists' or entrepreneurs' attitude surveys.

2. Demand for S&T

In historical perspective the demand for S&T is determined by the evolution of productive forces' distribution. When any form of the distribution of economic activities stabilises, each sector using human activity seeks to introduce new machines and replace the labour. Doing this effort the society calls for S&T. At the short run the demand for S&T shall not be reduced to requirements expressed by the population. But societal needs at some historical period reveal the demand for politics and obviously influence one aspect of them - the scientific priorities. For example, after WW II the shortage of nourishment directs the scientists' work. All disciplines followed a specific purpose - to increase the productivity of agriculture. Governments' support of agricultural research led to huge productivity increases in the relatively short, for the research and development, term. The biology and chemistry are faced now with different tasks – to repair the ecological inconveniences of this rapid growth and to improve the quality of goods and of human health. In the developed countries the biotechnology and medicine became leading domain of science in 1990s. The citizens not only express a demand for sciences, but also as patients, producers, or through their representatives they now make many decisions in scientific domains. For example, the group of French patients created an association for the treatment of muscular dystrophy that raised 80 million of dollars in charity. As the disease has a genetic origin the association has invested massively in molecular biology. Actually the total funding of basic research in this field by association is larger then one of French government.

Which forces incarnate the societal demand? It is the state, who finances massively the research. Hence, the state has all means to incite, to arbitrate, but also to curb the research arguing the principle of precaution. Citizens represented by their political parties and media reflect and seek to move the social demand into societal one. For example, they may support the proposal to increase research personnel at the periods of sharp unemployment. Finally, the role of scientist in a society is not only to simplify and to put an end to controversies, writes the French philosopher Bruno Latour (1998), but also to add new ingredients to the collective process of scientific policy making. In an industrial economy, knowledge is the departure for IPR contracts for transformation of machinery useful for manufacturing of new goods. In a knowledge-based economy the knowledge producers and different consumers interact directly, meanwhile the IPR protection becomes less important.

The beginning of disarmament coincided in Russia with political transformations. The military-industrial complex was reduced considerably. Old programs of research and whole branches, except fundamental sciences, were no more useful. Likewise the firms' demand for S&T is low and imprecise (see table 1.).

Table 1.

Appreciation, by directors of large research institutes of RAS in earlier 1990s, of the intensity of demand for research results (in %)

Demand expressed by	Intensity of demand				
	high	mean	low	Non-existent	Couldn't appreciate
State	16.7	40.0	26.7	13.3	3.3
Entrepreneurs	10.0	30.0	43.3	10.0	6.7
Foreign collaborators	46.7	40.0	10.0	0.0	3.3

Source: Institute of sociology, CISN, Institute of economy (1992)

The demand for science has both characters: social and individual. The social demand is of long-term type and needs probably the development of complex systems of knowledge. The new problems that must be resolved at this level are: sustainable ecology, creation of a post-nuclear energy civilisation, elaboration of a principally new element base for the computer, development of post neo-classical logic of information technology, but also terrorism, epidemics, or mass violence. The theories of such synthetic type could not provide profitability soon and that is why their elaboration should not be financed privately. The individuals' demand for R&D, for example the demand for new goods, may be satisfied in the short term. These aspects of the S&T mainly serve the productive side of economy and for this reason its social significance is badly perceived by politic power. The inspiring for health, education or mode of life needs permanent efforts for conciliating partially the population with political offers.

Knowledge creating: education, world-outlook and science, determines the civil society as well as the technological sphere. The two concepts of Russian science reforming (Guerasimov (1998)) developed in 1997, one by Science and Technology Ministry commission and other by Guild of Science Managers, differ on the weight they assign to the social aspect or to technology. The first text points out that new technologies really influence the Earth evolution, that the science became a powerful productive force and will determine in the next millennium the competitive capacities of countries on the world market. For those reasons the Russian science has to be managed in order to become the national resource for renewal and development. In the second conception the human aspects prevail over economic. The authors pay attention to the occurrence that the degree of civilisation in each country is determined by development of science, culture, education and health. As currently, culture, education and the health are imbued with the scientific ideas, the state and social priority must be concentrated on science development.

The survey realised on 9-10 January 1999 in Russia records: 70% of population are agreeing with the statement that "in future the technology will play more a important role in human life, than actually", against 17% having the opposite point of view (13% didn't express their opinion). There are equivalent shares of people supposing that "in future the people will learn (43%) to eliminate the detriment, that inflict the technology and civilisation to nature", and those convinced that "in future the destruction of the nature by technology and civilisation will strengthen" (42%). It is interesting to report also the view on the future values of the feeling and of the intellect. Only 21% of interviewed think that the intuition and feeling will be developing first of all, against 54% thinking that the people will be more rational and intellectual. The conviction is gained (65% against 19%)) that the labour will occupy more place and leisure less place then now in human life.

The societal demand regarding S&T is ambiguous. The media that consecrates a large place to scientific purposes amplifies the society restlessness. At the same time, the scientists are asked to secure all problems, to give rapid, precise solutions to the subjects where the knowledge is fragile. Such societal demand is clumsy, since the scientific community must not follow the rhythm of the media.

3. Specificity of the innovation system

Each national innovation system is specific. In this paragraph we single out some singularities of the Russian system and some elements that historically were introduced in the world practice by this country. By contrast, we omit many aspects of industrial innovation, even if we reveal later its weakness in terms of output. We stress the role of the state that was the first to do professional (full-time) the research activity. The USSR was a pioneer in creating knowledge based industrial cities. Other specificity is defense orientation of S&T. In that Russian system is similar to the US, UK or France innovation systems, and should be transformed following the analogous schema.

3.1. State S&T structures

In 1995 there were the following set of Federal Ministries and Committees charged with S&T development in Russia: Science and technical policy, Defense, Defense industry, Ministry of nuclear energy, Russian cosmic agency; Social Ministries: Health, Culture, Ecology, Social protection and others; Industrial Ministries: Transport, Construction, Energy, Machinery construction; High education. The State funded Academies are: Russian academy of science, created in 1724 by Peter the First, Art Academy (1757), Medical sciences (1944), Education (previously Academy of pedagogical sciences (1943)), and Academy of Agriculture (1929). Previously existed also Academy of Social sciences of the Central committee of the Communist party (1978). New institutions are:

- State Funds: Russian Foundation of Basic Research, Fund for Assistance to small innovative enterprises, Public Science Foundation, Fund for assistance to entrepreneurship and competition.
- Non budgetary funds: Russian Foundation of Technological Development, Funds for assistance for industries: energy, transport, conversion, electronic.
- Some investment foundations with state participation;
- Public organisations: Social Academies: engineering, technological, natural sciences and others (almost 50); Companies, Associations, Foundations, syndicates (some tens) with Ministries support.
- Regional Organisations: Municipal committees for science and techniques; Municipal foundations for entrepreneurship assistance.

The following table 3 and show the importance of government sector R&D employment in the Russian Federation. The number of researchers decreases slowly, but their importance in national total is increasing.

The 1992 - 1995 attests a dramatic fell of R&D expenditure and its short up in 1996-1997.

Table 2.

Gross domestic expenditure on R&D

	1992	1993	1994	1995	1996	1997
Million current PPP $	9 549.5	9 474.6	9 226.1	7 953.1	8 855.7	10 340.2
Annual growth rate	-56.9	-3.4	-4.7	-15.7	8.9	14.6
As % of GDP	0.74	0.77	0.84	0.77	0.88	0.94

Source: OECD (1999)

Table 3.

R&D personnel (full-time equivalent)

	1994	1995	1996	1997
Government research:				
- Total personnel	315 379	306 222	291 330	290 259
- Researchers	156 934	157 784	151 777	152 161
As a percentage of national total	25.2	25.9	27.0	28.6
Business enterprises				
- Total personnel	815 326	787 614	714 551	659 289
- Researchers	366 982	368 299	331 424	304 590
As a percentage of national total	59.0	60.3	59.0	57.2
Higher education:				
- Total personnel	133 170	116 404	106 344	102 627
- Researchers	97 738	84 030	78 245	75 237
As a percentage of national total	15.7	13.8	13.9	14.1

Source: OECD (1999)

3.2. Defense – oriented research

During and after World War II, new high-technology industries were driven by the states' push to strengthen national security. Defense programs dominated the S&T portfolio. The payoffs were substantial, with industry benefiting from defense-driven investments.

Referring to Earle and Komarov (1998) paper the number of enterprises in the Military and Industrial Complex (MIC) in the USSR in the late 1980s lie around 2 000, consisting of 1100 manufacturers and 920 research establishments. For Russia, more recent estimates are available: 1700 enterprises in 1993 (reported by Sanchez-Andres (1995)), 2 000 in 1994 (reported by Glukhikh (1994)), and 1 800 as of June 1995 (reported in Moscow News (1995)) supposedly subordinated to the State Committee for Defense Industry. Zhbanov (1992) reports that, as of 1991, 67 percent of Soviet military-industrial enterprises and 79 percent of research and development establishments were in Russia.

Today, though defense continues to be important in key areas of high technology research, the rate at which that innovation is actually moved into production often lags well behind that of civil industry in important sectors such as computers and microelectronics.

An increasingly inflexible defense acquisition process increased costs. Defense systems' development needs and benefits diverged from the world industrial main- stream, consisted in enterprises' reduction of costs.

Table 4.

Financial structure of R&D

Funding	1993	1995
State (civil)	37.5	45.0
State (military)	44.0	27.0
Foreign	12.5	14.0
Enterprises	6.0	14.0
Total	100	100

Source: OST Indicators 1998

The structural changes seem to indicate that Russian administration has put technology policy on the political agenda. Among the technology policy options one may note a shift from a 54 : 46 to 37.5 : 62.5 mix between state weapons and civilian R&D. The commentators are aware also of downsizing of the national weapons laboratory complex. Since 1991 to 1996 the payment for state ordered military sector production dropped more than 33 times. Still the conversion is not produced, as the civil production in military sector also decreased. The Russian authors insist on the political strongly negative role of foreign states in the evolution of Russian both defense and innovation systems.

3.3. Akademgorodok: applied military research or Knowledge based industrial city

The after the Second World War the history of some regions, as the Novosibirsk region, is inextricably intertwined with the needs of the military sector. The region was transformed into a hinterland of the military-industrial complex with a high concentration of defense-related production. The Siberian branch of Academy of Science was founded in 1957, and has consistently ranked among the Russian top recipients of S&T funding. Akademgorodok, an academic suburban town with more than 30 000 persons employed in institutes of the Academy of Science — elite part of the Russian scientific system. By comparison, 70 000 persons were employed in research sector of Moscow region and only 15 000 — in Leningrad. The scientific centre in the East of the country composed of specialised institutes has provided the industry with high level of scientific research and a possibility of multi-disciplinarity. It has been championed by Russian scientists as the "Prototypical City" of the future. The military industrial portion of the economy was centred on large state institutions and industries. This element of the regional economy has been a major source of technological innovation.

The applied sciences prevailed in the Novosibirsk region, by difference to Moscow and to St.Petersburg (Leningrad), where fundamental research prevailed. The applied sciences are present in the today Siberian branch of RAS albeit under intense pressures from defense downsizing.

The state seeks to “minimise the distance between the industry and science, to provide a transfer of scientific ideas and inventions toward industrial sphere” (Lavrentiev, first director of Siberian Branch of RAS, 1982). This issue was raised in numerous interviews. In the opinion of the majority of directors of Akademgorodok institutes, the “rapprochement of science and production sphere” represents “requirement to the science of XXI century”. In Koptug’s point of view (director of Siberian Branch of RAS from 1979 to 1997), the research centre has to conserve these principles of organisation of scientific institutes, since they “have successfully passed the test of surviving” after 1992.

The decree of the President of the Russian Federation “About the measures for development of science-cities as cities of science and high technologies” enforces the new industrial district option; encouraging the co-operative, innovative and governance conditions experimented in Akademgorodoks.

4. S&T Output

The number of publications characterises the efficiency of scientists in fundamental research, while the level of results obtained could be distinguished by which journals these results are published. This is a general rule, though some exceptions exist.

In total, nearly 70-80 thousands of scientists are deeply involved in scientific research in Russia. Considering the publication of scientists in the Russian and foreign issues with high impact-factor, we just can evaluate the number of authors of these publications, i.e. those scientists who today personify the research performance in a given country. In 1993 the scientific product of Russian researchers published in foreign and international issues, as well as in Russian journals with high impact-factor was approximately 23 thousand publications, while the number of authors per each of them was, in the average, 3.0-3.5.

Contrasting with previous cheerful picture, the evaluator of state research programs Veriovkin A. (1997) surprises us saying that in many final reports of granted projects the references to publications were entirely absent.

Table 5.

Position in the world and evolution of Russian scientific activity by domains

(Science Citation Index)

	USSR 1983	1990	1995
Fundamental biology		4.3	1.7
Medical research		2.7	0.7
Applied biology/ecology		2.6	1.9
Chemistry		15.3	6.9
Physics		13.5	7.3
Sciences of universe		7.5	4.0
Sciences for engineers		6.0	3.2
Mathematics		4.9	3.9
Total	8.4	7.2	3.3

Source: OST, Indicators 1998

The reduction of Russian scientific position since the state freed itself from S&T management is dramatic and too rapid in all domains. In mathematics it is relatively less perceivable (21 percent of decrease), but drastic in medical sciences (76 percent of decrease).

Looking at patenting activity we observe the same inauspicious trend.

Table 6.

Indicators of patent applications in Russian Federation

	1992	1993	1994	1995	1996
Dependency ratio (non resident/resident)	0.50	0.53	0.94	1.35	1.56
Autosufficiency ratio (resident/national)	0.67	0.65	0.51	0.43	0.39
Inventiveness coefficient (resident/10000 population)	2.70	1.90	1.40	1.20	1.20
Rate of diffusion (external patenting/resident)	-	0.16	0.31	0.42	0.82

Source: OECD (1999)

Inventiveness of the population and representation of resident patentees among the patentees granted in Russian Federation decrease persistently between 1992 and 1996. Both indicators (autosufficiency ratio and inventiveness coefficient) also testify to the slowdown of interests for national patenting, since the external patenting became a binding form of IPR protection only in some sectors of Russian economy (see table 7).

Increasing dependency ration signifies the growing interest of foreigners (especially from USA) to patent in Russia and protect their principally commercial advantages in this country.

Table 7.

Russia: Grants of European and of US patents by main groups in 1996 and in % of 1990

	European patents				US patents			
Groups	Percentages of the world total		Index of specialisation		Percentages of the world total		Index of specialisation	
	1996	1996 in % to 1990	1996	1996 in % to 1990	1996	1996 in % to 1990	1996	1996 in % to 1990
Electronic	0.16	107	0.62	125	0.08	103	0.54	133
Engineering	0.30	81	1.14	95	0.17	80	1.17	103
Chemical-pharmaceutical	0.19	101	0.71	118	0.13	107	0.93	139
Chemistry-Metallurgy	0.42	94	1.59	110	0.27	98	1.87	127
Mechanical-transports	0.30	73	1.12	86	0.12	54	0.85	71
Consumption, Construction	0.24	80	0.90	94	0.15	63	1.03	81
Total	0.27	85	1.00	100	0.15	77	1.00	100

Source: OST, Indicateurs 1998

Russia maintains the better position in the Chemistry-Metallurgy group in both European and US granted patents. The index of specialisation is increasing in groups of Electronics and of Chemical-pharmaceutical industry. However, the numbers of patent applications by Russia is too small in comparison with other industrialised countries of the Western world.

Using only these data (see table 8) one might jump to a hasty conclusion as for scientific or innovation backwardness. The weakness of Russia in terms of granted patents might have several causes that have nothing in common with scientific development and capability. For example, patents incite inventors to disclose their inventions when otherwise they would stay in secrecy. If we think over the share the defense industry occupies in Russian S&T, we couldn't be astonished at patenting deficiency.

The technology balance of payments registers the commercial transactions related to international technology and know-how transfers. This indicator may be used as an element of S&T output. It consists of the money paid or received for the use of patents, licences, know-how, trademarks, technical services and for industrial S&T carried out abroad.

Table 8.

Number of international applications received by International Bureau by country of origin and the corresponding percentage of the total

Country of origin	Number of applications		Percentage	
	1995	1996	1995	1996
Russian Federation	288	366	0.7	0.8
United States	16 588	20 828	42.6	44.0
Japan	2 700	3 861	6.9	8.2
France	1 808	2 307	4.6	4.9
Total	38 906	47 291	100	100

Source: WIPO 1998

Table 9.

Russian technology balance of payments

	1993	1994	1995	1996	1997
Receipts (millions rouble)	764	7 917	18 544	816 100	1 018 847
Payments (millions rouble)	3 6964	5 2498	20 113	225 818	64 480
Coverage ration	0.02	0.15	0.92	3.61	15.80

Source: OECD (1999)

After a relative equilibrium in 1995 of technology transfers in value the coverage rate, which shows to what extent Russia covers its own requirements of technological imports by its corresponding exports, increases significantly in 1996 and in 1997. To appreciate this breaking for Russian reconstruction process it would be important to know if it is or not the result of technology import reduction, which could take place as a consequence of the general industrial crisis in Russia.

Firms usually play a central role in translating advancement in knowledge into economic and social welfare. The indicators of introduction of innovations into industrial sphere may reveal the S&T development, but it must take into account the role of entrepreneurs. The failure of innovation process should not be attributed only to scientific inadequacy.

Indeed the following data show the significant decrease of product innovation in Russia in earlier 90-ies.

Table 10.

Share of novelty products in the total production

	1990	1991	1992	1993	1994
Over year	6.5	6.4	7.2	3.4	2.6
-completely new	3.0	3.0	3.0	1.6	0.9
Over last three years	23.6	21.4	19.3	11.3	5.2

Source: “ Rossia v tsifrakh ”, Goskomstat (1995), p.215

The quantity of new types of machinery, of equipment, of apparatus and of instrument decreases systematically. For example in 1996 it represented 84% of the 1995 level. Learning to handle new machinery using licensing declines as well as the share of exported new commodities (Svinarenko (1997) vice-minister of Russian Federation economy).

Some more recent data confirm, unfortunately, the persisting decline on innovation activity of firms.

Table 11.

Destination of sales and of innovation products sales, 1995-1997

	Sales			Sales of innovation production		
	1995	1996	1997	1995	1996	1997
Total	100	100	100	100	100	100
Abroad of RF	26.1	22.8	19.2	25.6	24.2	16.3
- to NIS	3.4	2.6	2.8	3.0	3.1	1.8
- other countries	22.7	20.2	16.4	22.6	21.1	14.5

Source: Roskomstat (1999)

We can see that RF itself uses about 80% of produced production and 85% of innovation production.

The objective of innovation activity of Russian firms - is a reduction of the cost related to expenditure of energy and of materials, in order to be competitive on the word markets. Only the small firms (under 49 persons) have the objectives of quality, ecology preservation, conditions of labour. The proper funds of the firms (80% of expenditure) are the main source of financing the innovation activity in 1997, the state participation is of 7% and FDI - 7.9%.

Modifications in investment priorities during this period may partly explain this decline. In 1990 the consumer goods and high-technology sectors determined the industrial strategy. At that period the more active in patenting were the sectors of consumption and of necessities of life, of technological processes and transport, and of chemistry-metallurgy. It is natural that in such conditions and in these sectors new products were introduced. In 1992 we find among the ten more attractive sectors oil processing, oil and chemistry, non-ferrous metallurgy, which are the export-oriented sectors with low product innovations.

Allocation of investments among firms is extremely unequal. More then 30% of firms do not carry out any investments for years. Still in the Russian economy in general fixed capital investments remain high, exceeding the respective indicators in Europe and USA. The share of fixed capital investment in GDP is more than 21% each year of 1990-th (Aukutsionok, Batyaeva, (1997)). Using the base of surveys of 200 Russian industrial enterprises Aukutsionek and Kapeliushnikov (1996) characterise the innovation activity of state-owned (principally large), and non-state (relatively small) enterprises. Product innovations prevail in small enterprises and process innovation in the large ones, as in other countries. The private enterprises seek more often to innovate in order to satisfy the demand.

5. Recent marked oriented innovation policy

The opinions were expressed (Shardiko (1997)) that there are no mechanisms to bring first the country out the crisis and then transform the science, but no more mechanisms to autonomous bringing out of science from crisis. The Russian generalised crisis will be overcome when giant scientific and technological innovations will be attendant, which will form the new long wave of economic development – synergetic Kondratiev wave. But what can do the current state policy and scientific community in the short run in order to modify the lamentable situation?

5.1. Incentive policy

Recently the Economic Ministry modified its policy by differentiating the investments according to the following considerations: for projects aimed at launching the production of completely new goods, state investment may cover up to 50 % of costs; for projects aimed at substituting imports, - up to 30 % of costs. Furthermore, the government must create conditions for the development of internal and external demand for higher-technology production: by helping to promote these products on foreign markets, through instruments of diplomacy, by offering state guarantees; by encouraging the start-up of joint ventures with foreign participation, which will promote the sale of Russian high-tech products on foreign markets.

Currently the government introduces some mechanisms to give incentive to investment into new projects:

- by guaranteeing to investors the ownership rights in new firms;

- by creating public and mixed investment and security funds;
- by developing investment insurance.

The possibility of tax exemptions is actually implemented in many Russian regions. In accordance with Russian law, the region authority may suggest tax reduction for the project, seeking to compensate political risk and unfavourable factors of environment. For example, in Novgorod region the exemption practice allowed to increase attractiveness of foreign capital. The region occupies the second position in Russia (after Moscow) according to the ratio foreign capital per capita. 160 firms with foreign capital participation were registered in 1996.

5.2. The legislative and regulatory basis of Intellectual Property Protection in Russia

Patent protection may be necessary to motivate investment of private resources in the development of commercial products based on scientific knowledge. A patent at an early stage is seen as providing the assurance that its economic rewards may be appropriated, thus causing a positive investment decision. The possession of patent enables the inventor to turn to capital market to get financing. This incentive to seek for capital might be important especially for SME facing large costs before it can introduce its invention on market.

The present state of legislation of IPR in Russia is a consequence of successive transformations (see Peaucelle (1998)). In the USSR the primary source of protection of inventions was a non-proprietary reward, known as the " Inventor's Certificate ". It entitled the inventor to payment for use of the invention, and the State received exclusive rights to use and authorise third persons to use the invention for 15 years. But patenting existed also, giving an exclusive right to inventor.

The basis for intellectual property, trademark and patents protection and regulation in Russian Federation are contained in the following federal laws and Civil Code:

The Constitution of the Russian Federation (Article 44)

Revised Criminal Code of the Russian Federation, January 1, 1997.

Civil Code of the Russian Federation (Articles 128 and 138), January 1, 1995.

The Law on Copyrights and Related Rights, July 9, 1993.

The Patent Law of the Russian Federation, September 23, 1992.

The Law on Trademarks, Service Marks and Appellations or Origin, September 23, 1992.

The Law on Competition and the Restriction of Monopolistic Activities in Commodity Markets, March 22, 1991.

The IPR regime in Russia also includes significant laws regulating specific industries and technologies, including "On the Customs Tariffs," "On the Legal Protection of Integrated Microcircuit Topology," "On the Legal Protection of Electronic Computation Devices and Databases," etc.

Eurasian Patent Convention went into effect on August 12, 1995. Under the Convention an inventor can obtain a single patent that provides legal protection in all nine member-states: the Russian Federation, Armenia, Azerbaijan, Belarus, Kazakhstan, Kyrgystan, Moldova, Tajikistan, and Turkmenistan.

The Russian Federation is a signatory to several international agreements that require compliance to international standards of IPR law and enforcement. These agreements include the following:

Paris Convention (Russian Federation, 1994, and USSR, 1965)

Universal Copyright Convention, 1994

Berne Convention, 1994

Geneva Convention (Russian Federation, 1994, and USSR, 1973)

The need for foreign investment and advanced technology explains the introduction of new patent regime, since the Western investors waited for an adequate protection of IPR. Certainly, the infringements in patent protection change foreign firms' location and direct investment decisions. The membership of international property organisations incites also the modernisation of national legislation.

The Russian law recognised patents as the only form of protection of inventions, protected product-by-process claims, created the Patent Office, and established a Patent Court. The law rectified the protection of an inventor's rights; at the same time it also contained several provision to protect the State's interest in ensuring adequate access to beneficial inventions. Additionally the "State Fund of Inventions" was created to which patent holders could unilaterally and voluntarily transfer their rights to an invention.

Today's prevailing wisdom is that strong patent rights are conducive to economic progress. But Mazzoleni and Nelson (1998) argue that the present movement towards stronger IPR protection may hinder rather than stimulate technological and economic progress. To rise patent protection levels in weakly protecting countries, it is salient to foster a significant research base in those countries. Since R&D activity influences patent protection after a country's research sector reaches a critical size.

Patent infringement cases are scientifically and legally difficult, they are expensive and time-consuming. Before choosing to pursue any form of alternative dispute resolution mechanism, the costs and delays inherent in court litigation must be weighed. Because of the huge sums which may be earned in a successful infringement suit, attempting an attack becomes attractive enough to raise venture capital to pay legal fees of the attacking party, even if the chances of success are objectively slim. And in the US at least, lawyers working on a purely speculative basis on potentially lucrative lawsuits are far from uncommon. It is known also that the lawsuits expenditure often exceeds the R&D funds of the firm.

5.3. Innovations in S&T management

Pending the revival of S&T the majority of recommendations is trivial: cutting, reduction and selection. The relatively low quality of scientific outlays in Russia and financial difficulties incite some authors to recommend a drastic reduction of the persons employed in academic institutions in order to increase the wages to remaining researchers. For example, the state has a lot of problems to support the wage level of research sector, which for many years is placed at the 8-9 position among all other sectors. Hence the average wage of researchers, representing 95.2% of Russian average, is larger than that in agriculture, forestry, trade, public catering, industrial services, health, education and culture. In 1995 the living wage represented 75% of the average wage in research sector. The situation is aggrieved by permanent state arrears in wage payment.

Another idea was about the creation of the centres of excellence in priority areas and about recognition of scientific merit and productivity. High scientific efficiency and international standard of research in the areas of national priority, corresponding to actual possibilities of the country, have to be set as the main criteria for nominating a limited number of research institutions as centres of excellence, which would receive a special governmental support and encouragement. In 1997 academician Alfimov considered that such formulation contained the appeal to quick administrative actions for reducing the Russian scientific potential. From his point of view the huge reduction was necessary mainly for budgetary and not scientific reasons. Demikhov (1998), referring to its German experience, suggests to those who will not be retained in academic institutes, to create their own firms and develop the production of different equipment.

Budget funding collapsed, especially as the real financing represented 55.3% of planed one in 1994, 60.4% in 1996 and 83.2% in 1997. Some arrangements were attempted to protect the research sector (see Vasin & Mindeli (1997)). For example some advantages of the taxes on profits, on equipment and on land were accorded to research institutions. The customs duties for scientific equipment and the income tax on grants for physical persons were reduced. The budget of 1998 has provided the young researchers with investments in dwelling. One measure is more decisive in this country than others – the decree of Russian president “On permitting the adjournment of conscription for several categories of population”(researchers, for example).

Recently democratic principals have also been taken into consideration. Among them the plurality of sources of financing and plurality of scientific approaches. The letter may subsist, as in actual Academy of science the plurality of approaches is guarantee owing to eligibility of all boards of decisions. In future it will be important to assure the rotation of committees of experts evaluating the projects and federal programs.

The discussions about the future of Russian science go some time beyond the economic problems of survival. For example, doctor of technology science Kulik (1998) takes notice of the following specificity:

- Increasing differentiation of fundamental science explains an exponential quantitative augmentation of scientific terminology often out of touch with imagery. Thus vitally important problems and achievements of many sciences are practically beyond the scope of comprehension for most citizens.
- In multiple versions of modern logic and cognitive science one may observe the loss of unity, of strictness and of ethical grounds.
- The growing gap between the science, literature, social and political journalism is a pernicious process.
- Pseudo-science intrudes into many scientific domains.

Consequently, in order to reduce the expenditure for fundamental research it is necessary to distinguish false –science from science, and elaborate for these reasons the criterion of "scientificity" or at least the criterion for research project choice. For this scientific publications and the projects have to be by preference inter-disciplinary, in which the stable links among scientific domains are revealed and explained. The papers must contain the definitions and means to eliminate the contradictions existing in the conceptual basis of corresponding domains. If the object of a work is the solution of some fundamental problem, a jury evaluating the correspondent project must favour the basing of the premise for some solutions of applied problems.

New forms of management and funding of Russian S&T were sought since the earlier nineties. In essence only the establishment of foundations for research development may be considered till now as some advance in the reform of the science. These organisations realise principles that are new for Russia, but the financing through them represents only 5 - 6% of total financing of S&T. Currently the scientists discuss the possibility to enlarge this form of financing in addition or in replacement of the basic one.

The Russian Foundation for Basic Research was established by decree of President in 1992. The foundation respects some principles:

- competition of research projects is enacted based on an obligatory expertise, giving the right of making the decisions about the support of research to the very scientists-experts,
- the openness;
- the independence of any administration; goal budgeting - only for research teams but not for organisations.

The core aspects of the system of budgeting used by RFBR are the following:

- Ground funding - ensures the accomplishment of target scientific research, salary, maintenance costs of scientific equipment, buildings, etc;
- State scientific-technical programs - ensures the orientation of scientific research in the directions declared as most important for the state and requiring extra support;
- The support of research projects, submitted by scientists in their personal initiative - facilitates the caring out of original searching and most advanced fundamental research;
- RBRF address budgeting of scientific projects on the basis of competition. It is held in the compliance with the Charter declaring the so-called principal of free fundamental research.

Certainly, the Foundation is not a universal panacea. The share of revenue of researcher granted by RFBR represent 50 –75% of its salary, which itself is too low. The projects are granted for relatively short period and they could not incite to realise profound research (Demikhov (1998)). The procedure of project elaboration and waiting of expertise decisions take too much time, often injuring the creative work. The competition for grants may be appreciated only if it is going in a sense of research interest.

The Moscow Public Science Foundation (MPSF) is a non-governmental not-for-profit public association supporting the development of humanitarian, social and political knowledge in Russia and the CIS. Especially this Foundation seeks to contribute to the promotion of democracy, of patriotism and of freedom. Special attention is given to two domains that are very important for the policy directed to the privatisation of scientific sector and for integration into the information and communication based world:

1) projects on law: raising awareness of rights and of law, and of the role of the rule of law in the modern society is considered as a contribution to the democratic and market reform in contemporary Russia;
2) by scientists and experts working in the field of social sciences is a way of joining the global information space, a step toward employing world-wide information resources for the benefit of the development.

The Fund for Assistance to Small Innovative Enterprises exists since February 1994 decree of Government of Russian Federation. Its task consists in analysing the commands required by Non State SMEs operating in S&T sector in regard to support:

1) SMEs' production through preferential credits for one year;
2) participation in national and international high technology expositions;
3) teaching and training activity in the sphere of innovation and S&T entrepreneurship.

One may put a question if the creation of funds should remove the obstacles in the way of innovation? Probably not, since the offer of capital is not a sufficient condition for the entrepreneurs' demand increasing, for engaging the researchers into enterprises and for inciting the firms to develop the networks. Innovation is not an easily separable factor of the country's development.

Concluding remarks

This paper depicts the current state of S&T in Russian Federation. The indicators of the quality of the research and of the innovation activity show that they are of second-rate. It is in contrast with the well-known achievements of Russian science and technology in some domains. The market introduction and economic openness play till now mostly destructive role in this sphere.

Obviously, the demand for S&T is large in Russia provided as well by citizens or scientific community. A list of steps realised in the area of S&T policy is proposed, reflecting the intention to access to knowledge based society. This relative perseverance begins to bear fruits.

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