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"Patterns of Preservation, Restructuring and Survival: Science and Technology Policy in Russia in the Post Soviet Era"

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PATTERNS OF PRESERVATION, RESTRUCTURING AND SURVIVAL:

SCIENCE AND TECHNOLOGY POLICY IN RUSSIA IN THE POST-SOVIET ERA[1]

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Abstract

This paper analyses the role of S&T policy in the adjustment and restructuring of the Russian S&T system in the post-Soviet period. The principal argument is that the adjustment of the S&T system in Russia has been evolving between the 'preservation of S&T potential', its restructuring, and survival strategies developed by researchers and R&D organisations. The interaction of these factors explains much of the pace and patterns of restructuring of Russian S&T system observed in the post-Soviet period. The model that emerged is the post-Soviet R&D model, which is relevant for Russia as well as for other CIS. The paper analyses strategic options available to Russian policy makers

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1. INTRODUCTION

During the socialist period science and technology (S&T) in the USSR enjoyed significant state support. Continuous attempts to accelerate S&T progress or to introduce new military and civilian technologies required that the R&D system, especially in the defence sector, be maintained on a large scale. The Soviet S&T system was implicitly based on two assumptions - the linear innovation model, and technology as a commodity (Hanson and Pavitt, 1987). The linear innovation model assumes that R&D is the main generator of technological innovation while the roles of users, engineering and other non-R&D activities are assumed to be irrelevant to technological advance. Technology is perceived as a commodity, which, once developed, can be transferred into or introduced into production without the need for continuous adaptation and improvement: production alone is not seen as an important source of technological innovation. These two implicit assumptions justified the hierarchical organisation of the innovation process and the separation of R&D and production in the Soviet period.

The continuous technological lag of the USSR across a wide technological frontier, especially since the mid-1970s, has highlighted the problems in the command economy system with regard to effectiveness in promoting technological innovation (Amman and Cooper, 1982). *Perestroika* reform attempts of the eighties did nothing to alleviate the basic deficiencies of the economic system. Radical changes in the economic system at the beginning of the 1990s, primarily the introduction of private property and market relationships, deeply affected not only the R&D system but the entire innovation process including the scale of innovation activities (Gokhberg and Kuznetsova, 1999, 2001). Uncertainty over property rights and absence of rule of law, severance of previous production and trade links, and lack of finance for restructuring, amongst other factors, led to widespread rent seeking and survival strategies. The widespread and general uncertainties led to pervasive co-ordination failures and short-termism which inhibited long-term innovation activities.

Given these changes the Russia's S&T system was not able to continue in its old form. The principal argument put forward here is that the adjustment of S&T system in post-Soviet Russia has so far been evolving in an attempt at 'preservation of its S&T potential', alongside restructuring and introduction of survival strategies developed by researchers and R&D organisations. The 'preservation' aspect is a policy attempt to save science in its old capacity and form in the face of inevitable functional, organisational and funding changes. Restructuring is policy attempts to reform the R&D system to conform to market based economy principles of operation. Survival strategies are the micro-strategies of institutes and researchers to try to cope with the shrinking public R&D budget and the absence of effective demand for domestic R&D. These features characterise not only Russia but also other post-Soviet states, in particular CIS. The next section of this paper depicts the pattern of the main changes in the R&D system that have transformed the Soviet R&D system, which include strong features of the past interwoven with adjustment strategies of today. The third section explains the post-Soviet system as the interaction between restructuring, preservation and survival in S&T. The fourth section analyses the strategic options of Russian S&T policy. The basis for the analysis is Russian statistics, secondary sources in English and Russian and the author's personal insights based on consultancy and research activities in Russia.

2. Soviet and post-Soviet R&D model: growth and structural crisis

The Soviet system of organisation of R&D was established in the 1930s in USSR and spread to other socialist countries in the 1940s and 1950s. Once the basic features had been instituted the system did not change substantially. Economic ties between the different actors in the innovation process were regulated predominantly through administrative methods. The most important of these concerned planning documents, which laid down and co-ordinated the whole complex of work by assigning to various performers different tasks in the innovation process. The economic orientation of R&D system was not dominant. The objectives of R&D were first and foremost to support the sophisticated military and space programmes and to provide a degree of technological self-sufficiency.[1]

The Soviet R&D system had a unique institutional structure, the principal organisational form of which was an independent industrial research institute.[2] Central industrial research institutes were part of the ministerial structure co-ordinating innovation process activities. Both enterprise R&D and university R&D was rather limited. While industrial institutes or 'branch science' was reasonably well developed, in-house or enterprise R&D was very underdeveloped. In Russia in 1990 , there were 2,628 branch R&D institutes but only 400 R&D laboratories attached to enterprises (OECD, 1997, p. 102). A total of 1,054m people were employed in industrial institutes while, at the enterprise level, the same work was done by 127000 people (Yudanov, 1996, p. 424).

Institutes of the Academy of Sciences played an important role in the innovation process most often working on the scientific and research components of the process. The system of R&D was vertically organised and any issues emerging from interbranch co-operation had to be dealt with by higher authorities, which usually resulted in delays, great bureaucratisation, opportunism and incremental change.

In all three subsystems – branch, academy and university - state interference was pervasive, even in basic research activities. For example, professional scientific associations had almost no influence over the formulation of state science policies. The decision-making concerning funding priorities 'was purely administrative and effectively ignored the process of the self-development of science and the interests of the scientific community' (Borkin et al., 1996, p.55). Autonomy in the Academy, university and industry R&D sectors was non-existent as state interference was equally pervasive in all three sectors (Malitski and Nadirashvilli 1995, p. 24.).

Partly as a result of the need to control the system and partly as a result of the relatively low levels of development there was strong centralisation of R&D and concentration of research institutes over the national territory. For example, 80% of Russian science is in three locations - Moscow, St. Petersburg and Novosibirsk. Applied R&D were hypertrophied, but due to risk aversion of the centrally planned system there were long delays in introduction of innovations (Dinkin et. al, 1999, p. 9; Martens, 1991).

The basic deficiency of the Soviet system was the absence of action by enterprises as independent agents and the main carriers of the innovation process. Enterprises were reduced to production units for whom any innovation was a nuisance and should be avoided. This risk averse nature of enterprises was coupled with huge barriers to moving innovations horizontally, i.e. between sectors. The centrally planned system did not have any mechanism for inter-industry diffusion of innovations. The innovation chain was contained within individual ministries and R&D capacities were fragmented across sectors. As Yudanov (1996, p. 424) put it: 'The innovation process could be upheld only due to a very powerful

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2 This should be taken into account when evaluating the effectiveness of the Soviet R&D system of that time. A system that was primarily considered from the viewpoint of political objectives and sustaining military potential of the State cannot be assessed entirely by economic criteria of today.

3 For a detailed description of the Soviet R&D model see Gokhberg, 1997.

pressure from outside, for which purpose a bulky system of “branch” (i.e. fulfilling tasks set by branch ministry) institutes engaged in R&D work, has been established.’

The Soviet science system passed through several stages of development until its break-up in the early 1990s (based on Malitski and Nadirashvilli, 1995).
In the first stage (1917-1945) any lingering elements of autonomy and self-organisation of science were replaced by the Soviet science model. Institutional building and spread of R&D organisations were very fast. Every industry had a science institute, department or laboratory attached to it, which served all enterprises in the branch.
In the second stage (1945-1975) development and extensive growth of science resources led to increased employment in science activities, a sector that had considerably outpaced growth of employment in the economy more generally.
In the third stage (end-1970s-1985) attempts at ‘intensification and acceleration’ of technical progress were faced with an economic slowdown which reduced the growth of resources in R&D (see Table 1). In this period inter-branch S&T complexes were set up through which it was hoped that the problems of ‘introduction’ of technology would be resolved.
In the fourth period, from 1985-1991 the emerging stagnation and economic crisis were accompanied by a liberalisation of relationships between R&D and industry. Despite the economic slowdown the R&D system still continued to expand, though at a much slower rate (Table 1). Direct linkages between different agents in innovation process were increasingly established in the form of contracts as complementary transaction mechanisms. However, the basic framework of the system with state property and system of state management and planning in R&D did not change.

Table 1: Changes in number of researchers in Russia and USSR (%)

	1950/40	**1960/50**	**1970/60**	**1980/70**	**1985/80**	**1989/85**
USSR	165	218	262	148	109	102
Russia	180	217	260	149	109	101

Source: Nauka Rossiyi v cifrah, CSRS, 1992

With the break up of the USSR and changes in the economic system, Russia’s S&T system had to adjust to radically reduced demand for R&D from industry. Of all the Soviet republics Russia has inherited the biggest R&D system. It accounted for 75.4% in terms of expenditure in 1985, 67.8% of researchers and 58.7% of establishments (Malitski and Nadirashvili, 1995, p. 37). In addition, Russia has inherited the most R&D intensive economy with the highest share of researchers and expenditure per capita (ibid, p. 36). However, the scale of reduction in demand as a result of the changes was such that this seeming asset became a liability.

2.1. The scaling down and transformation of R&D sector

The shock of ‘marketization’ in the early 1990s in Russia led to a sharp scaling-down of its R&D system (see Table 2). In the period 1992-98, the decrease in R&D spending in both current PPP dollars and in constant 1989 roubles was not so dramatic[3]. The decrease in spending was by 33% and 22% respectively (tables 2 and 3). This compares to the major decrease in spending that took place between 1991/92 when GERD was slashed by 71% in constant prices (!). So, the shock of marketization was felt most strongly in the last years before the break up of the USSR, and particularly in 1991 when the Soviet economy was in

4 PPP = purchasing power parity

deadlock[4]. . In this year the republics stopped paying their taxes to the federal budget, and inter-republican trade collapsed due to severance of links in the economy; As a result of the Republics claiming sovereignty over the assets located in their territories privatisation had yet to take place. Thus, rather than suffering from any one particular reform, the R&D system was critically affected by the break-up of the USSR and the ensuing political insecurity and politically driven disorganisation.

Table 2: Gross domestic expenditure on R&D (GERD) and researchers in Russian Federation

	1992	1993	1994	1995	1996	1997	1998
GERD in current PPP$mn	10526	9905.5	9690.6	7902.9	8779.5	9878.1	8053.7
GERD as % of GDP	0.74	0.77	0.84	0.79	0.9	0.97	0.93
Annual growth rate (constant prices)	-56.1	-5.2	-4.1	-10.3	10.8	8.2	-8.3
Total researchers (FTE)			621790	610357	562070	532469	492494
Annual growth rate of researchers				-1.8	-7.9	-5.3	-7.5

Source: OECD, 2000

5 This was the year of the anti-Gorbachov coup and the election of Boris Yeltsin

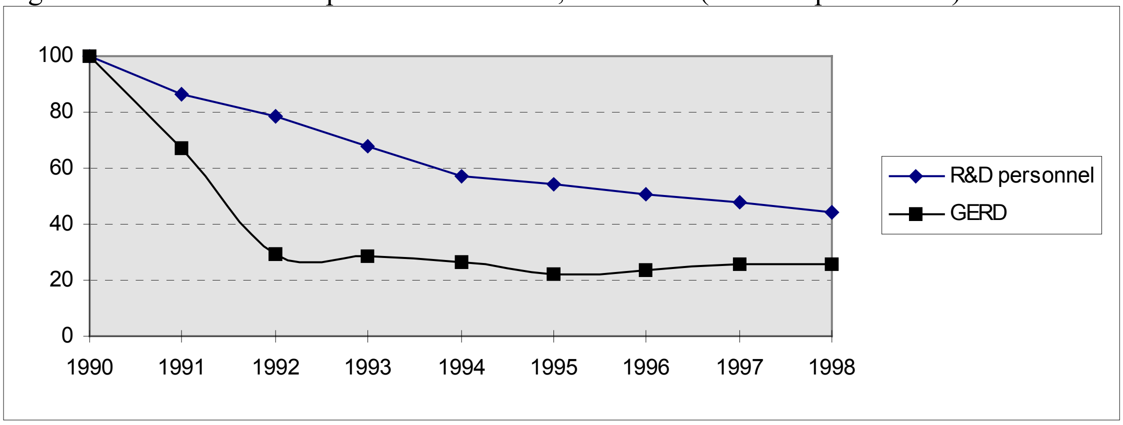
Table 3: Russian Gross Expenditures on R&D in bn roubles, (based on 1989 constant prices)

1990	1991	1992	1993	1994	1995	1996	1997	1998
10.9	7.3	3.2	3.1	2.9	2.4	2.6	2.8	2.8

Source: Bureau of Economic Analysis, 1999, p. 8

While in terms of finance the R&D system diminished in a very few years its downsizing in manpower terms was much more gradual (see graph 1). The difference between the L-shaped decrease of GERD funding and the almost linear pattern of R&D employment generated a huge funding gap. In the 1991-95 period, the number of R&D personnel declined by 37% while R&D funding decreased by 67% - almost halving the per capita expenditure for the R&D personnel that remained. Such a situation inevitably induced diverse restructuring, and strategies aimed at preservation and survival , all of which generated a peculiarly post-Soviet R&D model.

Figure 1: GERD and R&D personnel in Russia, 1990=100 (constant prices 1989)



Source: CSRS, 2000

Overall, the decrease in R&D employment was not nearly as drastic as the decrease in absolute funding levels. Between 1990 and 1998, the number of R&D personnel reduced by 56% and expenditure on R&D went down by 74% (figure 1). Despite a continuing decrease in R&D personnel, the period from 1994/95 up to the present has been a period of stabilisation in the Russian R&D system. The rate of decrease in numbers of R&D personnel has significantly slowed down. Also, in PPP$ terms, GERD per researcher actually increased between 1994 and 1998 from 15.6 thousand dollars to 16.3 thousand dollars respectively. In 1995/6, for the first time the share of R&D expenditures in the federal government budget increased to 3.2% of budget after falling from 7.4% in 1991 to 2.83% in 1994 (Dinkin et al., 1999, p. 16). A temporary drop in GERD of 10% in 1998 should be seen in the context of Russia's August 1998 financial crisis and its return of economic growth from 1999.

The huge funding gap in the Russian R&D system that opened in 1992 has led to a variety of adjustment strategies and policy responses. It is unlikely that any R&D system could quickly adjust to the 71% drop in funding that Russia experienced between 1990-1992. In such circumstances, even well-developed economies would not be able to undertake restructuring activities quickly enough to enable ordered adjustment. The response of the Russian R&D system was towards 'preservation of S&T potential' and various 'survival strategies'. For example, R&D institutes had enforced vacations, which left them without payments for several months. This practice was accepted in order 'to keep intact the institutes' potential'. As a result of such a policy whole departments and even whole institutes shifted to part time work arrangements. In addition, funding was entirely directed towards salaries and overheads, leaving very little room for purchase of equipment or materials. In parallel with the prolonged budget cuts and changing demand for R&D, the system was forced to changee its nature and functions.

The challenge of restructuring

The nature of the R&D system has been gradually changing as a result of various survival strategies developed at a micro level and government R&D policy. Initially, the Russian government tried to find ways to support as much R&D as possible, essentially conserving the existing Soviet R&D model. For some time it continued this policy by reforming the R&D system incrementally. Faced with the dramatic slump in demand for R&D, the government was unable to foresee or implement any coherent restructuring programme. The challenge was to shift from a system where the innovation process was centrally organised and managed, to a system where innovation would be generated by enterprises through a network of public institutions. The main difficulty that has to be overcome in restructuring the R&D system is that organisationally it is a mixed system in which public – private interfaces are essential for its effective operation. As Mindeli (1998, p. 64) points out, the last years of the Soviet Union brought no generally accepted concept of transforming or adapting those areas of society that could not be regulated by market mechanisms, including R&D. This political divergence carried over into the post-socialist period and contributed further to delays in restructuring.

Several years were spent trying to reach a consensus on the basic principles of R&D reform. According to the Bureau of Economic Analysis (1999, p. 4): the concept of reform of Russian R&D is now based, either explicitly or implicitly, on the following principles:

- *Reduction of state funding* accompanied by the demise of the planned system of funding scientific organisations, and a transition to the funding of specific projects;
- The setting up of a system involving *multiple sources of funding* and distribution of resources on a competitive basis;
- Strengthening *the selective principles of state support* through the mechanisms of targeted funding;
- *Lifting the restrictions on the activities of R&D organisation*s and granting them the freedom to choose clients and set prices for their products and services'

However, in direct opposition to these principles, in the first years of post-socialist transformation the policy was explicitly aimed at 'preservation of S&T potential'. In practice, this meant ditching the principle of project financing, and continuing the practice of support, irrespective of organisations' results (BEA, 1999, p. 6). It was only as recently as 1996 that more explicit attempts to formulate broader changes have started to emerge. For example, the 'Doctrine on the development of Russian science', the Federal Law 'On science and state's science and technology policy' and 'Conception of reforming Russian science for the period 1998-2000' all emerged between 1996 and 1998 (Mindeli, 1998, p. 69). Although, R&D funding is still dominated by basic funding of R&D institutions there is a gradual but continuous increase in the relative importance of goal-oriented budget foundations.

2.2. Post-Soviet R&D system

The interaction of preservation and restructuring policies coupled with a variety of survival strategies at the micro level have induced a degree of structural change that has produced a system that is quite different from the Soviet R&D system but also does not resemble the R&D systems of the OECD countries. This post-Soviet R&D system has several specific features. Organisationally the R&D system is still 'externalised' with:

(i) most R&D activities are still taking place in the commercialised, but state owned R&D sector;

(ii) R&D institutes that are dependent on public funding have become the dominant type of organisation;
(iii) reduced demand from industry has led to a polarisation of the R&D spectrum, i.e. the share of applied research is shrinking in favour of basic research and development;
(iv) the R&D system has become internationalised but this is a sign of crisis rather than dynamism[5].

(i) Externalised business oriented R&D

In contrast to countries with similar levels of GDP per capita where the bulk of R&D is performed in government organisations, the majority of R&D in Russia is performed in the business enterprise sector (Table 4). Although in 1992-98 the importance of the business enterprise sector as a performer of R&D was reduced at the expense of the state sector, it is still responsible for 69% of the R&D conducted in Russia. The marginal role of universities in R&D is a feature of the Soviet system which has remained unchanged since 1990.

Table 4: Russia: GERD by sector of performance (%)

	1992	1993	1994	1995	1996	1997	1998
Business enterprise sector	77.5	70.6	66	68.5	69.2	66.3	69
Higher education sector	5.7	5.6	5.9	5.4	4.8	5.4	5.2
Government sector	16.8	23.8	28.1	26.1	25.9	28.2	25.8
Private non-profit sector	0	0	0	0	0.1	0.1	0.1

Source: OECD, 2000

OECD harmonised data on the business enterprise sector fail to show one specific institutional feature of the post-Soviet R&D system, namely, that R&D is still carried out in independent, commercialised, state owned R&D institutes which operate based on R&D contracts for industry. The sector has not been integrated into industry and operates as a substitute for the limited in-house innovative activities of manufacturing firms. In 1997, almost half (44.8%) of the R&D activities were performed in this extramural sector (see table 5).

Table 5: Sectoral structure of total business enterprise intramural expenditure on R&D (%), 1997

Agriculture	1.3%
Mining	2.1%
Manufacturing	36.7%
of which	
Chemicals & chemical products	1.9%
Machinery n.e.c.	11.8%
Office, account & computing machinery	0.0%
Aerospace	8.7%
Electricity, gas & water supply	0.5%
Construction	0.9%
Service sector	58.4%
of which	
Research & development	44.8%
Communal, social & personal service activities, etc.	10.9%
Total	100.0%

Source: OECD, 2000

(ii) R&D institute as the dominant organisational form

6 For a more general analysis of post-socialist R&D model see Radosevic (1999).

The reduction in demand for R&D and technology has put those organisations that directly serve enterprises (design bureaux, construction and project organisations) in considerable difficulties. The number of these downstream organisations has been reduced while the number of R&D institutes (upstream activities) has increased (Table 6). The small number of R&D organisations in the higher education sector and in industrial enterprises remain an important feature of the post-Soviet R&D system. This is an indication of the poor performance by industry to embody innovation and of the limited shift of universities towards research. The increase in the number of R&D institutes is primarily due to the disintegration of large institutes into smaller ones. The average R&D institute halved in size between 1990 and 1997 from 418 employees to 240 employees (Dinkin et al., 1999, p, 27).

A decrease in the number of downstream organisations is explained by two interrelated factors. First, limited innovation and investment activities suggest that enterprises are not able to pay for these types of services. Secondly, enterprises are now beginning to undertake these activities themselves and are importing equipment. Overall, in terms of number of organisations and the average size of organisations, the R&D system has shrunk. R&D institutes, which now account for 63% of the total number of R&D organisations, have become the major form of organisation, indicating a departure from the Soviet R&D system as well as the dominantly extra-mural nature of the post-Soviet R&D system.

Table 6: Changes in types of organisations in the R&D system in Russia

	1990	**1998**	**1998/90**
Total	4646	4019	87%
R&D institutes	1762	2549	145%
Design bureaux	937	381	41%
Construction/project/exploratory orgs.	593	135	23%
Experimental enterprises	28	27	96%
Higher education institutions	453	393	87%
Industrial enterprises	449	240	53%
Other organisations	424	321	76%

Source: CSRS, 2000

(iii) Polarisation of R&D spectrum

It would be expected that the externalised R&D system would shift towards applied R&D searching for pockets of R&D demand in industry with funding. Table 7 shows a clear trend of ‘polarisation of R&D spectrum’ (Radosevic, 1998). The share of basic research and development is increasing at the expense of applied research. This polarisation reflects three factors. Firstly, the R&D system is becoming more upstream-oriented due to the government being the only secure source of funding for Academy of Sciences institutes. Secondly, the inability of industry and industrial R&D institutes to fund applied R&D. The radical reduction in their planning and financial horizons reduces their R&D activities for short-term development which would have the potential of immediate commercialisation. Thirdly, applied R&D, which in the past used to be financed by various ministries, government agencies and industry enterprises, and from the defence budget, has now significantly shrank.

Table 7: Types of R&D activities

Type of R&D	**1991**	**1995**	**1996**	**1997**	**1998**
Basic research	9.3	15.7	15.8	17.7	16.1
Applied research	33.4	18.1	16.2	16.8	16.9
Development	57.3	66.2	68.0	65.5	67.0

Source: MinIndS&T, 2001

This functional reorientation of the R&D system illustrates the main weaknesses in the post-Soviet R&D system. With the shrinking of applied research the system is polarised between basic science and short-term driven commercial developments. The issue of demand for innovation and linkages between different types of R&D activities will become of increasing concern to Russian policy makers.

(iv) Crisis driven internationalisation of R&D

Faced with radically reduced demand for their services, R&D institutes are continually shifting towards funding sources from abroad. Table 8 shows that the relative decrease in government funding has been replaced by foreign funding which now amounts to 10% of the overall R&D funding. This places Russia in fourth place among OECD countries, immediately after UK (14.9%), Canada (13.4%) and Netherlands (12.8%), countries with a strong presence of MNCs in their national R&D systems. However, in the case of Russia this degree of internationalisation indicates forced rather than self-induced internationalisation of Russian science. On the other hand, $830m (PPP terms) that in 1998 came from abroad to Russian R&D shows that even after 10 years of stagnation Russian R&D has retained areas of international competence. Internationalisation is not confined only to basic science and Academy of Sciences institutes. For example, in 1996, 74% of foreign funding in Russia was through independent institutes (classified as business sector) (Dinkin et al, 1999, p. 19).

Table 8: GERD by source of funds (%)

	1994	1995	1996	1997	1998
Industry	35.3	33.6	31.5	30.6	34.9
Government	62.3	61.5	62.1	60.9	53.6
Other national sources	0.5	0.3	0.8	1	1.3
Abroad	2	4.6	5.6	7.4	10.3

Source: OECD, 2000

Another expression of the internationalisation of the Russian R&D system is the continuously rising number of external patents or applications by Russian residents for patents in other countries (Table 9). In 1992-98, the simple average rate of growth of external patents was 36% while the number of resident patents was declining by 17% annually. As result, for the first time in 1998, the number of external patents surpassed the number of resident patents. The rise in external patents is also rising fast in the OECD countries and is an expression of the globalisation of the technology market. However, the number of resident patents in the OECD countries is stable while in Russia it is dropping sharply towards the levels in France and the UK. This suggests that the internationalisation of Russian R&D is not only an expression of the quality of its domestic inventions but also a sign of internationalisation or sale of patents driven by the financial crisis in the R&D system.

Table 9: Patent applications

	1992	1993	1994	1995	1996	1997
Resident	39528	28541	21278	17580	18076	15106
External	4660	6211	8822	8857	14384	20862

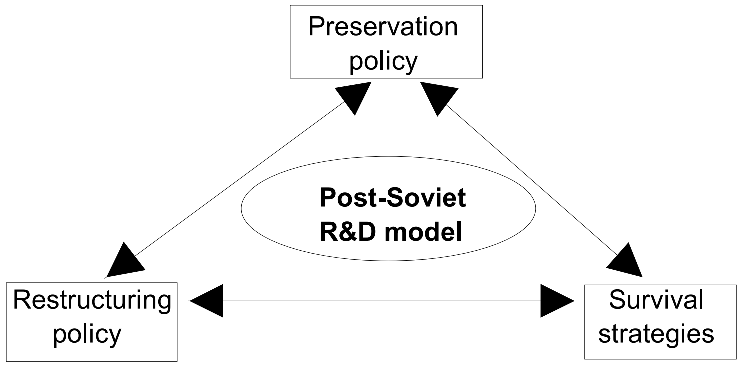
Source: OECD, 2000

Internationalisation of the Russian R&D system should, itself, be seen in a very favourable light. However, its restructuring potential is significantly undermined by the science co-operation being individualised to a great extent, i.e. conducted by researchers on an individual basis bypassing the institute as an institution (Mayntz et al., 1998). The effects would have been much greater could internationalisation have been used as a spur to the restructuring of research institutes instead of being seen as conserving them purely in survival mode.

3. Preservation, restructuring and survival patterns

The interaction of survival strategies, restructuring and preservation activities has produced a relatively stable and slow pattern of change and the R&D model which in section 2 we characterised as the Post-Soviet R&D model (see Figure 4).

Figure 4: Factors shaping Post-Soviet R&D model



Data on R&D suggest that the radical reductions in R&D funds and employment have finished. Currently, the R&D system is in a situation of low level equilibrium or relative stability. Low level equilibrium is the outcome of a balance between a restructuring and preservation policy coupled with survival strategies. The R&D system is semi-reformed and is a hybrid of new and old institutional features. We now turn to analysing each of three parallel processes.

3.1. 'Preservation of S&T potential'

By 'Preservation of S&T potential' we mean attempts to save the whole S&T system without reforming it. The policy of preservation has been practised and is still being applied, albeit with different amounts of vigour and intensity. Preservation attempts are those measures that aim at the solution of particular very acute problems without using them to promote cardinal changes in the S&T system, but employing them to maintain a basically unchanged R&D model. In the long-term this policy cannot be justified, as the new socio-economic system requires a reformed R&D system.
Policy attempts to preserve national science can be seen throughout the entire post-socialist period. Among the most prominent policy expressions are:

- RF President Decree 'On Emergency Measures for Preservation and Development of the S&T Potential of the RF' (No. 426 of 27 April 1992).
- State Duma Resolution 'On the Crisis Situation in the Russian Science' (No 77-1 GD of 25 March 1994)
- The RF Government's Decree 'On Governmental Support for the Development of Science and Technological Developments' (No. 360 of 17 April 1995)
- RF President Decree 'On Some Measures Strengthening the Governmental Support for Science and Higher Education Institutions' (no. 424 of 27 March 1996)
- RF President Decree 'On the Measures for the Development of Basic Research in the RF and the Status of the Russian Academy of Sciences' (No. 558 of 15 April 1996)

In order to halt the continuous decline in real value of the R&D budget, Russian S&T policy has fixed the share of R&D in the state budget.
Article 15 of the Law 'On Science and the State S&T policy' passed in the summer of 1996 contains the following clause:
'Funds for financing of scientific research and experimental developments of civil purpose are allocated from the federal budget in an amount not less than 4 % of the federal budget expenditures' (Mindelli and Pipiia , 1998, p. 6).

In reality, the annual budget is negotiated irrespective of this clause, so that its real impact remains limited.

The preservation policy is a highly politicised process in which different stakeholders have different bargaining power in the ‘preservation’ game. It seems that industrial research has been weakest in this process while Academy of Sciences and defence R&D are among those that have managed to maintain a relatively larger share of the budgetary funds.In assessing the future of Soviet science Kontorovich (1994) argued that completely opposite outcome should result.

‘Military R&D and related sectors of the Academy were the strongest segments of Soviet science. And it is precisely these sectors that will have to shrink the most under the new system.’ (Kontorovich, 1994, p. 117).

However, the reality is more complicated. The Russian Academy of Sciences and the branch academies still retain their traditionally special place in the system of science administration in Russia[6]. ‘Those organisations have, to a large degree, preserved their right, gained in the Soviet times, to distribute state financing earmarked for the support of fundamental research. That right is confirmed by the Federal Assembly during the adoption of the Federal Budget, in which the financing of each of the Academies has a separate line to itself.’ (Rozkhova, 1996, p.17).

In relative terms, the lowest decrease in funding is accompanied by very little change in the way the Academy system operates. As Schweitzer (1995, p.125) points out ‘the leadership of the Russian Academy of Sciences takes a great pride that the Academy is the only institution which was not changed after the collapse of the Soviet Union in 1991. They emphasise that the Academy has not closed a single one of the more than 300 academy research institutions’

The Academy continue to operate as associations of institutes, polyfunctional and without an analogous organisation in the West. For example, Gokhberg (1998, p. 136) points out that ‘to date, the academies (in CIS) have not undergone any major changes in the structure and organisation they inherited from the Soviet era and have maintained administrative control over associated research institutes’

Protection of R&D sector through tax measures

The tax system could be used as an incentive for restructuring of R&D towards specific activities or sector but also as a way to support or preserve R&D in general. In Russia at the outset of transition R&D was treated in the same way as other sectors. This meant extremely high levels of taxes, especially land taxes, which would have made it impossible for R&D organisations to survive. Therefore, by the decree of president of RF No. 426 (1992) ‘About urgent measures for preservation of S&T potential of the RF’:

- R&D is free from VAT payment for funds received from the Russian Foundation for Basic Research, . The Russian Foundation for Technology Development and from extra-budget funding sources
- Higher education institutions, Russian Academy of Sciences and other academies are not liable for Land Tax.
- Property tax reliefs are enjoyed by State Research Centres, Russian Academy of Sciences, other academies, Research institutes of ministries (Dinkin et al, 1999, p. 105-106).

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7 Similar to Russia, in Ukraine the absolute decrease of funding was relatively the smallest for Academy institutes. See Malitski et al, 1997, p. 11, table 4.

In addition, tax on the profits of enterprises and organisations is not imposed on the part allocated by enterprises and organisations for R&D (no more than 10%) if profit is invested in construction, reconstruction and renovation of fixed production assets. Tax on property is not imposed on the property of public R&D institutions. Grants allocated to persons by foreign charitable organisations are not subject to personal income tax

For R&D institutes, the importance of tax exemptions is enormous, as they are comparable to the annual value of funds from the federal budget. 'In other words, the total value of government R&D funding would be spent on taxes to be paid to the state' (Mindeli & Pipiia, 1998, p. 12). These measures basically try to correct for problems in the tax system.

However, their drawback is that they effectively hinder R&D restructuring . As Mindeli and Pipiia (1998), p. 12) point out they stimulate inappropriate use of fixed assets by public institutes and increase tax obstacles to the development of new organisational forms of S&T and innovation activities in the private sector. 'Some R&D institutes are becoming, in effect, real estate organisations' (ibid. p. 12). Also, this attracts informal or spontaneous privatisation in R&D. This problem is likely to be addressed by the new tax law where the tax relief will be enjoyed only by accredited research organisations where 'S&T production will be not less than 70% of total turnover' (Dinkin et al, 1999, p. 108).(BEA, 1998, p. 12)

3.2. Policy of restructuring

The S&T policy in the post-Soviet period is not confined only to preservation of S&T potential. The political nature of policy making, loss of initial momentum for change and decreasing public budgets have led to a mixture of restructuring and preservation elements in S&T policy. The restructuring elements of S&T policy are the most visible in three elements; first, : in new criteria for public funding of R&D; second, in privatisation of R&D, and third, in new forms of institutional support for S&T. In addition, an increasing number of recent policy documents addresses the issue of innovation policy[7].

3.2.1. Restructuring through new sources of funding and new funding criteria

The introduction of programme and project funding, besides old institutional (per capita) funding, represents the most important change in the R&D system. This change hass required the parallel introduction of new sources of funding, and contract system for its implementation.
Table 10 lists the main S&T foundations in Russia, which have been formed in the post-1991 period.

Table 10: S&T foundations in Russia

Name	Established	Sources of funding	Objectives
1. Russian Foundation for Basic Research	April 1992	4% of the federal R&D budget (6% since 1997); voluntary contributions	Support for basic research in sciences
2. Russian Foundation	September 1994	1% of the federal R&D	Support for basic

7 Examples are: 'The Concept of Russian federation Innovation Policy', The RF Government Directive 'On Approving 1999-2000 Plan of Action to Implement Russian Federation Innovation Policy in 1999-2000', The Government Resolution 'On Creating Prerequisites for Attracting Investment in Innovation sector', RF President's Decree 'On State Policy Aimed at Involving the Results of S&T research, and Intellectual Property Items in S&T, in Economic Turnover',', the 1998 – 2000 Inter-Agency Program to Invigorate Innovative Activity in Russia's S&T.(MinIndS&T, 2001, p. 4).

for Research in Humanities		budget	research and publishing projects in humanities
3. Foundation for Promotion of Small Enterprises in S&T	February 1994	1% of the federal R&D budget; voluntary contributions (Funding provided on repayable basis)	Support for innovative small-size enterprises and innovation infrastructure projects in S&T
4. Russian Foundation for Technological Development	May 1992	20% of 1.5% sales contributions by industrial enterprises to sectoral and inter--sectoral non-budgetary funds (Funding provided on repayable basis)	Support for S&T projects
5. Fond for support innovation activities in Higher Education System	April 1996 Ministry of Education	Voluntary contributions by universities from non-budgetary sources	Support for innovation activities in HE institutions
6. Federal fund for production innovation	August 1995	1.5% of centralised capital investment	Support of innovation projects and activities in industrial branches
7. Federal Fund for support of small entrepreneurship	December 1995	- federal budget; income from privatisation of state property - share capital - income from entrepreneurial activity of fund - voluntary contributions	Support to projects; stimulation of small entrepreneurship
8. Russia Venture Fund	December 1997 - by initiative of the Government and participation of Min. of S&T		Attracting private capital in area of high technologies with state guarantees
9. Venture Innovation Foundation	2000 – by initiative of Ministry of Science		Improving procedure of awarding grants to business ventures
10. Sectoral and inter-sectoral non-budgetary funds[8]	May 1992	1.5% of sales contributions by industrial enterprises to sectoral and inter-sectoral non-budgetary funds	Support for sectoral and inter-sectoral S&T projects

Source: Dinkin et al, 1999, p. 82 and p.100; Mindelli and Pipiia, 1998, p. 14., MinIndS&T, 2001, p. 4.

[8] According to Mindeli and Pipiia, (1997) there are 71 foundations and according to Dinkin et al (1999), there are 91 foundations.

These funds represent a significant departure from the branch structure of the organisation of science, as they are open to all organisations independent of jurisdiction and authority. Some of them have been formed as the only way to set up a new system of competitive project-based funding. For example, the monopoly that the Academyies used to have over the distribution of government financing for fundamental research was broken with the creation of the Russian Foundation for Basic Research. Other foundations, like non-budgetary funds, have been formed as a substitute for decreased government spending on large sectoral R&D and for liquidation of previous sectoral funds. However, these funds have not yet become important sources of funding due to the voluntary nature of contributions. They are highly dependent on the financial situation in the sector or commitment of enterprise to maintain sectoral R&D capacities.

Among new sources of funding, regional funds aim to address problems of a regional character. Given the previous centrally oriented nature of R&D these funds are important in restructuring Russian R&D though they make a very small dent in the federal budget. In 1993, the federal government started to co-fund regionally oriented programs which amount to 0.3% of the federal R&D budget.

Among new sources of funding in Russia are venture capital funds. In 1997, the Russian Ministry of S&T, Finance Ministry and Ministry of Economy established a first Russian venture fund. A set of project proposals has been developed amounting to $10m. Legally, other funds have also acquired the right to establish venture funds (Dinkin et al, 1999, p. 114/115). However, the amount of Russian venture capital is still very marginal. Ninety percent of venture funds operating in Russia are with foreign organisations.

Contracting system
The Russian Law 'On Science and the State S&T Policy' (1996) establishes that the principal legal form of relationship between R&D institutions, and customers (ministries etc.) is agreements (contracts) in 'creation, transfer and utilisation of S&T output', including contracts on joint S&T activities and profit distribution. Mindelli and Pipiia, (1998, p. 8) report that the Ministry of S&T has adopted a contracting system. However, so far, the system has been used only on a very limited scale. Factors that inhibit its further application are weaknesses in the intellectual property rights system and the lack of payment discipline, which works against the introduction of the repayment principle.

A shift from basic (institutional) to goal-oriented and competition-based funding is still happening on a very limited scale. In Russia, competitive financing presently amounts to 5-7% of all allocations for R&D. In an attempt to provide competitive- based funding, but also to satisfy the large number of project proposals, the number of fundeding projects is very large. Also, priority-setting often turns into a game where everybody tries to find a place, which results in a large number of state programmes. Given the enormous pressures on limited resources, and mixture of preservation and restructuring principles in the policy, this is might be expected.

3.2.2. Privatisation in R&D

Privatisation of R&D establishments has to be an important component of the restructuring system . It allows for integration of R&D institutes into industrial enterprises or their conversion into service or industrial companies. However, privatisation may also result in the closure of R&D institutes and their conversion into sources of estate income. Given the lack of strategic investors and lack of cash for privatisation, government has been either very reluctant to privatise R&D institutions on a large scale or has attempted to preserve the S&T

character of the R&D organisations to be privatised. This is in contrast to the strategy of mass privatisation of other enterprises which occurred between 1992 and 1994.

In 1998, there were 323 R&D organisations in private ownership and 736 in mixed which amounted to 26% of all R&D organisations (CSRS, 2000). By itself this number is significant. However, a high share of organisations in mixed ownership (18%) and government control via the existence of a ‘golden share’ mean that as in mass privatisation the control of the state remains much more pervasive than the numbers would suggest.

One of the principal conditions for privatisation of R&D institutes is preservation of S&T activities as the major activities and continuation of jobs for researchers for at least one year after privatisation (Mindeli and Pipiia, 1998, p. 13). While such privatisation represents a form of restructuring, it is also an attempt to preserve the R&D activities in privatised R&D institutions.

3.2.3. Institutional support for S&T

Policy actions to set up new or to restructure existing organisations are an indispensable element of reform of the R&D system. Politically, and in terms of policy implementation capability, these are the most difficult tasks. Relatively easier are indirect changes to institutions through introduction of new funding criteria. The establishment of State Research Centres, S&T parks, and non-governmental associations has so far been the major form of institutional support for S&T[9].

The most significant measure in this respect is the establishment of 59 State Research Centres (SRC) the first of which was created in 1994. The rationale for SRCs is to retain the core of Russian science through priority funding. SRC will be the system of national laboratories and the core of the national R&D programme. The problem with this concept is that it tries to introduce differentiation at the level of institutions and avoid differentiation at the level of projects, programmes and laboratories. This is a weakness that is further magnified because SRC are extremely large organisations. Schweitzer (1995, p. 129) points out that some SRCs employ more than 5,000 people. In effect, priority support for selected organisations irrespective of how good are their individual parts, perpetuates the very problem it is designed to solve.

Another form of institutional support has been support for S&T parks and similar set-ups like technoparks or innovation centres.[11] Innovation centres are the latest trend in the attempt to build bridging institutions in the Russian S&T system to help commercialise available R&D results and technologies. The earliest to appear were the technoparks at the end of 1980s. Initially, around 50 technoparks were created under the auspices of the Ministry of Education but most of them never got off the ground: they did not reach the stage of a developed institution. Currently, it is estimated that about 26 technoparks are in operation. Most of them provide services similar to those of other institutions for supporting innovative firms (i.e. innovation centres, technology incubators) which makes it difficult to differentiate between them.

A second group of institutions - business and technology incubators - followed the technoparks. In 1997, existing business incubators set up their own association: the National

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9 In addition to institutional support there are programmes designed to change the portfolio of activities of R&D organisations. For example, in Russia, the Federal Programme on State Support for the integration of higher education and basic science was adopted in September 1996 to provide incentives for collaboration between the Academy and universities both in research and education (Gokhberg, 1998, p. 145).

11 Based on similar principles Ukraine declared the creation of one such centre, but without adequate financial and organisational support (Egorov, 1996, p. 212).

11 For analysis of this issue for Russia see Radosevic and Dranev (1998).

Association of Business Incubators. Its mission is to develop and organise a network of business incubators as a structure through which favourable conditions for small firms will be created.

The Association was founded by 22 organisations. It is estimated that in Russia there are about 30 business incubators. The number of small firms attached to them ranges between six and fourteen. They all rent business premises, offer training programmes and individual consultancy. They are also instrumental in small firms obtaining loans or micro credits, especially when these sources are organisationally close to the business incubators. The number of technology incubators among them is probably very small. It is estimated that in Russia there are only 3 that are exclusively technology incubators (Radosevic and Dranev, 1998).

3.3. Survival strategies

Freedom for individual researchers and lack of direct ministerial control over the S&T system have enabled a degree of structural change which is bottom-up, i.e. change that is not policy directed. Micro-strategies are an important determinant of the way post-Soviet R&D system develops. They are not planned but are a spontaneous reaction to the financial and structural crises in the R&D system. Much of the bottom-up changes have been expressions of the fight for survival of the R&D institutes. Survival tactics have been developed mainly by the research organisations themselves. The most typical of them are second employment, spin-offs, and diversification.

Second employment

Faced with the low wages and/or limited prospects for better paid employment elsewhere, a large number of R&D personnel had to take a second or even a third job. Unfortunately, large-scale data that would indicate the extent of this phenomenon are not available. Sociological surveys of academic science by Mirskaya (2001) show that half the researchers have additional jobs. However, these jobs are usually related to the researcher's basic area of research and, consequently, yield scanty extra income. Thirty percent of scholars would like to get an extra job in another, better paid area, but fail to find one, while 20%, mostly young scholars, 'moonlight' in spheres other than that of academic science[12]. Indirect evidence which addresses overall R&D employment provides a more gloomy picture by suggesting that only 50% of researchers continue to do research (Tichonova, 1998)[13]. Irrespective of the vague understanding of this phenomenon the widespread diversification of individual activities within the R&D system, which now includes a large share of non-R&D activities, is changing in character.

Spin-offs

In order to commercialise the results of their R&D many institutes in Russia have either established small firms or allowed their employees to do so. Formation of the informal sector of small firms attached to R&D institutes started in 1987/1988 with the liberalisation of R&D. Already, by 1990 there were more than 10,000 S&T co-operatives (Dinkin et al, 1999,

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[12] Surveys in the Ukrainian Academy of Sciences show that more than 36% of research scientists and engineers asked had complementary employment (Malitski and Nadirashvilli, 1995, p. 43).

[13] Out of 500,000 researchers there are about 80,000 'active' researchers in civil science who apply regularly for grants, another 80,000 are working in defence research and do not apply because of secrecy to grants, and 70,000 are in branch science doing contract R&D and rarely applying for grants. This gives a maximum of 250,000 active researchers (Tichonova, 1998, p. 6, based on Poisk, 10/1997, p.3).

p. 91). In the 1990-93 period the number of small enterprises with an S&T profile reached 64,800 (ibid, p. 92). From 1994, the rising trend has been reversed and, by 1997, the number of small firms had reduced to 46,000, from 65,000. At the beginning of 1997 there were 20-25,000 small firms operating in the R&D sector (ibid, p. 92) [14]. Many of these enterprises are fictious organisations (i.e. they exist on paper only) that operate in symbiosis with a research institute. In this respect they could be defined as 'quasi spin off'' firms as they actually have not 'spun-off' from institute. These firms are to a great extent an expression of the crisis in the R&D system and of the limited opportunities for absorption of technology-based products or services in the national economy. Quasi spin- offs are an important element of the 'survival' of science in conditions of limited opportunities for reformation of its organisational structure.[15]

Diversification

Diversification is a logical strategic response in a situation where demand is shrinking and where uncertainties regarding potential demand are pervasive. The effect is that the portfolio of activities of R&D organisations becomes so stretched that it is difficult to define the company profile of such organisations.

From 1989 to 1996 the average share of non-R&D activities in the portfolio of activities of R&D institutes rose from 8.5% to 20.9% (Dinkin et al, 1999, p. 72). In this, the share of micro-production rose from 4.5% to 16% while the share of services rose only from 4% to 4.9% (Ibid.p. 73). Of research institutes 51% rent their premises, 15% rent equipment and 21% have micro-production (data of CSRS) (Dinkin et al, 1999, p. 73). The need to complement income with additional sources of revenue has put into relatively better situation those institutes that posses either attractive property or have micro-production capacities. This area has been institutionalised (legalised) in such a way that from 1997, 70% of income from rents goes to institutions and 30% to the state. Since 1998, this does not apply to higher education institutions as stipulated by the law in the federal budget of 1998 (Dinkin et al, 1999, p. 79).

4. Strategic options to Russian S&T policy

During the 1990s, S&T policy in Russia has been a mixture of preservation and restructuring policies. [16] Although relatively stable, especially when compared to the 1991-1993 period, the situation in R&D is far from sustainable in the long-term. During the 1990s, the R&D

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[14] This phenomenon is not limited to Russia but is typical for the Post-Soviet R&D systems. In Ukraine, In 1993 their number was reduced to 3,420 from 4,300 two years earlier. According to Malitski and Nadirashvilli, (1995, p. 31) around quarter of them have continued to operate as technology based firms while the rest have turned into trading firms and agents. In our view this is a quite optimistic assessment of the presence of technology based firms.

[15] In Ukraine, SMEs doing R&D accounted for more than 3,000 units in 1994 (Yurevich, 1996, p. 273). In 1991 in branch 'Science and scientific services' there were 4,370 such organisations of which 2,901 were small enterprises (SE) and 1,469 co-operatives. In these enterprises 45,000 people was active who combined this employment with the basic work in state organisation. In Belarus in 1990-92 about 100 small enterprises of various forms of property were founded at the Academy of Sciences, but by 1995 as few as 53 of them continued to function (Nesvetailov, 1997, p. 15).

[16] The balance between preservation and restructuring varies between Russia, Belarus and Ukraine. The impression is that the elements of preservation are strongest in Belarus, elements of restructuring in Russia, with Ukraine being an intermediate case

system operated in a 'survival' mode, under an acute shortage of effective demand, organisationally isolated from enterprises, which are unable to embody innovation activities. The main changes have taken place in R&D institutes while state policies have shaped these processes to a limited extent. As Nesvetailov, (1997, p. 21) pointed out, at present, the potential reserves of the 'survival' tactics are almost exhausted. Simultaneous outdating of the R&D topics, the material and technical base and ageing of R&D manpower have become a long-term problem even if demand for R&D were to recover immediately. The recovery in the Russian economy that started in 1999 brings hopes that this growth could also revive demand for R&D. However, it should be borne in mind that demand and supply factors for products are not the same as demand and supply factors for R&D (Tunzelmann, 1995). Recovery of aggregate economy demand may not automatically bring a revival in demand for R&D and innovation.[17]

Russian recovery may be based more on imitation than on innovation with a limited role for R&D. The role R&D could play in Russian growth will be to a great extent determined by the restructuring of the R&D system and by the matching of supply and demand for R&D. This would require further modernisation of Russian S&T policy and its integration with growth strategy (Stiglitz and Ellerman, 2000). Next, we analyse the strategic options for Russian S&T policy. First, we argue that dilemmas as to whether and how much to 'preserve' or 'downsize' the R&D system lose sight of the primary problem which is how to further restructure the R&D system. The current policy of passive gradual adjustment should give place to a policy of active gradual adjustment. Second, this policy should change focus from mission oriented to diffusion oriented S&T policy. Third, the scope of S&T policy may be quite limited if framework conditions do not improve.

4.1. Preserving, scaling down or restructuring of R&D ?

The crisis of Russian R&D was for quite some time perceived as cyclical while being primarily of a structural nature. As Schweitzer (1995., p 124) points out:

'Since 1991, the members of the 'new' Russian science establishments, from ministers to laboratory technicians, have been convincing themselves that the one and only solution to the plight of Russian R&D is more money, that the current economic crisis will soon be history, and that the money will eventually appear'.

The recovery of R&D is not only a matter of revival of aggregate demand for R&D but also of changes in its nature and functions. The political fight between preservation or scaling down of R&D is a false dichotomy. By expecting downsizing to the 'optimum level' of R&D spending the problem is perceived as finding the natural equilibrium level between aggregate demand and supply for R&D instead as the problem of organisational, funding and functional restructuring of R&D. Even if the R&D system shrinks to a tenth of its current size that, by itself, would not ensure its meaningful role even though its budgetary burden would be fairly light. For example, the OECD Report on Russian S&T policy recommends downscaling to 300,000 research scientists and engineers (OECD, 1997). Similar to the OECD opinion, Russian analysts conclude that the new balance between the level of domestic demand on production and R&D services and their supply 'has not yet been reached' (Dinkin et al, 1999).
This is seeing the problem of R&D only as a supply side problem where the nature and composition of demand is assumed to be fixed (Batstone and Westhead, 1998, p. 81). When

[17] Radosevic and Auriol (1999) show that very different trends in GDP rates in the 1990s among CEECs led to similar decreases in GERD.

reduced to a supply side problem the linear model of innovation appears to be a reasonable approximation of the reality and the policy initiatives that aim to ‘preserve S&T potential’ or to scale it back to an optimal level. However, the radically changed composition of domestic demand, and its convergence towards foreign demand in the post-Soviet period, mean that it is unrealistic to treat demand parametrically.

The issue is not whether to ‘preserve’ or ‘scale down’ R&D without taking into consideration changes in the nature of demand for R&D. For example, the Russian aviation industry can only develop as a subcontractor and/or through joint ventures with foreign partners which radically changes the nature of its demand for R&D. Also, the shift in electronics from being an imitator of chips to being a low-end electronics subcontractor radically changes sectoral demand for technology.[18] In both cases, the restructured industries will most often no longer produce final products but only components or parts, or will become assemblers in the case of electronics. This means that the structure of demand for technology will change significantly as technology capability will be much more dependent on co-operation with foreign partners. In such a situation the issue is not what would be the size of R&D system but whether the system can cater for the needs of an economy whose demand-pull is likely to come from subcontracting links.

For example, the optimal size of R&D in the Russian space industry cannot be determined unrelated to how it will integrate itself into the world rocket-launching market (Bzhilianskaya, 1997). Its demand for R&D in this area will depend on how successful its joint ventures are in co-operation with foreign partners.

Much more important than the size of the R&D system is its organisation and orientation. Technology demand is derived from demand and supply for products and their coupling goes through enterprise, and not through market as is the case with products (see Tunzelmann, 1995, for the basic approach along these lines). On the demand side, reduction in the size of enterprises, and how demand for products gets translated within enterprises into demand for technology, play a part in the explanation of weak innovation capability. Also, whether demand from product markets gets transposed into demand for technology depends on how far restructuring of enterprises has advanced. Schweitzer (1995, p. 130) gives an example of a rocket design institute that developed more than 580 new types of materials for use in many civilian products. However, the institute could not give away any of the technologies since the civilian sector did not have the equipment or trained personnel to use the materials, let alone the marketing skills to transform the materials into successful commercial products. The relevant question in this case is not whether R&D activities are too large or too small but whether the large-scale manufacturing capabilities, including finance and marketing, are developed. Any ‘optimal’ level of R&D is optimal only at a given organisational structure of supply and demand for technology. These factors should be made explicit if the ‘optimal’ scale of the R&D system is to be judged.

4.2. From passive to active gradual adjustment strategy

Russian S&T policy has faced challenges similar to other CEE economies. The diversity of different national responses can be classified by distinguishing between two components:

(i) Whether countries have pursued *radical* or gradual changes in the rules of public funding of S&T. For example, in the Czech Republic, the government rejected any active policy in restructuring R&D institutes and abruptly withdrew financial support to the majority of industrial institutes. Since 1991, industrial companies in the Czech Republic have had to

[18] For analysis of these changes in Ukraine and Belarus see Egorov and Slonimski (1998).

finance their R&D activities themselves. Industrial institutes suddenly lost a relatively secure income and had to find a means for survival. Also, in the course of privatisation R&D institutes were treated as 'normal' production enterprises. This 'shock therapy' led to a massive conversion of their activities to services and production.

(ii) Whether countries have pursued active organisational restructuring in the R&D system or whether they have left the organisational structures intact. In its strongest form, active restructuring was pursued in eastern Germany where individual institutes were evaluated and then either closed, split, reorganised, or merged. In the case of passive adjustment the organisational structures remained intact. Changes are gradual only in terms of financing through the gradual introduction of competition principles.

Using these two criteria, the degree of shock or gradualism in public funding and the existence, or lack of an active micro restructuring policy, we can distinguish four different national situations (Table 11) (see Radosevic, 1996)[19].

Table 11: Different national patterns of R&D restructuring

'Radical active restructuring' (I) Example: eastern Germany	'Gradual active restructuring' (II) Example: Poland, Slovenia
'Radical passive adjustment' (III) Example: Czech Republic, Estonia	'Gradual passive adjustment' (IV) Examples: Russia, Ukraine, Belarus, Bulgaria, Romania

In this matrix Russian, together with Ukrainian and Belarussian S&T policies, fall in the box 'Gradual passive adjustment'. It seems that the momentum for radical change never existed in any of these three countries. Institutional (basic) funding for R&D is still dominant and elements of preservation are mixed with elements of gradual adjustment. More than half the basic funding is targeted to R&D institutions in the industrial sector, with the result that, as before, budget funds continue to be a substitute for applied R&D financing by enterprises (Gokhberg and Sokolov, 1998). If this were part of an active restructuring then it would not be a problem. However, there is no sign that this policy is leading to any integration of R&D into industrial enterprises.

How do we evaluate different national options in restructuring of S&T? Are some better than others? Whether policy is 'good' or 'bad' depends very much on the policy capability and consensus of stakeholders to implement policy. Policy options can become a problem when they are inconsistent, i.e. when objectives cannot be supported by funding or other mechanisms. Whether a policy should be in the direction of active or passive restructuring, or gradual or radical reduction in public funding, depends on the capability of policy to achieve its objectives without generating too much cost for the S&T system and economy.

A gradualist policy in conditions of limited budgets could be very costly in terms of erosion of the R&D system and prevention of active restructuring. If budgets and a management capability are available to undertake organisational restructuring in an S&T system, as was the case in eastern Germany, then radical solutions are the 'cheapest'. When the decline in financing is so marked that an orderly restructuring of R&D institutions is impossible, then

[19] Hungary and Slovakia do not fall clearly in this matrix as they have followed inconsistent policies which may be described as 'Combined radical and gradual passive adjustments' (see Radosevic, 1996).

gradual passive adjustment may be the only option for some time. This was indeed the case in Russia, Ukraine and Belarus in the early 1990s. However, we think that the continued persistence of this policy has become counterproductive and has actually speeded up the erosion of the S&T system.

The political philosophy of Putin with its emphasis on stability and gradual change makes unlikely any radical restructuring[20]. Yet, the need for active restructuring has been recognised by Russian analysts of S&T policy who argue that:

'To form an efficient system of multi-channel R&D funding, it is not enough just to establish budget and non-budget funds for science and stimulate private investment in R&D; neither are own funds of R&D institutions sufficient. It is also necessary to rationalise the use of finances possessed by R&D at present. Therefore, reform of R&D must include restructuring the network of R&D institutions in the government sector of R&D to expel inefficient R&D institutions from budget financing' (Mindeli, 1998, p. 69).

After 10 years of gradual changes in the principles of funding but with no active organisational or functional restructuring being undertaken, S&T policy in Russia should finally develop the component of active restructuring. In terms of the matrix in Table 11 this would mean moving from quadrant IV to quadrant III. However, as with any strategic change, its complexity lies in its implementation, costs and resistance to change rather than in its design. The difficulty involved in active restructuring lies in the need to ensure that the restructuring is decentralised and bottom-up and yet, that it is co-ordinated at the same time.

Active restructuring should not be based on supporting R&D institutes but rather R&D programmes/projects and innovation activities. A considerable amount of basic financing of the R&D institutions must be rearranged in favour of particular research projects. Active restructuring of R&D institutes through new criteria for project funding should be given advantage over differentiation of individual institutes. This latter option is administratively demanding, politically very difficult and does not differentiate at the level of individual researchers and laboratories.

There are signs of increasing awareness in Russia that the costs of maintaining the system intact became too high. A shift from survival to major reforms requires a revision of the network of R&D organisations or active restructuring. So far, S&T policy has been oriented primarily in support of R&D institutions as such, irrespective of their results in different forms. Selectivity in funding institutes over selectivity in their activities (projects, programmes) actually reduces funding for the most capable groups and thus blocks restructuring.

4.3. Russia between mission vs. diffusion oriented S&T policies

A useful classification for understanding the main features of S&T policy in Russia is the classic distinction between mission and diffusion-oriented policies (Ergas, 1986). Mission-oriented policies are those primarily concerned with major projects of national significance, often with an emphasis on national defence. In the mission-oriented countries (US, UK, France), the primary goal of public policy has been to encourage the development of technological capabilities in technical fields considered to be of primary national importance. Diffusion-oriented policies (Germany, Japan) are largely concerned with upgrading the capacity of firms to respond to new technologies. The emphasis is less on developing entirely

[20] However, this may change as Putin gradually builds support for change.

new, cutting-edge technologies and more on promoting the widespread dissemination of technological capabilities throughout industry. Mostly, this involves the strengthening of institutional mechanisms for technology transfer, particularly with respect to education and vocational training systems, systems of industrial standardisation and networks of co-operative research (Ergas, 1986, p. 4-5).
The last 10 years have seen the strengthening of diffusion components in mission-oriented countries, but the main distinctive features between countries with these policies still hold.

Due to its Cold War origin, Russian S&T policy shares strong features of the mission-oriented S&T policies. Its ‘mission’ character comes from its:
* Inherited strong defence character,
* Strong focus only on the R&D component and a neglect of diffusion, and
* Its supply-orientation and neglect of demand.

The goal-oriented and predominantly R&D-focused policy of Russia is becoming incompatible with the need to develop the diffusion-oriented components of S&T policy. The need to develop the diffusion component is becoming essential for the following reasons:

* Mission-type policy can only be justified in an environment where demand is strong and a rich network of market institutions and infrastructure exist to make use of the results generated in the R&D sector. In the foreseeable future the framework conditions, business factors and business infrastructure in Russia will remain the main weakness in the innovation process (see 4.4.). If S&T policy continues to retain its mission-oriented character this will only deepen the gap between general economic conditions and the S&T system which will further weaken the S&T itself.

* The technology lag, particularly that which has been accumulated in the last 10 years, cannot be reduced without strong innovation policy focused on quality, training, diffusion, standards and organisation. At best, with the mission-oriented technology policy, Russia may develop a few isolated sectors while the rest of industry will lag behind.[21]
* The new features of the emerging 'knowledge based economy', which is focused around the Internet, business services and information technologies, require diffusion-oriented policies. With only mission-oriented policy, Russia will further lag behind in the application of new information and communication-based technologies.

4.4. The scope of S&T policy in Russia

For proponents of S&T policy the issue is whether S&T policy can help the Russian economy to get out of its protracted structural crisis. Whether S&T will become a part of the solution or part of the problem will determine the long-term rate of economic growth as well as the nature of its S&T system. However, we should not overestimate the role and the scope of S&T policy. Technology and innovation policies do not operate in a vacuum and their success or failure should be seen in relation to framework conditions and other institutional factors that influence innovation process.

Table 12 evaluates the state of the two main groups of factors that determine one important aspect of structural change - the creation and growth of new technology -based firms: framework conditions and technology and innovation policy.

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[21] In Ukraine and Belarus even this is unlikely to be (or do you mean likely to be)due to smaller size of their R&D systems and weak domestic demand

Table 12: Assessment of factors influencing the creation and growth of new technology-based firms in Russia

Framework conditions (demand side)	Technology and innovation policy (supply side)
Declining economic growth during the 1990s/ Turnaround in growth in early 2000s	Developed public R&D and technology procurement but not used as a tool of innovation policy
Weak competition policy	Undeveloped system of intellectual property rights and international standards
Unstable macroeconomic situation and uncertain expectations inhibit innovation and long-term investment	Systems of business and technology incubators is still in early stages of development
Weak relations with large firms as customers or vehicles for access to technology	Undeveloped systems of specialised advisory services
Weak relationships of NTBFs with large firms as customers or vehicles for access to technology	Large firms & universities as sources of qualified personnel
Weak demand for technical business services	Undeveloped management skills
Undeveloped enforcement of payments among firms	Undeveloped general and SME-targeted financial support to innovation
Low mobility in labour markets	Lacking direct promotion of formal & informal venture capital
Large pool of qualified labour force	Finance for innovation is extremely limited
Complicated and destimulative tax system	
High interest rates	
Very low sophistication of financial markets	

Given the number and type of shortcomings in framework conditions, S&T policy cannot fully compensate for deficient framework conditions. Often, the key solutions are not in the S&T and innovation policy in the narrow sense but are lie in economic reforms in other 'non-technological' areas like the tax system. Without inflow of industrial investments the State alone cannot ensure support for R&D. These in turn depend on the competition and enforcement of property rights, especially for small shareholders. Commercial banks play a marginal role in funding of innovation projects. They serve more as vehicles for soft budget funding of the cash flow needs of large firms (Lane, 2001). High profitability of investment in financial markets made, until the August 1998 financial crisis, unattractive investments in the real economy. Macroeconomic policy has caused serious deformities in the structure of fixed assets and cash flow. Widespread non-payment, demonetisation of the economy; spread of barter; and money surrogates hinder the normal operation of enterprises. All this has blocked the generation of demand for R&D and technology in enterprises. Hence, there are serious limitations in the S&T policy to restructure R&D and foster innovation in the face of stagnant demand and lack of enterprise investment activities.

Table 12 suggests that innovation and technology policy cannot compensate for unfavourable framework conditions, weak business opportunities or other hindering factors. Yet, a developed innovation and technology policy is one of the essential ingredients for changing unfavourable framework conditions. The issue is whether current S&T policy in Russia is contributing to changing framework conditions and to innovation. As argued in the sections above Russian S&T policy is still not operating as a promoter of structural change but more as buffer to further erosion of the R&D system. Revival of growth offers unique opportunity for S&T policy to play a more active role in promoting structural change.

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