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Russia

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Russian history is full of contradictions in the evolution of its innovation system, its state policy and its position in the world.[1] Russia as a successor of the USSR is known for its contribution to global science and technology (S&T). During its long history the basic elements of science and an innovation system were put in place under political and economic objectives which led to the acceleration of S&T to serve military requirements and industrialisation. Intensive investment was made in R&D facilities and equipment, and it became possible to carry out research in the most important scientific areas. As a result, the very specific — but at the global cutting edge — S&T sector and national system of innovation (NSI) were created (Gokhberg 2003).

In the USSR the government was spending about 4 per cent of the country's budget on R&D. In certain years total R&D expenditures amounted to 3 per cent of the GDP. According to official statistics, even in 1990 (the last and not the best year in the history of the USSR) 2 per cent of the GDP was allocated to support the R&D sector. 'Science and related services' employed about 4 million people (including almost 1 million researchers); the share of researchers in the economically active population was one of the highest in the world — more than 200 R&D personnel per 10,000 employed.[2] Though R&D potential during that period was mainly concentrated in a few major R&D centres, an active regional policy was pursued. All large regions (the Soviet republics) had academies of science, universities, big R&D centres, informational centres, etc.

Advanced research, cutting-edge technologies, innovations have radically changed the way of life the world over, and continue to do so. Many experts agree that losing the pace of S&T development was one of the main reasons leading to the collapse of the USSR. Here we refer specifically to the relationship between science, the NSI as a whole and the state. This covers the organisation, management and the support for S&T development. It concerns the efficiency of mechanisms for the reproduction and use of R&D potential and the application of R&D results in the economy.

Against the background of the overall stagnation of the Soviet economy, its painful inability to adopt and implement R&D results and new technologies, the opportunities to mobilise additional resources required to sustain a high S&T level began to shrink. One might think that in a planned economy it should not be a problem to create optimal conditions for regulating the S&T and innovation activities sphere but this was not the case. Due to predominating centralised management, the conditions for pursuing an S&T and innovation policy were extremely adverse. In reality nothing except direct government intervention into the activities of specific research institutes or enterprises encouraged S&T progress. Indirect motivation and promotion of S&T and innovation activities practically haven't been used at all.

Immediately after the collapse of the USSR the S&T complex faced a systems crisis, and some of its consequences still haven't been overcome yet. According to official statistics, gross domestic R&D expenditures (GERD) just in 1990–1995 dropped by four times (in constant prices); federal budget allocations (FBA) on R&D dropped five times; the number of R&D personnel two times.[3] Despite the subsequent improvement, by 2009 GERD had increased to just 75 per cent of the 1991 level (and to just half of the 1990 figures). R&D expenditures as a share of GDP in 2009 amounted to 1.24 per cent (2005–2006 — 1.07, 2007 — 1.12, 2008 — 1.04 per cent); expenditures per researcher were $40.1 thousand (several times less than in many developed countries).[4] The S&T potential is still unevenly distributed across the country's territory (in certain respects the situation became even worse). In 2009, 21 per cent of all R&D organisations were located in the city of Moscow (and almost 28 per cent of them in Moscow together with the Moscow region), with a further 10 per cent in St Petersburg.

Practically until the disintegration of the USSR and even a few years afterwards, its system of innovation existed in narrow scientific-technological space. Scientific results and innovations were created and introduced (as a rule) on the basis of the centralised decisions of the government, and in the areas connected to the state's interests. Note that the term 'national system of innovation' was never used in the USSR, and the actual NSI was not considered worthy of research or of a special government policy.[5] Only during the last years of the painful transformations of the economy, the state and society, has a comprehension of a key role of innovations, and the necessities of a wider understanding of NSI as a system of national institutes been emerging.

The wide understanding of innovation and the new approach to NSI have been fixed in key documents of a state policy only in the beginning of the current century. Most of them were adopted by the government of the Russian Federation. Among them were the basic direction of the Russian Federation's policy on S&T development until 2010 and subsequent period (2002), R&D and Innovation Development Strategy in the Russian Federation until 2015 (2006) and the Ministry of Education and Science (MES) basic report 'The Development of Innovation System of Russian Federation' (2008) documents.

The position detailed in these documents are consolidated and widened in the main official initiative at the current stage (2008) — 'Conception of a Long-Term Development until 2020' (CLTD 2020).[6] This document reflects the world trend connected with increased importance of long-term socio-economic and S&T development priorities, affected both by global trends and limitations and national specificities and potential. International experience suggests that understanding these trends and taking them into account when developing national policies is necessary to select adequate policy tools which would allow the implementation of national concepts and priorities in the environment of open economy and international competition. The importance of speeding up the country's 'leap' becomes even more apparent against the background of the global financial crisis and its manifestation in the Russian Federation.

All segments of the NSI and all economic actors feel an urgent need for a systematic representation of the country's R&D and innovation system, as well as an improvement of appropriate government policies. This is due to the fact that all of them feel the pressure of a whole host of legal, administrative, financial, and other limitations and barriers which hinder their efficient operation and hamper the economy's transition to innovation-driven development, which, in turn, are the strategic objectives of the country's development policy.

A major result of the CLTD (including the long-term forecast of socio-economic and S&T development prepared in the course of this work) and other documents is the consensus arrived at by the society and economic community regarding the unquestionable need to shift the national economy from heavy reliance on raw material exports to innovation-driven, socially oriented development.

Note also another aspect important in the context of the study. In effect for the first time in Russia, the Concept documents use the modern definition of NSI which comprises the following:

(*a*) interlinked structures engaged in production and/or commercial exploitation of knowledge and technologies and;

(*b*) a set of legal, financial and social institutes which ensure interaction of educational, R&D, entrepreneurial and non-profit organisations in all spheres of the economy and social sector.

For example, CLTD 2020 is based on three main elements:

- Policy framework — the conception brings together the key policy directions and establishes connections between NSI development policies and other spheres: education system development, progress of high-tech sectors, environment protection strategies, health system development, regional development strategies, etc.
- 'Roadmap' for reforms — this component of the CLTD 2020 sets out the structure of each direction as well as a basic plan of action. For NSI it is represented by six initiatives including development of human resources for innovation, infrastructure support, stimulation of demand for innovation, and others. For the first time in the history of Russia this document confirms the invariance of its transition to an innovative model of development and submits the restrictions, opportunities and directions of this transition so much in detail.
- Target indicators — a statistical tool for tracking the main macro effects to monitor the progress of the reforms. There are several indicators proposed to refer to the NSI development goal: GERD-to-GDP ratio, labour productivity, share and other indicators for the high-tech industries, etc. Some of them can be seen in Table 3.1.

Table 3.1: *The Key CLTD Target Indicators for NSI Development*

(%)	2007	2020
GERD to GDP ratio	1.12	2.7
Labour productivity growth rates	6–7	9–10
Share of high-tech sectors in value added	10.9	17–19
Share of high-tech products exports in the world's total	0.3	2.0
Share of innovative products in total sales	5.5	25–35
Share of industrial enterprises engaged in technological innovation	13.3	40–50
VA of innovation sector to GDP	10–11	17–20

Source: GRF (2008a).

In spite of the inevitable adjustment of the indicators presented in the table — and of the other target CLTD 2020 indicators — due to the effects of the global financial and economic crisis, in the long term the suggested ways and means to ensure sustainable increase of the population's standard of life, improve national security, achieve dynamic growth of the national economy, secure a better position on the global arena should remain valid and develop further. Russia's political leaders repeatedly made statements to this effect, speaking about plans to sustain the level of support to R&D and high-technology sectors.

Evaluation of the Current Form of State and Its Position in Relation to NSI

In the USSR (and in Czarist Russia before 1917) R&D was developed as a government sub-system, and concentrated in government-owned structures such as institutes and universities. In terms of the scale of the S&T complex, the USSR was quite comparable with the USA but its development was accompanied by numerous ambiguous and controversial phenomena which ultimately eroded that positioning. In 1989 the Soviet R&D sector comprised more than 4.6 thousand organisations including research institutes, design bureaus, higher education institutions, and enterprises. It employed over 4 million people, or almost 4 per cent of the national workforce. Fourteen out of every thousand workers were researchers (Centre for Science Research and Statistics 1992).

During that time the scientific community and the society generally became convinced that universal, comprehensive government support (funding, planning, supervision, etc.) was natural and necessary. Until about the late 1970s scientists and university teachers received sufficiently high (by Soviet standards) salaries and their professions enjoyed a high prestige in society. Then the situation deteriorated dramatically.

The combination of two key factors — reliance on permanent patronage by the government and gradual worsening of the majority of the researchers' material situation — partially explains why a proportion of the scientific community, a rather appreciable one, did not accept the liberal market reforms of the early 1990s. Up to a point this attitude is still there. For example, a study of researchers' opinions regarding the current state of the R&D sphere and efficiency of various government policies suggests that about 50 per cent of the scientists still remain quite sceptical about the prospects of a national system of science and those of their own career development. Among the least appreciated government initiatives are those on privatisation and incorporation of R&D organisations, the limitation of their business activities (as part of downsizing and restructuring of the public R&D sector) and other institutional changes.[7]

In any country society's needs are met, economic potential grows and national security is achieved through development of the S&T sphere. During the 1980s, when the efficiency of the Soviet S&T complex was obviously declining, according to the then president of the USSR Academy of Science, G. Marchuk, in 40 per cent of the 400 priority S&T development areas Soviet scientists were either the leaders or on par with the top world level. In other areas the lag was apparent. In 1980–1988 the share of R&D results which were better than the top world level dropped from 9 to 4 per cent, and of those on par with it from 34 to 22 per cent (Avdulov and Kulkin 1996; *Scientific–Technical Progress in the USSR* 1990).

After the disintegration of the USSR when wide ranging reforms including privatisation and market liberalisation were being undertaken, the Russian economy and the Russian state changed dramatically. The state became more democratic; market institutes, elements of a civil society (which are not always accepted 'canonical' forms) gradually began to develop. All this occurred in a background of economic crisis — deep contraction of output with GDP as well as industry output declining by roughly 50 per cent (1990–1995). The collapse of the Soviet Union, and the transition to a market economy radically affected the inherited national S&T system.

However, the reforms of the S&T system and other sectors of the Russian economy were much different in terms of speed and depth, in favour of the latter.

These developments prompted the government to turn to international experience. Modern mechanisms for supporting the S&T and innovation sphere attracted a lot of attention, though not per se but rather in the context of an open (or not so open) contest of the two systems — socialist and capitalist. The Soviet leaders had to admit that some of the Western countries had more advanced S&T potential, developed more efficient mechanisms for application of R&D results to production, and that their governments were more successful in encouraging research and innovation activities. Analysis of international experience revealed not just factors due to the differences between the economic systems but also certain significant socially neutral elements of S&T organisation, a sensible combination of direct and indirect management and promotion techniques.[8] Attempts to develop and implement similar components under the 'brand name' of 'self-financing R&D sector' were made in the USSR and then in Russia after the mid-1980s.

At the beginning of the 1990s the situation in the S&T sphere started to develop along a worst-case scenario. The share of internal R&D expenditures dropped to 0.7–0.8 per cent of the GDP, and then for several years remained under 1 per cent — a typical level for countries which practically do not develop (or do not have at all) their own S&T potential. The radical transition to market economy affected all sectors of the economy and all spheres of social life, and the effects had profoundly different scales and sometimes different directions as well. Due to a very large number of reasons (identified in the course of this study), the R&D sector was among those which have been largely negatively affected by the market reforms and their consequences.

If market reforms of the overall Russian economy were generally implemented during the 1990s, in the R&D sphere this process still remains unfinished. Accordingly, if in the overall economy in the 2000s only 3.3 per cent of organisations and enterprises were publicly owned, the appropriate figure for the R&D sector was over 70 per cent (Rosstat 2008: 349; HSE 2011a: 28). As owner of the major share of the R&D sector's property and in effect the only solvent customer of R&D products, the state (on behalf of the government) could have implemented a tough 'top down' reform in this sphere at the very beginning of the market reforms period. That was the case in almost all Eastern European and Baltic countries. However, due to various reasons a different way was chosen — allowing the R&D sphere to self-adapt to the new environment.

Table 3.2: *R&D Institutions by Ownership (percentage)**

	2000	*2002*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Total = 100%	4099	3906	3656	3566	3622	3957	3666	3537
Public	71.6	72.1	73.2	73.8	73.2	71.3	74.1	75.1
Federal	67.2	67.7	69.0	69.6	69.2	67.0	69.9	70.8
Voluntary Associations	1.5	0.8	0.7	0.8	0.8	0.9	0.8	0.7
Private	9.5	11.7	11.5	11.8	13.9	16.1	13.9	13.4
Joint**	15.5	13.5	12.8	11.8	10.3	9.7	9.4	8.8
Private and Joint, Total	25.5	25.2	24.3	23.6	24.2	25.8	23.3	22.2
Joint***	1.4	1.5	1.4	1.3	1.2	1.57	1.1	1.1

Source: HSE (2009a); HSE (2011a).

Note: * Municipally-owned and cooperative organisations are not listed due to their very small number (in 2009 there were 14 and three such organisations, respectively).

** Without foreign participation.

*** With Russian and foreign participation.

Analysis of the data in Table 3.2 makes the failure of this strategy quite evident. The data clearly shows that during practically the whole period of reforms privately owned R&D organisations did not have opportunities, motivation or prospects for successful development. Rare examples of corporate science's success rather confirm than refute this argument. The non-profit private R&D sector in Russia is even weaker. About 1 per cent organisations brand themselves as private non-profit institutions in this sector. As a rule most of them are financial mediators, which are not engaged in research in practice.

The S&T system which developed under the Soviet 'rules' had three special characteristics: it was very large, centrally directed and government-financed (Kiseleva et al. 1991; Kuznetsova 1992). These features were ill-suited to a market economy and it was not surprising that the system of S&T underwent a system crisis and posterior deep stagnation. In principle, the same could be said about a wider sphere than the S&T complex — the NSI.

The period of 1999 to the middle of 2008 may be considered as a period of stability and socio-economic recovery. However, this growth was not based on real labour productivity or innovation. The Russian science sector and the NSI are still mostly inefficient. There is a striking imbalance between resources devoted to research activities (carried out mostly in government institutions outside of the higher education sector and industry) and the innovation performance.

A specific feature of the Russian situation is the fact that the government's influence over R&D and the NSI was predominant under both the 'totalitarian Soviet regime' and in democratic Russia, as well as during various crises and periods of economic growth. In the early stages of the reform it was believed that restructuring the R&D sector would be impossible without overcoming the negative heritage of the USSR — namely the highly militarised, government-controlled nature of this sphere, weak links with the international scientific community, and insufficient connections with innovation, industry and education. The result of the 20-year period of reform is paradoxical — a lot of good things inherited from the Soviet era were abandoned and rejected while the 'Soviet' R&D model's features that the reformers were set to transform still largely remain in place.

Here are three examples to illustrate the point:

(*a*) Shares of R&D organisations controlled by various government agencies (including state academies of science) have changed, but the approach to the management of science is still based on the same government supervision principle. Government agencies provide more than 50 per cent of R&D funding — just like they did 15–20 years ago. Approximately 13 per cent of all R&D spending was provided for the basic support of the Russian Academy of Science's institutes.

The share of funding allocated through tenders is growing slowly. For example, only 15–16 per cent of total R&D expenditures were allocated through target programmes. This figure includes the inflow from public R&D foundations also.[9] In total these foundations allocate about 7 per cent of civil R&D expenditures. About 2 per cent more came in grants (to support young and outstanding scientists, scientific schools, etc.). Of course, in the federal budget the share of funding allocated through tenders is much higher, at about 37 per cent.

Furthermore, this approach is quite likely to become even more pronounced.[10] The evidence of that is the invariably high share of public funds in the R&D expenditures (65.5 per cent in 2009); the predominant share of research institutes among the R&D (53.1 per cent), and of academic institutes in the public R&D sector (almost 70 per cent). Another proof is the results of modernisation of the academic sector (more truly — the absence of evident results) and creation of large government-owned S&T corporations (see later). Public administration's efforts to coordinate initiatives in the S&T and innovation sphere in most cases amount to just 'declarations of intent'.

(*b*) The R&D sphere in the USSR was indeed highly militarised, and the reasons of that are well-known. Before the collapse of the USSR domestic science began to lag behind other countries in many civilian areas which determine the modern S&T 'image' of the world. However, drastic reduction of government military orders in the 1990s can hardly be seen as a good solution to the problem. Damage was done not just to the military but to civilian R&D as well as to all innovation and technological chains and networks. Some of the enterprises which were vital for the country's economic and geopolitical interests have been closed down. Moreover, military products and technologies happened to be one of the few things Russia could 'boast' of in the international markets.

Today Russia remains a country with a high military potential, and, obviously, to support it, it should develop military R&D. Despite the substantial losses suffered by the sector the chances of its future expansion remain rather high.

(*c*) Despite substantial efforts to promote innovation activities (see later), real changes are very slow to materialise. At first (in the beginning of 1990) the progress was hindered by objective factors — the long period of recession and low demand for locally produced innovations from industry. Today the situation is gradually changing. Enterprises, R&D organisations, research centres, higher education institutes all feel the need for joint innovation activities. However, the laws on the promotion and support of S&T and the innovation sphere are incomplete, insufficiently thorough, or are poorly enforced.

Accordingly, only a small share of Russian enterprises

- are engaged in innovation activities (near 3,000 or 9.4 per cent from the total in 2009);
- produce innovation products (appropriate output amounts to just 5.5 per cent of the total output of industrial enterprises engaged in innovation activities);
- participate in networks and cooperation. The share of industrial enterprises participating in joint R&D projects (on a regular basis) in the total number of enterprises engaged in technological innovations is 33.2 per cent; the share of enterprises which are buying new technologies is 37 per cent; transferring new technologies, 3 per cent; using feedback information from consumers of their products, 11 per cent.

Twenty-seven per cent of technological innovations conducted by industrial enterprises are based on R&D; 7.2 per cent are achieved through industrial design, and less than 1.5 per cent through acquisition of new technologies. A major share of total expenditures on technology (51.2 per cent) is spent on the acquisition of machinery and equipment.

Public R&D organisations and higher education institutes still have problems with setting up small enterprises to transfer their R&D results and technologies to the real economy, with securing and exploiting intellectual property rights, and undertaking joint projects with industrial enterprises. Lots of small enterprises have to go through the same 'sieve' of tax returns and tax inspections as large companies (which can afford to hire numerous accountants, financiers and planners). However, the tax regime for them is extremely volatile.

Succession between the USSR and Russia in the S&T sphere and the NSI on the one hand increased the stability of the new 'object' — the Russian S&T sector — even in the situation of the very hard transition crisis of the 1990s. On the other hand, conservation of the archaic organisation and support system had significantly hindered the reform of the S&T sector to suit the needs of market economy. Today the Russian S&T sector is structured mostly in the same way as it was 20 or 30 years ago. In effect we're talking about the same segments of the S&T network — academic research institutes, higher education institutions and their associated R&D organisations, R&D divisions of industrial enterprises. The difference is that in today's Russia they operate in a market environment, and include a small number of newly emerged privately owned organisations.

It can be argued that today the fate of Russian R&D and NSI still remains in the hands of the government. In recent years this position was considered unfashionable and absolutely irrelevant by a lot of Russian liberal experts and officials. However, it is reflected in many government decisions, in the orders (instructions) of the president of the Russian Federation to the Russian government, ministries and various agencies. In particular these orders concern creation of large national (public) research centres and research universities; adoption of joint funding and cooperation mechanisms between public and private sectors to finance innovation projects; creation of a favourable tax environment for R&D and innovation activities; development of the 'territories' favourable for innovation, etc.

In spite of the necessary (and inevitably promoted by the very 'rules' of a market economy) trend towards reduced government participation in various spheres of socio-economic activities, in reality the role of the state is still very high in any country. The innovation activities of business being supported by the state, is a key factor of the country's competitiveness and sustainable economic growth. In today's Russia the government has sufficient resources (as well as adequate power) to sustain and develop the S&T potential, and to increase its contribution to achieving national objectives.

Periodisation and analysis of institutions and policies of the state concerned with innovation

The evolution of Russian S&T and innovation policies post-USSR can be divided into four main stages for convenience.

The first one was a period of 'marker romanticism' in the early 1990s, driven by the vain hopes of reformers for quick and automatic transfer to a market economy. However, these high initial plans were not met. Multiple mistakes in planning the market reforms and corresponding actions resulted in a deep systemic crisis within the Russian NSI — the dramatic funding fall, the shedding of human resources, the disbanding of scientific organisations during the first wave of privatisation. The consequences of this crisis have not been overcome even now.

In the next stage ('market formalism', the middle and end of 1990s) the S&T sphere fell into deep stagnation. Formally, it was subjected to the same market transformation as all other sectors of the economy, but the real shifts here were lagging far behind the overall economic reforms. Government initiatives were reduced to urgent measures to slow down the definitive disintegration of the S&T complex.

In the early 2000s, during the third period (the stage of 'market pragmatism') important strategic decisions were outlined for the future or were just started. Practical actions were planned and carried out mainly based on the criteria of economic expediency and budgetary savings. However, the strategy of postponing decisions for national science and NSI resulted in serious risks and narrow focus on the short and medium-term programmes and projects at the expense of long-term ones.

The fourth stage, lasting from the mid-2000s to the present day, is characterised by a complex set of measures adopted by the government. Their key aim is the transition towards an innovative model of national economy. All measures of the current period can be divided into three groups. The first one is the creation of a structured NSI policy framework. The second is the implementation of the policy mechanisms for efficient regulation in the main areas of government activity: national priorities, performance-based budgeting, restructuring the government R&D sector, human resources and infrastructure development, etc. During that period yet another cycle of programme development actions took place, producing documents describing a platform and the main development areas — for the medium and long (10 years) terms. The last one is a complex period of anti-crisis and post-crisis activities.

Tables 3.3 and 3.4 provide some quantitative data describing Russia's development during these periods, based on official statistics. They show that during the period of reforms the Russian R&D sphere became one of the areas negatively affected by the market transformation of the economy. The evidence is well-known — the unprecedented decline of funding and of the number of R&D personnel (until the mid-1990s), worsening of the 'scientific climate' and environment in which R&D organisations operated, deterioration of material basis and the country's position in international high-technology markets.

Development trends of an economy in transition are quite different from the laws of a developed market. In any country going through a transitional period the government must increase targeted impact in certain areas, take over some medium- and long-term obligations. In that sense the Russian situation in the 1990s can hardly be considered unique. Since the level of government interference was traditionally quite large in this country, transformation of the science and education sphere would probably have been painful even without the crisis. The 'revision' of the traditional national priorities, the government's refusal to carry on with many of its previous obligations led to corrosion of the previous motivation factors (the defence interests, prestige, etc.). In effect, at the initial stage of the reform period science and innovation have been excluded from the list of strategic priorities, which later on has been judged the reformers' very grave error. Consequences of these decisions are still being felt in Russia (Kuznetsova and Kitova 2003).

Table 3.3: *Main Development Indicators of the S&T Complex, 1990–1999 (The First and Second Periods)*

	1990	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*
1*	10.9	7.3	3.2	3.1	2.9	2.5	2.7	3.0	2.6	2.9
2	2.0	1.4	0.7	0.8	0.8	1.0	1.0	1.0	1.0	1.0
3		25.8**	11.2**	9.9**	6.3**	5.03**	4.3**	6.02**	1.8	1.9
4	–	1.85**	0.94**	0.91**	0.66**	0.24**	0.6**	0.8**	0.24	0.24
5	258	227	213	186	162	160	150	144	134	136
6	–	–	–	32.2	23.1	22.2	23.2	20.0	21.4	24.7
7	–	–	–	27.8	40.3	31.6	33.6	46.0	23.8	19.52
8	–	–	–	–	–	–	–	–	–19.9	– 283.2
9	4646	4564	4555	4269	3968	4059	4122	4137	4019	4089
10	449	400	340	299	276	325	342	299	240	289

Source: HSE (2007); HSE (2009a).

Note: * 1: Gross Domestic expenditures on R&D (GERD) at constant 1989 prices (billion roubles); 2: GERD as a percentage of GDP; 3: Federal Budget Appropriations (FBA) on civil S&T at constant 1991 prices (million roubles); 4: FBA on civil S&T as a percentage of GDP; 5: R&D personnel per 10,000 employment; 6: patent applications by resident applicants in Russia (thousands); 7: patents granted (thousands); 8: technology balance of payments (million US dollars); 9: R&D institutions; 10: among them industrial enterprises.

** Total Federal Budget Appropriations on S&T at constant 1991 prices (million roubles) as a percentage of GDP.

Table 3.4: *Main Development Indicators of the S&T Complex, 2000–2006 (The Third and Fourth Periods)*

	2000	*2001*	*2002*	*2005*	*2006*	*2007*	*2008*	*2009*
1*	3.3	3.9	4.3	4.6	4.9	5.6	5.5	6.1
2	1.05	1.18	1.25	1.07	1.08	1.12	1.04	1.24
3	2.0	2.35	2.65	4.16	4.54	5.5	5.7	7.5
4	0.23	0.26	0,28	0.36	0.36	0.4	0.6	0.5
5	138	136	133	122	122	135	128	126
6	28.7	30.0	29.2	32.3	37.7	39.4	41.9	38.6
7	17.6	16.3	18.1	23.4	23.3	23.0	28.8	34.8
8	20.6	–153.8	–361.0	–564.8	–595.0	–796.0	–1254.0	–1001.0
9	4099	4037	3906	3566	3622	3957	3666	3536
10	284	288	255	231	255	265	255	265

Source: HSE (2009a); HSE (2011a).

Note: * 1: GERD at constant 1989 prices (billion roubles); 2: GERD as a percentage of GDP; 3: FBA on civil S&T at constant 1991 prices (billion roubles); 4: FBA on civil S&T as a percentage of GDP; 5: R&D personnel per 10,000 employment; 6: patent applications with the indication of Russia in Russia (thousands); 7: patents granted (thousands); 8: technology balance of payments (million US dollars); 9: R&D institutions; 10: among them industrial enterprises.

During the first and second stages the development of the R&D sphere was irregular and controversial, mostly due to problems with public funding. The allocated resources and the reaction of the sphere in general didn't match the declared objectives. At the same time reduction even of the small amount of funding promised by the government became common practice.

Despite the crisis, important documents have been developed during that period, summarising the experience of the first years of reforms and defining key principles and approaches to the management of science. These include The Doctrine of Russian Science Development (1996), the federal law 'On Science and the State S&T Policy' (1996), The Concept of Reforming Russian Science in 1998–2000 (1998). A large amount of work was undertaken to implement previously non-existent forms, mechanisms and relations determining the model of science adequate for a market economy.[11] All this has been done in a uniquely short space of time. For the first time in Russian history documents were published to define objectives and areas of the national S&T policy; a legal framework for international S&T cooperation was developed; attempts to restructure academies of science were made.

By the mid-1990s the management model for the Russian R&D sphere started to look similar to the models used by other developed countries (formally, in terms of principles and approaches adopted). However, its practical implementation was inconsequential and contradictory. Accordingly, the actual effect of even the most progressive ideas did not match the expectations and the S&T sector's contribution to the nation's development in terms of the emergence of a modern NSI seemed incomparable to its true potential. The R&D sphere's social rating dropped, and the public perception of its role in the country's development became more sceptical. The public image of 'science falling to pieces' in itself was a serious barrier hindering implementation of the reforms (Shuvalova 2007). The stratification of the academic community became more pronounced, the level of their social and political activity dropped. In effect it amounted to the lobbying of interests of specific groups, projects, programmes representing group or personal interests.

After 2000 Russian government policy became more oriented towards promoting innovation and sustainable economic development. The favourable market situation and macroeconomic and political stability allowed the development and implementation of a wide range of measures to put together a modern NSI and support high-technology sectors of the economy. The ultimate goal of these steps was defined as technological modernisation of industry, exploitation of national competitive advantages (including the R&D potential) to increase the population's standard of life, competitiveness and national security.

It is not easy to identify the precise boundaries of this period due to the beginning of the world crisis (in the end of 2008) and the real perspective of its continuation (the second wave). Thus the start of the fifth period for Russian R&D is more than uncertain.

Specificities of the system of innovation in the country and its relationship with the state

Despite the high rate of economic growth achieved in the 2000s — regarding many indicators reflecting development levels and prospects — Russia is not catching up with the world leaders (see Table 3.5). Low (compared with other developed countries) levels of such indicators as R&D expenditure calculated as share of GDP, scientists' publication activity, innovation activities of enterprises, remained practically unchanged throughout the period of market reforms, including the years of economic growth. Due to a host of objective reasons (very often external to R&D, innovation and even production spheres) companies still are not really interested in the intellectual component of the innovation process. Within the structure of technological expenditures the accent is placed on acquisition of machinery and equipment, in most cases foreign-made. Successful R&D organisations have to work increasingly for foreign companies and international organisations. Higher education institutes are still regarded as non-serious players in the innovation sphere.

Table 3.5: *Parameters of Productivity: Loss of Competitive Positions (International Comparisons)**

Indicators	*Russia vs. Some Other Countries*
Publication in world scientific journals (publication activity)	Russia: 1.8, 16th position in the world (1995 – 7, 1980 – 3)
	China: 15.1, 2nd position (1995 – 1.6, 14 position)
Technology export	Russia: 0.6 bln $, Austria: 7.3 bln $, USA: 89.1 bln $
Patents applications by resident applicant	Russia is lagging behind Japan 9 times, USA 11, Korea 4 times
Share in the world hi-tech market	Russia: 0.3%
	Singapore, Korea, Taiwan: 4–8%
Innovative activity of enterprises	Russia: 9.4%
	EU: from 24% (Latvia) to 80% (Germany)
Share of innovative products in total sales of industrial products	Russia: 1.93%
	Germany: 2.18, Finland: 2.76, Sweden: 3.18%
Share of innovative products (new to the market or new to an enterprise) in total products of industry	Russia: 2.5% Germany: 25.5, Finland: 23.7, France: 20.7%

Source: HSE (2011a); HSE (2011b); HSE (2011c).

Note: * Russia: 2009; other countries: 2007–2009.

Most of the Russian industries remain technologically obsolete while the overall economy still has a serious structural misbalance — which makes its position in the international markets very vulnerable and unstable. The national economy is largely based on mining, processing and exporting fuel, and a few traditional manufacturing sectors (see Table 3.6).

Table 3.6: *Certain Characteristics of the Russian Economy (by Industry) 2010*

	Agriculture	*Manufacturing*	*Mining*	*Wholesale and Retail Trade*
Share in the total number of enterprises and organisations (%)	4.0 (-)	8.3 (-)	0.4 (+)	37.1 (-)
Share in the total turnover of all enterprises and organisations (%)	1.5	21.7	7.1	42.0
Industrial production index	88.7	111.8	108.2	104.5
Share in the total output (%)	4.2	24.6	7.1	15.8
Share in the total added value (%)	4.4	14.5	8.9	18.1
Productivity growth	89.3	109.0	101.3	98.5
Share in total exports	2.3 (+)*	5.7 (+)**	68.8*** (-)	-
Share in total imports	15.9 (-)	44.5 (-)	2.6 (-)	-

Source: Rosstat (2011: 38, 313, 315, 345, 346, 354, 371, 411, 511, 713, 766).

Note: «+» – Growth in the last 2–3 years; «–» – decline in the last 4–5 years
* Food stuffs and agricultural materials
** Machinery, equipment and vehicles
*** Only minerals

So far there are no major technological breakthroughs achieved by Russian industry, nor significant implementation of R&D results which are typical to any innovative economy. Innovations hardly affect Russian economy. At the same time innovation activities are hindered by various barriers engendered by the overall macroeconomic context and the institutional environment. The low level of the latter is evident in all industries, and in all kinds of innovation activities — technological, organisational and marketing innovations.

The potential to achieve dynamic, sustainable and innovative economic growth is limited, on the one hand, by the very weak interest the Russian business sector displays in technological and non-technological innovations alike, and on the other by insufficient productivity of Russian science, lack of a critical mass of innovative projects attractive to investors. Factors such as an insufficiently developed competitive environment and lack of motivation for enterprises to develop and implement new technologies, should certainly be taken into account too.

Some data in support of these conclusions has been included in Table 3.5. For a deeper understanding of Russia's 'innovation paradox', we provide a few additional estimates:[12]

- In 1995–2009, the number of organisations engaged in technological innovations has doubled (from 1,363 to 2,761), but in the last two–three years it remained practically unchanged. In 2009 the number of organisations engaged in all types of innovation activities in industry was 2,682, in manufacturing 2,256 and in the service sector, 644.[13]
- Innovation activities are different in various industries. On the aggregate level, minimum innovation activities (for all types of innovations) are registered in mining (approximately 7 per cent) and maximum in manufacturing (12–13 per cent).
- It is a well-known fact that innovation activities largely depend on the specialty and technological level of production. In Russian high-technology industries, the overall level of innovation activity amounts to about 30 per cent, in medium-technology industries to 13–20 per cent and in low-tech industries to 2–11 per cent.
- In high-tech service sectors (communications, ICT) this figure reaches 10–15 per cent, but the overall innovation activity level in the service sectors remains low.
- A vast majority of innovative enterprises and organisations (86.5 per cent) belong to the manufacturing industry, in particular, production of food, machinery and equipment, electrical equipment, medical equipment and instrumentation, radio, TV and communication equipment, etc.
- Large, economically sound organisations with sufficient financial, human and intellectual resources are the most active in the innovations field. Half of the industrial enterprises engaged in technological innovations employ a staff of more than 500.

- The share of small enterprises engaged in technological innovations varies around 4 per cent. The most active are small enterprises manufacturing medical equipment and instrumentation, pharmaceuticals and computer hardware.

The current S&T development in Russia is still affected by rather conflicting trends. On the one hand, the government R&D funding is growing (FBA on civilian R&D in 2004–2009 grew by 2.45 times in real prices). About 34.6 per cent of the government funds are allocated to support basic research. Financial support of R&D through contracts, programmes and tenders has also grown. The number of researchers (369,000, 49 per cent of R&D personnel in 2009) has nearly stabilised: the rate of its reduction was within 1 per cent from 2003. The number of people employed by private research institutions is increasing (29 per cent increase since 2000). However, the level of government support still lags behind the world's economic leaders. Evidence of that is provided by certain financial indicators given in Tables 3.7 and 3.8.

Table 3.7: *The Role of the State in R&D (Some Statistical Indicators)*

Funding	*Organisations*	*Personnel and Fixed Assets*
FBA on civil R&D: 2.23% of federal budget expenditures (2009) FBA on civil R&D: 0.56% of GDP (2009) Government contribution as source of R&D funding: 66.5%	75.1% of R&D organisations are owned and established by federal and regional governments GERD by ownership of R&D institutions (public ownership): 74.3%	78.9% of R&D personnel work in government organisations (federal and regional) 86.9% of R&D fixed assets are public

Source: HSE (2011a).

On the other hand the stagnation in the S&T sector is evident. It stems from both insufficient demand for and underdeveloped supply of R&D and technologies. Private business does not show much interest in innovation. Since 2000 the innovation activity has remained at the level of 9–10 per cent.[14] The EU economies' figures are significantly higher. Investment in innovation is considered by private businesses to be more risky and less profitable than investment in mining and quarrying activities. Demand for R&D comes mostly from the government, and the federal budget remains the key source of R&D funding (in 1998–2007 it grew threefold in real prices).

As it has already been mentioned, on the national economy level, the overall effect of R&D and innovation activities is almost invisible. Only high-technology sectors show progress. Unfortunately, their success — relatively higher levels of innovation activity and effectiveness — so far has been unable to change the 'state of affairs' of innovation in the Russian economy, and this effect is limited by the number of working enterprises, number of staff and the actual output. Advanced tools to support and encourage R&D and innovation activities, create innovative infrastructure, upgrade and adjust development institutions, are not used to their full potential in Russia; their conceptual, methodological, organisational, legislative, and law enforcement support is fragmentary, incomplete and occasionally even controversial in nature.

Table 3.8: *Expenditures: A Little to Invest, a Little to Receive? (R&D Funding in Russia)*

	Positive Trends	
Increase of GERD	1998–2009 — more than 19 times	
	At constant prices — more than 2.5 times	
Government Budget Appropriations on R&D (PPP)	Russia*: 23 bln $ (2009)	Far from USA (7 times lower), but very close to Germany and Japan; more than in France and in Great Britain
	Negative Trends	
	Russia	**Other Countries (2007–2009)**
GERD as a Per cent of GDP	Russia: 1.07% (2006), 1.12% (2007), 1.04% (2008), 1.24% (2009)	Israel: 4.77%; Japan: 3.44%; USA: 2.79%; China: 1.54%
GERD (PPP)	Russia: 23.0 bln $ (2009)	15 times lower than in USA; 6 than in Japan; 5 than in China; 1.5 than in Britain

Source: HSE (2011a); HSE (2011b); HSE (2011c).
Note: Russia: Civil R&D.

Due to the fact that the organisation and management of R&D and innovation activities (including reliance on government support) still retain a number of specific features, there are the following short-and medium-term risks:

- further reduction of entrepreneurs' demand for R&D products; weakening of cooperative interdisciplinary links throughout the whole R&D and innovation cycle;
- limitations hampering efficient development of knowledge-generation environment may remain in place (regarding all kinds of resources and periods of time); the range and development level of scientific results may deteriorate;
- reduced level (quality) of staff training and retraining for innovation-driven economy (science, education, high-technology sectors);
- reduced appeal of the NSI for international contacts and cooperation;
- reduced quality and effectiveness of R&D, lower novelty level of Russian innovation;
- further slowdown of innovation activities;
- reduced range (and shares) of non-government funding sources, increased pressure on the federal budget.

Analysis of the latest science and innovation policy documents creates an impression of structural wholeness and completeness, on par with the best international practices. The wording of their general provisions and principles corresponds with the approaches adopted in developed countries. However, the progress regarding their further, more detailed development (objectives, techniques, mechanisms) is quite slow. Many support measures still and inevitably include an excessively large element of direct financial support (mostly from the federal budget). Measures to promote research and innovation, develop infrastructure, modernise development institutions are not fully implemented.

It is obvious that S&T and innovation in Russia as well as in other developed countries are based on a rather complex relationship between those who provide knowledge, those who control and regulate this process, and those who apply the results. Taking account of negative factors hampering innovation activities in Russia, the primary fields for government S&T and innovation intervention may be listed as follows:

(*a*) promotion of technology transfer (protection of intellectual property rights, building innovation infrastructure, organisational innovation, etc.);

(*b*) creating a favourable environment for S&T and innovation activities, direct support to S&T;

(*c*) development of public–private partnership (PPP) (cooperation), motivating of private business to co-fund and participate in projects initiated by the government;
(*d*) promotion of innovation activity and improvement of innovation climate (support to efficient innovators, creation of a competitive environment, improving legislation);
(*e*) increasing level of professional education, for example, in the field of innovation management;
(*f*) ensuring the prospects of the long-term sustainable technological development.

The practices of developed countries prove that all efforts to create these as well as other frameworks to work out relevant transformation schemes and procedures (including the fundamental reforms of the government S&T sector) appear to be even more effective than direct budget subsidies to S&T activities. In any case this effectiveness depends on adequacy of goals, real substance and the scale of the government's initiatives.

For example, we can examine the appearance in Russia of the system of various foundations for S&T support that were created in the middle of the 1990s. On the one hand, these (rather new for Russian practice) institutional initiatives in fact are based on the government (direct or indirect) subsidies. On the other hand, the spreading in Russia of the idea of competitive support to scientific teams has already played a noticeable role in promoting scientific activities.

The practical measures provided by the government on reorganisation of national science and NSI during the last 15 years did not always have a positive effect. They had not resulted in deep science integration into market economy and increasing impact on the social and economical progress. As a result, many parts of NSI nowadays still retain the features left from the centralised economy, while relevant and efficient policies are lacking. Changes in the situation will strongly depend on the success of measures aimed at improving the overall business environment, the stability of the economy, and the rule of law.

Today, we can assert that in Russia some success can be observed mostly within the groups of policy agenda mentioned earlier under (*a*) and (*b*). Some positive shifts exist within integration of science and education, creation of research universities, introduction of courses for the training of skilled managers for high-tech sectors etc.

(group of policy actions under [*e*]). For the other mentioned issues the Russian government does not so far demonstrate a deep interest in a real improvement of the innovation process. The modest success of S&T and innovation policy (and even the collapse of some parts of it) is to a certain extent determined by the lack of coordination between different elements of such policy, between government bodies dealing with S&T and innovation issues, etc.

In general, specific actions in the areas described in groups (*c*)–(*f*) are planned as part of the CLTD 2020 strategy (as well as other strategic documents mentioned earlier). Their implementation started in 2009 and is continuing at present. Implementation of government policies described in the Long-Term Development Concept will ultimately allow dealing with the main systems problem of the Russian S&T complex — inefficient use of resources allocated to the R&D sector combined with insufficient demand for innovations by businesses. This should lead to increased quality and supply of domestic R&D products and technologies, and increased demand by the real sector of the economy for technologies and innovations.

Explicit and implicit state policy towards science, technology and innovation

Effectiveness of the Russian S&T and innovation government policy is largely determined by the fact that Russia needs to deal with a whole host of problems immediately — those connected with the generation of new ideas, their transformation into high technologies and finally, production of actual goods and services. Constraints hindering acceleration of these processes take place at both ends: among customers and suppliers of R&D products (Gokhberg and Kuznetsova 2010a; Gokhberg and Kuznetsova 2010b).

In the USSR the national S&T policy was shaped under very strict ideological control, and in the situation of an appreciably closed S&T sphere. Creative freedom was allowed and even encouraged (especially in natural sciences, engineering and technology), but the opportunities for research, exchange of ideas and results were either a priori limited or could be made so at any time due to some ideological consideration or an official's whim. Academic mobility of scientists was almost not encouraged at all, though as early as the 1970s it was accepted the world over as a major factor and a sign of innovation-based economies.

After the collapse of the USSR the ideological limits and the closed nature of the S&T sector were overcome quite easily, maybe even too easily, from the point of view of sustaining the S&T complex and the national security. Abandoning the management and behavioural stereotypes which affected the country's social, economic and political development and life of its citizens, had turned out to be much more difficult. In effect the S&T sphere in Russia was (and still is) incorporated into the non-manufacturing sector and funded out of the state budget, mainly according to the leftover ('residual') principle and the 'achieved level' of appropriations. Thus, in the years of prosperity, rather significant public funds are channelled into this sphere, in effect without any analysis of these expenditures' efficiency. In the periods of crisis or stagnation the S&T sector is the first candidate for reduced government support. Usually the cuts are applied equally to all relevant budget articles, again without analysing the efficiency of appropriate recipients and the results they produce.

A negative effect of such an approach is the risk that the S&T potential's structure might deteriorate. The larger, traditional areas (and established R&D structures) get increasingly bigger government appropriations while many of the new, breakthrough S&T areas do not receive adequate funding. In this section we'll show how the Russian government is trying to deal with these negative effects. However, advancing in the right direction is turning out to be very difficult to achieve.

Overcoming the industrial approach to management of the R&D sphere also appears to be hard. The lengthy period of extensive development of the Soviet R&D sector allowed many of the ministries and government agencies to set up and maintain their own networks of R&D organisations, funded out of the government budget but working mostly to satisfy the needs of specific appropriate industries. Departmental approach as a management principle cannot be good or bad per se. However, its domination in the overall system of organisation, planning and funding of R&D activities resulted in fragmentation of R&D organisations and structures, which in turn led to the dissipation of resources, duplication of work, monopolistic practices, expenditures-based and extensive development of the R&D sphere, and an inability to deal with interdisciplinary and inter-industry tasks in sufficiently quick and flexible ways. As was already noted, the drawbacks of this approach have not been overcome in Russia yet. Furthermore, now they are manifesting in new ways — unlike anything seen in the USSR. In particular, goals and objectives of the national S&T and innovation policy (developed primarily by the MES) quite often clash with valid laws regulating the economic activities, and with the general civil legislation which defines the overall environment for R&D organisations (i.e., where this policy is implemented), which are developed primarily by the ministries of finance, economy and industry. The loser is always the S&T sphere and the NSI in particular.

Even further, in the course of modernisation of the budgeting process (see later for more) a quite decentralised (between ministries and government departments) scheme for planning R&D appropriations and distributing responsibilities for the sector's advancement has developed. Basic research is the responsibility of the state academies of science; the S&T sector as a whole and the development of appropriate legislation is the responsibility of MES; state S&T programmes are developed and implemented by the Federal Agency for Science and Innovation (at present abolished); R&D components of major goal-oriented programmes are the responsibility of the Ministry for Economic Development (MED); certain expenditures not related with programmes are administered by the Ministry of Finance. Technology implementation zones, venture funds, development of breakthrough (critical) technologies are responsibilities of MED and MES; Ministry of Information Technologies and Communication and MES are responsible for creation of technoparks; property of federal R&D organisations is managed by the Agency for Public Property Management; regional and local authorities allocate land to build innovative facilities, etc.

These inter-departmental barriers hinder complex, efficient restructuring of the S&T sphere, implementation of integrated R&D and the innovation cycle, development of common understanding among government officials regarding how much resources the state should allocate to advancement of science, and exactly how these resources should be spent. Nevertheless, the contemporary economic potential of the Russian economy is high enough to launch the NSI reforms and complete the transition of the S&T and innovation sector.

As was noted in the report 'Innovation-Driven Development as the Basis for Modernisation of the Russian Economy' (HSE 2008) prepared with the participation of Institute for Statistical Studies and

Economics of Knowledge (ISSEK) experts, there are two approaches to development and evaluation of national S&T and innovation policy:

(*a*) narrow approach which only takes into account a set of decisions affecting (directly and indirectly) R&D and innovation processes;

(*b*) and a wider approach, when decisions are evaluated taking into account the whole range of national goals (including technological modernisation, development of human capital, adjustment of development institutions, positioning of the country as a global power).

In the first case, recommendations and suggestions should cover traditional policy areas: government funding of organisations, enterprises, programmes, and projects (including promotion of cooperation and networking of innovation actors); legal framework, development of infrastructure and appropriate linkages. Certain progress has been made in Russia in this area during the years of reform. Now the accent should be placed on extending the range of available tools and mechanisms.

In the second case there's the need to discuss and adjust approaches to developing a better understanding of the role science and innovations play in the economy, and the S&T and innovation policy plays in the public administration system. It was noted earlier that inefficient government policy became a significant obstacle hindering development of R&D and NSI in Russia. However, the opposite is also true — the state of R&D and innovation activities largely determines available options for policy development and for increasing its efficiency.

By now the main directions of S&T and innovation policy in Russia, the reforms of science and NSI are the following:

National Priorities Setting

In Russia the efforts to select S&T priorities were first launched at the federal level in the middle of the 1990s, and have since been continued on a regular basis. National S&T priorities are formulated in two lists — priority S&T areas and critical technologies.[15] The list of priority S&T areas for the Russian Federation sets the general trends of the country's S&T development and represents the S&T areas deemed to provide new technologies and facilities to contribute to the development of national economy and society.

They are specified in the List of Critical Technologies of the Russian Federation, which serves as a background for making decisions on concentrating public resources in the most important areas of science, technology and innovation and on implementing the available S&T potential.

The first list of eight priority areas was approved by the Government Commission on Scientific and Technological Policies in 1996. In 1999 it was submitted to a large-scale examination by more than 1,000 leading experts. That analysis revealed an urgent need to reconsider the system of priorities, concentrating on 'breakthrough' directions. In 2000–2001 new lists of nine S&T priority areas and 52 critical technologies were developed; in 2006, eight (34); in 2010, six (26). The aim of their formulation consisted in the optimisation of the number of priority areas, so as to concentrate resources in the most important fields of innovation.

As already mentioned, in 2002 the Russian president approved the basic directions of the Russian Federation's policy in S&T development. This document has become an important element of Russia's social and economic development strategy, with its goals of innovation-based economic development, creating of an effective national innovation system and making science and technology one of Russia's key priorities. The S&T priorities and critical technologies approved within that document resulted in the list of research areas that was still too broad to become real targets for selecting technologies for priority government support and for private investment. That was the reason for Russia's MES to organise the revision and correction of the lists immediately. This was done in 2003–2004, and then in 2007–2008. The revision of S&T priorities was carried out during a period of sustained economic growth and great improvement of the state government system. Within the process officials and experts modified the list of priority areas considerably. They took into consideration that it should cover the current international technological development priorities, on the one hand, and the innovation development potential defining the formation of new global markets on the other.

This is particularly true for information technologies, the nanosystems industry and new materials and living systems, national security, etc. Efficient use of available S&T potential and practical implementation of R&D results already achieved in these areas will increase Russian enterprises' competitiveness in domestic and international markets in the medium term.

International experience shows that long-term sustainable development is achievable only through high entrepreneurial and innovation activities both in production and service sectors, diversification of production and a greater share of sophisticated and hi-tech products. So concentrating resources in the areas where Russia's competitive advantages can be exploited helps to accelerate innovation based on latest research outcomes and technologies, which is now a key factor determining the competitiveness of a national economy. This is particularly important for Russia because of its present strong dependence on the international markets for fuel and mineral resources.

The S&T priorities (as well as the critical technologies set) are a powerful tool for innovation policies and especially resources distribution. All NSI development instruments and initiatives (including policies discussed later) are based on the national priorities system. Target-based budgeting and performance evaluation are the mechanisms most closely related with them.

Restructuring Government R&D Institutions

Domination of the government-owned budget-funded institutions in the S&T sector remains one of the most painful problems facing Russian science. Various types of commercial and non-profit organisations were allowed during the transition period of the Russian economy, but there was a minimal change at the level of the state R&D organisations. As it was mentioned earlier, over 70 per cent of all R&D organisations in Russia are public-owned and 39 per cent belong to the state sector (though many R&D institutions de facto belong to the state sector being formally placed by statistics services in the business sector). After federal executive agencies got the right to establish new institutions at the beginning of the 1990s, their number even grew by 1.5 times.

Russia has a huge system of state academies, a legacy of the former USSR. The most unusual feature of their legal status is their 'mixed' nature, which combines elements of government institution, public association and some other forms (e.g., corporation and alliance). Another specific feature is the fact that academies act as holdings, 'owning' non-profit organisations. Therefore, as government institutions, academies have control over a number of various organisations and enterprises. The creation of an institution (academy) consisting of many other institutions (research institutes) causes property conflicts and is not in fact allowed by Russian civil laws. However, under the Federal Law 'On Science and the State S&T Policy' (1996), state academies are an exception, organised exactly in this way. Finally, an important feature of state academies' status is that they operate as government institutions. Academies receive and manage government funding provided by the state to support their research institutes. They can manage and control institutions, create and close them.

This 'mix' of various organisational, legal and administrative forms has no precedent in other countries, and remains a big problem for the Russian government. The most worrying issue is the mismatch between performance and economic results in the R&D carried out by the academies and the amount of their public funding. There are other problems as well: inefficient monitoring of the use of federal property and public funds, along with insufficient transparency in the allocation and use of financial resources. One should mark that in general at least 26 per cent of all public funds allocated for civil S&T go to state academies.

In 2005 the special programme for modernisation of the structure, functions and funding mechanisms in the academic R&D sector was adopted. The aim was to streamline the network of academic organisations and to introduce some new organisational forms for R&D. It was supposed to be implemented by 2008, but it did not happen in full. The resistance of the academy's top management was strong enough to preserve the academy's autonomy (operational and budgetary). Therefore, the plans for more radical changes are still far from final realisation. The longer academies resist innovation, the more negative the consequences are for the academic system collapse.

The large number (and proportion) of government-owned R&D institutions makes Russia very different from other industrially developed countries. State R&D institutions funded by the government have to keep budget limitations. They have almost none of the rights (or responsibilities) needed for adequate economic operations. While claiming large amounts of public money, they cannot guarantee that these resources will be used efficiently. In such conditions the performance of the entire government S&T sector is affected. A similar situation is found in the other social sectors of the Russian economy (education, culture, health care, etc.), showing the need to design and implement new, more flexible, autonomous and independent organisational forms.

To meet this challenge, it was decided to create a new kind of government institutions to operate in the social sphere. The new flexible model is known as 'autonomous institution' which is adopted by the federal law 'On Autonomous Institutions' (2006a). Unlike existing budget-funded institutions, the new structures will not be funded through fixed budgetary institutional grants; but they will receive funding from various sources (including the government). This would increase their responsibility for the expected results. At the same time they will remain government-owned entities. Autonomous institutions will have certain autonomy and independence in attracting (and spending) funds from non-government sources, including credits and investments. It will give them new development opportunities, not available for 'traditional' budget-funded institutions.

The prospects for transition of the government-owned R&D organisations into the new form are outlined in 'R&D and Innovation Development Strategy in the Russian Federation until 2015' (2006b). At least 250 R&D institutions and higher education institutions (HEIs) should move to the new status over a fairly short period of time. Taking into account the period planned for this institutional transformation, the task looks quite complicated.

Large national R&D centres are also expected to operate this way. CLTD 2020 includes creation of several such centres whose objective will be to provide S&T support to high technology sectors of the Russian economy. Another aspect of institutional reforms is related to the integration of science and education. To this end, a special law on integration can be mentioned as well as initiatives stimulating R&D activities in HEIs. The new federal law 'On Changes to the Selected Legal Statements of the Russian Federation Concerning the Integration of Education and Science' (2007a) was adopted to boost S&T and innovation activities at universities and to establish closer linkages between HEIs and research institutions. The new law legalises existing models for such integration and provides a scope of efficient measures including a subset of necessary regulations. These regulations should help to eliminate the existing institutional barriers for fruitful integration.

Unfortunately the adopted law can be characterised as a sort of compromise between the government, the university community and the research institutes. As a result, it does not fully satisfy any of these entities. It just solves some evident problems of integration.

Further amendments are required to make the interaction between science and education not only possible, but also efficient.

Another part of the integration policy is support for the best 'innovative HEIs' and 'research universities'. The National Priority Project 'Education' contains specific policy measures to this end. An important component of this scheme is the government of the Russian Federation's statement entitled 'Support Measures for Higher Education Institutions Implementing Innovative Education Programmes' (2006c). It is devoted to the distribution of competitive grants for developing university innovation (including human resource development, unique R&D and innovation projects, improvement of innovation infrastructure, acquisition of research equipment, etc.). There were 57 winners in 2006–2007. Each of them received funding in the range of US$ 6–30 million for two years depending on the scale of projects. The average annual R&D expenditure of the grant-recipients was a little bit more than US$ 4,000 per member of R&D and teaching staff but the difference between minimum and maximum amounts was very high. This means that only some winning universities are actually able to develop large-scale innovation projects.

However, the scheme marks the first government experiment with the earmarked support for research universities as centres of excellence. The main challenge for today is to continue this practice on a regular basis.

In addition, in 2007–2010 within the framework of integration seven large national universities were established by presidential decrees and 29 leading higher education institutes transformed into research universities.

Evaluation of the Performance of R&D Units

The efficient restructuring as well as current operation of the state-funded R&D institutions also requires a set of comprehensive tools for performance evaluation. Such mechanisms are widely present in many countries and show positive effects. During the post-Soviet period, state funding of the state R&D entities was not based on the estimates of their efficiency and the results of their activity. As a result, positive dynamics of expenditure on R&D from the budgetary sources was followed constantly by negative dynamics of the output indicators.

To improve the situation the Russian government adopted the statement 'On the System of Civil R&D Organisations Performance Evaluation' (2009). The main goals of this system are comprehensive planning and funding for the R&D projects, optimisation of the network of R&D organisations and benchmarking for non-public R&D organisations. The plan is to organise regular surveys (every five years) and support the database containing statistical information about R&D institutions. So-called evaluation commissions are represented by involved interest groups — such as state executive bodies, business, academies, scientific community, NGOs, etc. The key evaluation criteria are put together in order to show the relationship between resources (inputs) and results (outputs).

Output is measured by:

- R&D results (publication activity, project results, etc.);
- commercialisation and application of the results (patents, start-ups, etc.);
- scientific involvement (international contacts, joint projects, etc.).

The further criteria relate to human capital (quality and structure of personnel, salaries, etc.), tangible and intangible resources (equipment, facilities, etc.) and financial sustainability (incomes and expenditures structure, debts, etc.). The final criterion shows the potential for further development. A typical report by an evaluation commission consists of a conclusion on the performance against the key criteria and recommendations. Every R&D organisation should be assigned to one of three groups by performance — from 'outsiders' to 'leaders'. The recommendations therefore can vary from closure (for 'outsiders') to special support (for 'leaders') respectively. The evaluation system will apply not only to the state-funded R&D institutions but also to other NSI components including the innovation infrastructure institutions.

Innovation Infrastructure

There are many different forms of innovation infrastructure in Russia. In the state policy context we'll stop on the presentation of three important elements — technoparks, science cities and special economic zones (SEZs). Technoparks are micro-level instruments for technology transfer, while science cities and SEZs are macro-level mechanisms for balancing the responsibilities of local and federal authorities in the knowledge transfer (and support) activities.

There are several tens of technoparks in Russia, although only some have official licenses. Technopark policies are full of hidden problems. First of all, multiple 'white spots' in the legislation dramatically weaken the commercialisation capability of universities and R&D institutions.[16] State universities or government R&D institutions are limited in creating and directing supporting of SMEs. A state university can create a start-up, but cannot provide any funding or facilities for it. That is why Russian technoparks do not operate independently but only as a part of the 'host organisation's' structure. They lack performance monitoring and mechanisms for the diffusion of best practices. They also suffer from underdeveloped business consulting mechanisms.

The response to these negative factors is 'industry and manufacturing special economic zones' (see later). This makes it possible to significantly reduce tax pressure and attract investors. There also exist other solutions such as business incubators and mechanisms to provide financial support for start-ups; providing conversion and commercialisation mechanisms for defence 'dual-purpose' technologies, etc. Other initiatives are connected with new legal mechanisms. One should mention three main directions —provision of federal lands for technoparks on a competitive basis (both for ownership and for long leasing); direct investments in technopark infrastructure by government bodies; creation of favourable conditions for technoparks investment (construction sites, transport and housing infrastructure funding) sharing expenditures between federal and regional authorities.

An important instrument of the interaction between federal and local authorities takes the form of so-called 'science cities' or technopolises.[17] Russian science cities are the 'oldest' secret communities created in the 1930–1970s in the USSR in order to solve major state defence problems by R&D and new technologies. About 70 cities, settlements and outlying districts were ranked as science cities in previous years. Twenty-nine of them were located within the Moscow Region. About 40 per cent of national S&T potential is still concentrated in the science cities today.

These cities are populated mainly by researchers and their families. 'Mono-orientation' towards scientific activity and specific tasks explains the lack of 'traditional' infrastructure elements, such as industry (in some cities) and the agricultural complex. Therefore, after a dramatic decrease in state support in the 1990s these cities faced extremely difficult economic and social problems.

To improve the situation it was decided to 're-inventory' all former Soviet science cities. The science city concept and special state support mechanisms are regulated by the federal law 'On the Status of Science City in the Russian Federation' (1999). According to the text of this document, the science city is a municipal entity of the Russian Federation with a particular urban science and production complex. This complex consists of institutions carrying out research, development and innovation activities, and training of personnel in accordance with the national priorities in science and technology.

The science city status is confirmed by the president of the Russian Federation for a period of 25 years. The president approves the priorities determined by the government for the science city as well as the state programme for science development which specifies the form of federal support for science cities in accordance with their specialisation. Science city funding, along with logistical and maintenance support, is provided from the federal budget, the regional and local authorities budgets, and other funding sources in accordance with the constituting instrument.

Obninsk and Dubna were the first to obtain the official science city status in the Russian Federation (2001–2003). They are famous for the world's first nuclear power station and the Joint Institute for Nuclear Research (both founded in 1950s). The successful science cities are located in the most populated regions. Today there exist another 12 settlements (officially recognised in this respect in Russia after 2003). Among them are the world renowned Zjukovski (scientific support of aircraft manufacturing), Koltsevo (bio-tech), Korolyov (scientific support of spacecraft manufacturing), Michurinsk (bio-tech, agriculture), etc. Nine of them are located in the Moscow region.

Since 1999, the issue of state support for science cities has been much discussed. Problems for discussion include the state's responsibilities, efficient infrastructure creation and use, mechanisms for transition to autonomous grant-free development, etc. The creation of incentives and favourable conditions for transforming of these regions into centres of high technology and advanced R&D is considered to be a major task for the science city policies. The law on the status of science cities regards investments tax credit as the main support measure. For example, it was planned that the Obninsk administration should have the right to spend at least 50 per cent of tax revenues on the innovation infrastructure development during the first five years. However, this mechanism was later rejected. The reason for this rejection was related to the total absence of industrial activity in a number of cities. There was no industry, so no considerable tax revenues were spent on innovation development.

Finally it was decided to use internal resources of research organisations for the intensive production of R&D. Science city status presumes additional federal funding targeted specifically for the implementation (on a competitive basis) of innovation projects. The main problems today are lack of mechanisms to transfer federal funding to specific scientific projects and regulation potential (legal rights) of local authorities.

In general, science cities are supposed to attract considerable investment as venture business centres and as hubs of science, education, technological excellence, and integration.

There also exist special mechanisms to promote the development of industry-oriented science cities and innovation-active regions. One is the ‘special economic zone’. This instrument was introduced in Russia in 2005 by the special federal law, ‘On Special Economic Zones in the Russian Federation’. Special zones are the Russian Federation territories defined by the government, where a special regime for entrepreneurial activity applies. They are intended to promote high-technology industries.

There are three types of such zones — industrial (special tax preferences, favourable investment regime); technology and innovation (out of the customs zone, favourable for imports/exports) and recreational zones (special conditions for tourism). Special economic areas can be created on land owned by the government and/or municipalities. However, official initiatives aimed for innovation infrastructure development (as well as other mechanisms discussed earlier) do not guarantee growth in demand for and/or supply of innovation.

Particular NSI elements created directly to compensate missing actors providing demand for (and investment in) innovation are the Russian Venture Company (RVC) and several state corporations. They act as intermediaries, guarantors and sponsors in the public–private partnership mechanisms.

The Public–Private Partnership Mechanisms

The Russian high-tech sector is still unable to absorb enough investment and to find demand for innovation as well. To solve the problem the Russian government established the Russian venture company (RVC) in 2006. Another part of resources should be mobilised by state corporations. Seven state corporations (such as Russian Corporation for Nanotechnology, State Corporation for Nuclear Energy, etc.), were founded in 2007–2008 to support hi-tech sectors.

The role of RVC is to promote venture investment and financial support for S&T throughout the country. The resources for RVC capitalisation are allocated from the Investment Fund of the Russian Federation. In 2008 the authorised capital stock amounted to 28.2 billion roubles (about 775 million Euro). RVC invests in regional and industry venture companies (in the form of so-called closed end investment funds established under the Russian legislation and regulated by the Federal Service on Financial Markets). A special management company manages each fund. These companies compete for the right to sell fund investment shares to RVC. Funding can be provided only for the projects corresponding with the critical technologies.

Once the venture fund has acquired all its funding, the fund management company can start investment activities: launch innovation companies in the areas of microelectronics, information technologies, telecommunication technologies, biotechnologies, medical technologies, environment-friendly energy, and nano-technologies. The management company team of each fund can finance from 10 to 15 innovation companies for several years. Thus, the output can be up to 15 venture funds and up to 150 innovation companies.

State corporations act as financial instruments to insure concentration and distribution of resources in the areas in line with the state interests and priorities. The need to create such a corporation was expressed in 2007 by the Russian president in his annual message to the Federation Council of the Federal Assembly of Russian Federation. As a rule, they are founded by special federal laws proclaiming the legislative basis, organisation principles, creation and activity goals of state corporations.

For example, the Russian Corporation for Nanotechnology (Rosnano, the Federal Law ‘On the Russian Corporation for Nanotechnology’ 2007b) addresses the growing challenge arising from the rapid development of new technologies on the nanoscale and enjoying direct budgetary support. Three key directions of

Rosnano activity are related to assistance to the state policies in the sphere of nanotechnology, development of the innovative infrastructure for nanotechnologies and achievement of projects aimed at creating innovative nanotechnologies and nano-industries. In order to achieve its goals, three main functions are carried out: R&D, nanotechnology education and financial support for innovative projects. The first two functions are provided by financial support of the R&D and nanotechnology education projects. The third function includes support of the entire innovation cycle, from project evaluation, financing and provision for commercialisation and production.

At the starting point its five-year budget it had more than 130 billion roubles (about 3.7 billion Euro). Due to its special status, the corporation is not government property and has outside control from executive bodies. The director is appointed by the Russian president only. Operational and stable support for the projects should considerably boost their efficiency. However, such 'freedom' may also lead to an unforeseen abuse. In the opinion of many Russian experts, this fact could lower expected effects from the activity of the company. Their arguments were acknowledged as completely serious, and Rosnano was transformed into another commercial company (a joint stock company with government share).

Another problem already faced by Rosnano is the lack of human resources in this field. That is why education activities there are closely tied with R&D. However, the whole NSI requires constant reproduction and development of human resources (see later).

From 2010 Russia shows visible progress within two more directions of R&D and innovation policy — creation of technological platforms (23 have been organised already) and innovation programmes of big public companies (the government has bound them to develop such programmes).

Human Resources for S&T and Innovation

Relatively high levels of human capital development, high education and skills parameters of the labour force are among the important competitive advantages of the Russian economy (Gokhberg et al. 2009). The need to sustain and increase them is declared in all key documents on the national policy of the Russian Federation (including the long-term CLTD concept, see earlier). Important practical steps in this area have already been taken by the government

(The Federal Programme 'Science and Education Manpower for Innovation Russia', 2008). This promising programme should improve and develop human potential for R&D and innovation activity in HEIs and R&D institutions. It is designed for the period 2009–2013. Its proclaimed aim is to provide institutional support of the development of efficient human resources in the S&T, education and innovation sphere. In order to achieve this goal, it is proposed to attract and involve young talent and highly skilled professionals in S&T and innovation projects and to consolidate excellent and competitive scholars in the best universities and R&D institutes. To this end, the programme includes a number of actions and instruments: centres of excellence for science and education, system of grants for young promising scientists and teachers, special schemes to attract young promising scientists and teachers from abroad, grants for innovation infrastructure development, etc. All these initiatives are going to be implemented in spite of the current financial crisis. The programme budget amounts to 90.5 billion roubles, or about 2.6 billion Euro (88.9 per cent will come from the federal budget). The share of R&D funding is expected to be 73.6 per cent. The programme includes three main directions and 20 tasks.

The programme calls for significant shifts in the S&T human capital sub-system. Among them — annual support of up to 450 centres of excellence; decrease of the average researcher's age by 34 years by 2013; increase in the number of top-level researchers by 2–3 per cent; increase in the number of top-level university teaching staff by 4–6 per cent; increase in Russia's share in world scientific publications by 1–1.5 per cent. One of the goals of the programme is to stimulate and develop non-government funding of supported projects. Therefore projects attracting support from the business sector and NCOs should have an advantage.

Sustainable development of the S&T complex and strengthening of its innovative orientation should be based on an efficient regulation system, including direct funding and indirect motivation. Indirect motivation techniques include tax breaks, discounts and special procedures for property depreciation.

In the conclusion of this section we'll discuss two more items characterising mainly the external conditions of scientific and innovative activity, namely budgetary and tax reforms.

Budgetary Reforms

Most of the industrially developed countries are trying to find more efficient mechanisms and forms of government support for R&D.

The complexity of the problem is explained by the obvious need for such support and by strictly limited resources. The solution found by the Russian government in the current situation looks quite realistic. It is based on a more efficient budgetary resources allocation together with institutional reforms in R&D and the innovation sphere.

Today the federal budget for civil S&T is almost equally distributed between direct and competitive funding. The main portion of the competitive funding stream goes to the federal goal-oriented programmes. Almost a half of the civil S&T budget is still allocated in government R&D institutions under academies of science and under state ministries and agencies. This funding stream is not based on S&T priorities or on performance of R&D institutions. This is the sphere where new mechanisms for evaluation and institutional reform are to be implemented.

The appropriate budgetary legislation was developed in Russia throughout the whole reforming period. The Budgetary Code of the Russian Federation was adopted in 1998, though the country put in place a framework for 'normal' regulation of budgetary relationships. However, the restructuring of the budgeting process did not start for six years. Only in 2004 was the concept of budgetary process restructuring approved. It was based on four key principles:

- separation of existing and newly approved expenditures;
- limiting approved expenditures to objectives clearly defined in advance, according to government policy priorities;
- targeting and programming planning techniques application;
- developing a system of real and target indicators to evaluate performance of government agencies.

Russia has also entered into a new stage of public funds management — mid-term performance-oriented budgeting. All its principles were applied in the 2006 budget, when a prospective three-year financial plan was developed alongside the traditional one-year budgeting projections.

Under the new classification, R&D expenditure is divided into basic and applied parts, which in turn are split into sections. Basic research expenditure comes under the 'general issues' section. Applied research expenditure is mostly accounted for under all other sections of expenditure functional classification — in order to support R&D for education, economy, defence, etc. One of the most important elements of the development of the budgeting process was the restructuring of budget classification and accounting. Under the 'Concept of Budgetary Process Restructuring', the new classification was brought in line with the main functions of government agencies and with international standards for accounting and public finance statistics. The streamlining of the general budgeting process should encourage development of a flexible and dynamic NSI as one of the top national priorities. It should be noted that the potential for streamlining the budgeting process in the R&D sector exists at all its stages — budget expenditures planning, shaping the budget and adjusting appropriation (allocation of funds to recipients), funding of R&D organisations (financial management techniques), legal framework, etc.

During 2010–2011 the process of deep revising was started again.

As long as the state remains the largest R&D 'sponsor' as it will be for the foreseeable future, the Russian government is planning to continue reforms in three directions:

- more concentration on the national priorities;
- optimisation of the funding structure;
- new principles of the budgetary funding.

Concentration on the national priorities requires that direct government support of applied research and technologies should be reduced to a certain minimum, supporting those most relevant to the national priorities only. Foresight is considered to be the most useful tool for national priorities setting. It is a highly discussed topic among Russian scientists and officials. The first project for practical implementation of foresight technology in Russia was launched in 2006–2008 (the second was finished in 2010; the third has just begun).

Optimisation of the funding structure is an important measure both when the total GERD is growing, as well as when it is falling (for example, due to the negative effects of the world crisis). A dramatic change in the structure of the government expenditures is expected. Funding should be re-allocated in favour of target programmes and state R&D foundations. However, a large-scale reallocation is impossible before the reform of the R&D sector.

A crucial principle of the forthcoming restructuring of R&D funding is a transition from subsidies towards credits, while moving along the innovation 'chain' (basic research — applied research — development — implementation of innovations — consumption of innovation products).

New principles for budgetary funding can be defined as liberal funding and competition. The share of so-called basic funding in the R&D budget (funds allocated to particular organisations for specific purposes regardless of their performance) should be decreased. However, each government-owned R&D organisation having survived after the restructuring of the government R&D sector should receive enough public money to meet its actual needs. The so-called package funding practice known in many countries is also being considered in Russia. It would provide a certain freedom of financial management and increase the operation flexibility of R&D institutions (Gokhberg 2003).

Streamlining the mechanisms of joint innovation programmes and project funding is an important element of the budgeting process. Improvement in this area requires creation and development of legal instruments regulating cooperative agreements in the R&D sector and NSI, grant support and long-term government orders for R&D, technologies and innovation. These forms are used to establish public and private sector partnerships and apply the R&D potential efficiently in all developed countries. Using such tools and mechanisms, developing standards and frameworks for independent expert evaluation would improve the whole system of government funding in general, promote a practical shift towards projects and programme funding, increase financial transparency and streamline procedures for making and spending profits, as well as sharing the risks of R&D and innovation activity.

In the context of the current debate, the federal budget can be said to have four main functions:

- *Ideological* (as a programme providing financial support for S&T and innovation reforms) including evaluation of the prospects of this sphere in Russia, the role of the government in its preserving and developing (i.e., as it is declared in CLTD 2020). Ideological function in our context means that the budget reflects the structure and 'ranking' of national targets and the attitude of the state and its leaders to national science.
- *Political* (as a strategy and a set of measures to mobilise and allocate financial resources). It is based on the creation integration of a hierarchical system of national objectives. This function involves the: (*a*) coupling of designations, (*b*) specific decisions of the authorities, (*c*) quantitative parameters of budget obligations for the 'science block', etc.

- *Economic* (as a financial plan to support sectors of the economy). This is concerned with the preservation and development of S&T and innovation by increasing effective demand for and commercialisation of R&D products and technologies.
- *Management* (as a procedure to establish objectives, structure, techniques and mechanisms for managing financial flows, monitoring and evaluating results). It includes coordination, succession and transparency of budgeting process stages, realistic nature of obligations.

Despite all the changes, budgets have not yet become an effective government policy tool, and do not fully carry out functions crucial for developing Russia's R&D and innovation sector. The fourth function is implemented most widely (perhaps even too strictly; the third one is implemented partially while there is still little evidence of the first and the second. To improve this situation the reform should extend outside the budgetary sphere, taking the form of broad institutional reforms.

Some Other Examples of Implicit Measures

Currently Russian S&T and innovation policy is being shaped in an incomplete legal framework for R&D and innovation activity. Taxation laws still do not include provisions that would make an efficient system of tax breaks and benefits, similar to those existing in all developed countries. Inconsistency of legal reforms, lack of continuity of legal provisions brought about a situation where many of the previous norms of tax legislation that have proved their efficiency did not find a place in the Tax Code of Russian Federation (1998, with subsequent amendments). That, in turn, caused problems hindering radical growth of innovation activity and efficient use of the country's intellectual and economic potential. For example, according to the current tax code, R&D expenditures are subtracted from revenues when the tax base is calculated, which encourages organisations to make them. At the same time tax legislation in effect does not encourage activity of R&D organisations participating in practical implementation of knowledge and technologies, or organisations funding R&D and innovation projects.

The work on developing taxation rules for S&T and the innovation sphere in Russia started in the mid-1990s, and was completed in general in 2007 — with the adoption of a number of laws and regulations aimed at reducing the tax burden for innovative enterprises. In 2008 tax breaks provided by the latest amendments to the Tax Code became valid. The most important of them are new rules for calculation of VAT, profits tax and overall simplification of the taxation. For example:

- Profits generated via sales of intellectual property rights (inventions, utility models, etc.) have been exempted from VAT, as well as earning generated by licensing intellectual property. A list of tax-exempted services supporting development of new/improved products was also approved.
- Regarding profits tax, the number of R&D foundations whose money does not have to be included in calculation of the tax base has been increased.
- Other improvements included more favourable accelerated depreciation conditions, additional breaks for organisations contributing to the Russian Technological Development fund, as well as to industrial and inter-sector R&D foundations.
- The list of expenditures not to be included into taxpayers' taxable income under the simplified taxation system includes expenditures on acquisition of exclusive intellectual property rights, patenting and R&D.
- As already noted, more breaks are provided for residents of special economic zones and companies oriented towards exporting information and communication technologies.

It should be noted that compared with the legislation regulating taxation of innovation activities in developed foreign countries, the Russian tax system even after adoption remains insufficiently wholesome and coordinated. The mentioned taxation innovations will contribute to creating a more favourable innovation climate, but they won't play a crucial role in changing private businesses' investment strategies regarding R&D and innovation activities. The new tax breaks are just not big enough (in the context of the overall economy and the S&T and innovation sphere). Problems with property and land taxes for R&D organisations remain unsolved (appropriate tax breaks have been cancelled in the new Tax Code). The lack of such breaks is particularly painful to large R&D organisations engaged in applied research and development.

The new round of tax legislation development began in 2009, although it was slowed down due to problems created by the global financial crisis. Now this process still continues. Its focus is on innovation and innovation-friendly taxation instruments which will help to create a more favourable innovative climate. For example, the government introduced tax benefits for entities investing in R&D and priority S&T areas, such as bio- and nanotechnology, nuclear energy and new types of transport systems; easier conditions for compulsory social security payments for employees of companies whose main economic activities are ICT development, engineering and R&D, etc. (Gokhberg and Kuznetsova 2010a).

Outcomes and Impact of State Policy and State Institutions on the NSI

The preceding analysis of statistical data and various government policies clearly shows that traditional troubles of the Russian S&T and innovations sphere have not been dealt with yet, which makes the 'innovation shift' envisaged in the long-term CLTD 2020 strategy (and other strategy documents) even more complex and important. That is true for development of target indicators as well as designing the overall government S&T and innovation policy. Note that in the process of that shift government agencies have to deal with an increasingly large 'management object' — the growing S&T and innovation activities sphere, which makes decision-making significantly harder and requirements to the quality of such decisions more strict (see Table 3.9).

Relevant government policy should be developed keeping in mind the following objectives:

- to eliminate/temper the existing negative trends.
- to deal with the tasks typical to catch up with leading development models. As experience of foreign countries shows, approaches, tools and mechanisms used for such purposes don't always match.
- to ensure breakthroughs in the sectors of the Russian economy which determine the country's role in the global economy — mainly low- or medium-low research-intensive, with an obsolete technological basis. Mining and energy industries, other basic sectors need a deep modernisation and radical increase of their technological level. Equally important is ensuring major progress in restructuring of the R&D sector itself.
- to develop a new social model, radical restructuring of the institutional environment and legal regulations aimed at promoting R&D and innovation, entrepreneurship, private

investment. The actual Russian experience shows that change is slow to come in these areas, doesn't happen in a systematic way and faces serious opposition at the middle and lower levels of the management hierarchy.

Table 3.9: *Scope of S&T and Innovations Sphere and Amount of Financial Support it Received in 2009*

Indicator	*Value*	*Change Compared with 1995*
R&D institutions	3536	Reduced by 11 times
HE institutions, total state and municipal	1134 660	Increased by 1.17 times (compared with 1999) Increased by 1.01 times (compared with 1999)
R&D personnel (head-count, thousands)	742.4	Reduced by 1.4 times
R&D fixed assets, bln roubles	705.0 (in constant prices – 43.3)	Reduced by almost 2 times
Industrial enterprises engaged in technological innovation*	About 3,000	Increased by almost 1.5 times
Patent applications, thousands	38.6	Increased by 1.7 times
GDER, bln roubles	485.8 (in constant prices – 6.1)	Increased by 10 times (compared with 1999) Increased by 2.1 times (compared with 1999)
FBA on civil R&D, bln roubles	219.1	Increased by 19 times (compared with 1999)
at constant prices	7.51	Increased by 3.9 times (compared with 1999)
FBA on higher education, bln roubles**	280	Increased by 12 times (2008/2000)
Expenditures on technological innovation (total), bln roubles	327.9	Increased by 7.6 times
– from government budget	About 14 bln roubles	NA
Venture companies, bln roubles (2007)	30	NA

(*Cont.*)

(*Cont.*)

Indicator	*Value*	*Change Compared with 1995*
RVC (initial payment of the Government)	15	
Nanoindustry and nanotechnology (initial payment of the Government), bln roubles	130	NA
Volume of “nanoproducts”, bln. roubles	112	

Source: HSE (2011a: 24, 36, 69–71, 233, 274); HSE (2011b: 9–11, 37, 39); HSE (2010: 68, 350–51); HSE estimates.

Note: * Mining, manufacturing industries, power generation and distribution, gas and water supply, communications, etc.

** Consolidated budget of Russian Federation and public non-budgetary foundations.

The following issues are crucially important for increasing efficiency of the Russian government S&T and innovation policy:

- variety and integrated nature of management and development tools;
- coordination and harmonisation of various policy tools and areas across the levels of the hierarchy;
- targeted design of laws, programmes, strategies to deal with specific (global and national) challenges;
- ensuring optimal balance of direct supervision and control on the one hand and promotion and motivation of R&D and innovation activities on the other;
- regular monitoring and assessment of government policy’s efficiency, to adjust the management and decision-making process accordingly.

Conclusions and Recommendations Targeting Improvements in the NSI with Specific Emphasis on the Role of the State

This chapter has represented an overview of the Russian S&T and innovation sphere, emphasising the most recent trends and policies. Russian history is full of contradictions as well as the evolution of its science, innovation system, the state’s policy and positions in the world. In the USSR the innovation system existed in a narrow scientific-technological space. Scientific results and innovations were created and introduced on the basis of the centralised decisions of the government, and in the areas connected to the main interests of the state. The term 'national system of innovation' was never used in the USSR, and the actual NSI wasn't considered worthy of research or special government policy. It is only in the last few years during painful transformations of economy, state and society in Russia that a comprehension of a key role of innovations and the necessity of wider understanding NSI as a system of national institutes has emerged. The wide understanding of innovation and the new approach to NSI have been fixed in key documents of the state's policy.

The analysis in this study allows us to make several important (in our opinion) conclusions regarding possible ways to improve the domestic S&T and innovation system (with specific emphasis on the role of the state):

(*a*) After the disintegration of the USSR when wide-ranging reforms including privatisation and market liberalisation were being undertaken, the Russian economy and the Russian state changed dramatically. The state became more democratic; market institutes, elements of a civil society (which are not always accepted 'canonical' forms) gradually began to develop. Within that process the Russian S&T and innovation sphere reached a turning point in the arduous transformation from a centrally controlled and administered structure to a flexible system operating in the free-market environment. Unfortunately the reforms of S&T and NSI were lagging behind the transformation in other sectors of economy.

Though the transition towards a demand and supply balanced system is not complete, the demand for R&D has already shifted and the institutions meeting it are themselves going through changes towards more efficient and accountable forms. Initiatives aimed for stimulation of demand for R&D and innovations, and for PPP development will have a temporary effect. In the long run institutions — such as Rosnano or RVC — will not be able to replace the traditional market actors that ensure the demand for R&D and innovation. At the same time Russia still lacks high quality supply from R&D institutions. One of the reasons for this is that institutional reforms in the Russian R&D sector are incomplete too.

(*b*) Many experts believe that the current state of Russian R&D and NSI, the barriers and limitations hindering their rapid restructuring and successful development which remained intact for many years, are in a way the end result of inefficient, illogical, inconsequential, and uncoordinated initiatives pursued by various government branches, lack of coordination between ministries, agencies, various legislation, etc. The accumulated negative impulses constitute a serious obstacle not just for practical implementation but even for the theoretical design of an efficient policy including appropriate institutions and mechanisms.

However, the opposite is also true: the current state of the science and innovation sphere creates objective limitations on development and implementation of an efficient policy.

(*c*) It is shown that the Russian S&T and innovation policies transition can be divided into four main stages. The fourth (the current) stage lasting from the middle 2000s to now is characterised by complex activities of the government aimed at the transition towards an innovative model of national economy. One can easily imagine two main dimensions of the policy making activities. The first one is creation of a structured NSI policy framework. The second is the implementation of the policy mechanisms for efficient regulation in the main areas of government activity: the national priorities, performance-based budgeting, restructuring the government R&D sector, human resources and infrastructure development, etc.

This stage of rather stable recovery of NSI was interrupted in 2008 by the painful economical and financial crisis. The consequences of this crisis in Russia have not yet been overcome and are not entirely obvious. What is obvious is that further research in this area is required.

(*d*) The history of reforms of S&T and NSI in Russia shows that they cannot wait for a full economic transition. Innovation activities themselves can contribute to the restructuring of enterprises and industrial change, as well as to the improvement of education, science, health care, and environment. It is crucial to speed up all these reforms in the complex.

Future policy actions in this field will be coordinated with a complex framework including three key components: the development of the S&T sector (and the supply of innovation); increasing demand for innovation; and human capital development. Simultaneously the future of the Russian NSI certainly depends on the reform of the entire economic system and the overall macroeconomic situation. It is evident that an economy based solely on oil and natural gas export is unable to follow an innovation growth trajectory. Accordingly, enterprises can be encouraged to compete and play a central role in directing R&D and innovation only after broad structural shifts in the economy.

In addition, it is obvious today that the important and vital reforms of S&T and NSI cannot wait for a new era of prosperity (after the crisis period). It is critical for Russia (as well as for other counties) to make the following choice — to invest in the future, for example, to continue its efforts in supporting science and innovation activities, or to stop them. The second scenario means a serious risk to worsen the position in the world science and technology development coming out of the current crisis. The leaders of the world economy understand this dichotomy, and demonstrate rather good examples of the first approach.

There is a lot still to do to encourage the contributions of science and innovation, especially in the fields of public policy and reorganisation of the R&D sector. The S&T and innovation policies should be driven by complete priority of complex and dynamic reforms, aimed at efficient innovation and support to the best performers.

(*e*) Progress in the field of S&T and innovations achieved in developed countries is based on a complex system of interaction between all major actors: (*i*) generating various kinds of knowledge (R&D and educational organisations, large companies, small and medium firms, etc.); (*ii*) monitoring (controlling) the flows of this knowledge (and flows of resources) and (*iii*) ensuring their practical implementation. Efficiency of the whole process in each country is determined by the specific way these actors interact as components of the collective knowledge-generation and utilisation system.

Analysis of domestic and international experience suggests that the government's role in this process amounts to creating conditions for the following:

- enterprises and R&D actors (including science and higher education institutions) are motivated to participate in innovation activities (emergence of efficient proprietors, competitive environment for producers and consumers of knowledge, development of cooperative relations between them);
- increased education level of management and easier access to information required for R&D and innovation activities;
- transfer of technologies (including creation of enterprises utilising new technologies);
- organisation of the very process of knowledge creation and dissemination based on advanced forms and mechanisms including cooperation between private and public sector organisations (PPP) in the R&D and innovations area, etc.

(*f*) Effectiveness of Russian S&T and innovation policy is largely determined by the fact that Russia needs to deal with a whole host of problems immediately — those connected with the generation of new ideas, their transformation into high technologies and finally, production of actual goods and services. Constraints hindering acceleration of these processes take place at both ends: among customers and suppliers of R&D products. Nevertheless, the contemporary economic potential of the Russian economy is high enough to launch the NSI reforms and complete the transition of the S&T and innovation sector.

(*g*) The development of the Russian S&T and innovation policy should be ultimately aimed at dealing with the key problem of the country's NSI — inefficient use of resources allocated to the R&D sector combined with insufficient demand for innovations by businesses.

Relevance of this problem increases even further in the situation of the global economic crisis and the changes it brings about. Note that government initiatives to support and promote demand and supply in the S&T and innovations sphere should be accompanied by a serious effort to widen the range and increase efficiency of tools and mechanisms used, including various forms of partnership between the state, business and science. This would certainly help to put together a system of long-term S&T development goals and map the ways of accomplishing them (as it has been already done in frameworks of CLTD and other strategic documents).

(*b*) To increase the real sector's demand for R&D products and technology in the situation of financial crisis and post-crisis recovery, a sensible combination of targeted government policy to promote innovation activities and an overall improvement of instructional environment for entrepreneurship plays a very important role. So far this environment is by no means perfect: administrative, legal and other barriers hindering emergence and functioning of modern market institutions and competitive climate still remain in place in Russia, and occasionally even grow.

Accordingly, measures planned or already on line seem to be particularly important to the country. Among them:

- the promotion of a national network of development institutes (social, financial, etc.). These should provide funding and other support to innovation projects at all stages, as well as to innovation infrastructure and to small and medium companies engaged in technology (and other R&D products) transfer, production of innovative products/services;
- the modernisation of technological apparatus (basis); development of new technical management (technical regulation) tools;
- the improvement of the situation with enforcement of new regulations in the area of intellectual property protection and use;
- the development of the preferential credits system, government guarantees and other forms of risk sharing between the state and the business. This is especially relevant to high technology companies (including small and medium firms) exporting high-tech products/services;
- the creation of new opportunities to implement results of the national technological foresight analysis (this work

was launched on a full scale in Russia in 2007) in public administration, including development of target federal programmes, initiating long-term projects, etc.

(*i*) As to improving the quality and increasing supply of R&D results available to the real sector of the economy, measures which have been implemented during several recent years still remain crucial in Russia. These are aimed at completing the restructuring of the public R&D sector and increasing its efficiency.

The following priority steps are envisaged to achieve significant progress in this area:

- to create a centre of excellence network (based on the existing or new components of the Russian NSI — large R&D organisations and universities), on national, industrial, regional and inter-regional levels; provide special government support to them; promote their networking and cooperation;
- to carry on with measures aimed at improving conditions for integration of science, higher education and business, regardless of organisational structures and operational modes of the participants;
- to implement and actively use in public administration a system for assessing efficiency and effectiveness of R&D organisations (the system for evaluation of R&D units' performance); to improve implementation of appropriate procedures, indicators, criteria, etc.;
- to increase opportunities for R&D organisations and universities to participate in commercial (entrepreneurial) activities, including establishment of small innovation firms and partnerships;
- to work on improving institutional structure of R&D network, by increasing the share of autonomous (public and non-profit) organisations, etc.

(*j*) To widen the range and increase efficiency of government policy tools, efforts are envisaged to increase efficiency of the public–private sector partnership mechanisms. Since in Russia this policy area remains to a certain extent exotic, accent should be placed mainly on using various ways to motivate and encourage potential participants of such partnerships established to prepare and implement large-scale innovative projects.

The following must be done in this area, and as quickly as possible:

- eliminate the remaining limitations on investment of public funds in authorised capital of innovative companies. In a wider context, fund-raising mechanisms to finance innovation projects from all possible sources must be improved (including government budgets, non-budgetary funds, venture capital, foreign investments, etc.). Such mechanisms are necessary to create large-scale and mass supply of new technologies and innovations in Russia;
- increase the amount of government-backed credit to organisations implementing innovation projects;
- make government procurement more innovation-oriented;
- improve the quality of expert evaluation and tender procedures;
- provide financial support to patenting by Russian inventors (both in Russia and abroad), and a number of other initiatives.

(*k*) Government policy is a major factor and an impulse promoting development of the Russian NSI model which would ensure efficient use of the country's R&D and innovation potential to speed up economic growth and improve the quality of life. However, Russian experience sometimes provides examples when government initiatives turn into serious barriers. The economic crisis has already made 'inefficient zones' in the Russian R&D and NSI spheres more evident. One would like to hope that dealing with the existing problems won't be postponed 'until better times' yet again, like it was done 20 years ago.

Accordingly, incorporation into various international S&T initiatives (projects, programmes, alliances, foundations) becomes increasingly important to Russia. In the modern global economy participation in international coalitions and networks (in particular, in the framework of the BRICS project) not only opens access to modern management techniques, practical experience accumulated during design and implementation of crisis management measures, advanced ideas for development and implementation of government policies, but also enables countries to protect their own interests in a more efficient way, develop joint approaches, identify niches for S&T cooperation and expansion on the international markets.

Notes

1. The chapter was prepared with the use of the results of the National Research University 'Higher School of Economics' (HSE) Basic Research Programme.
2. According to the industrial classification adopted in the USSR (*Scientific–Technical Progress in the USSR: Statistical Abstracts* 1990).
3. GERD 1990 is 5 times larger compared with GERD 1995 (in constant prices). Sources (here and after, except specially stipulated cases): the statistical data books published by HSE.
4. For example, expenditures per researcher in Germany amount to about $ 238,000, in the USA, $ 233,000, in Korea, $ 173,000. Sources: HSE (2005); HSE (2007); HSE (2009a); HSE (2009b); HSE (2010); HSE (2011a); HSE (2011b); HSE (2011c). For figures for foreign countries, data for 2007–2009, or the nearest available, is given.
5. The most current (but not adopted) documents are 'Innovative Russia — 2020' (Ministry of Economics 2011); 'Strategy 2020: New Model of Economic Growth — New Social Policy (prepared by expert groups, 2011).
6. In the USSR this lack of usage occurred not only among governments, but among the majority of experts and in the scientific community too. However, it needs to be pointed out that the dissolution of the USSR came about just as the NSI concept was entering the language of policy makers worldwide.
7. Survey of about 3,000 Russian scientists 'Assessment of Scientists' Working Conditions and Appeal of a Career in Science', conducted by the HSE in 2007 (Kuznetsova 2008; Gokhberget al. 2010).
8. There was no question of implementing any major changes in the USSR, nor could anybody raise such an issue.
9. Russian Foundation for Basic Research, Russian Foundation for Support of Small Enterprises in R&D Sector, Russian Foundation for Research in Humanities.
10. Especially in the period of crisis.
11. In particular, foundations to support R&D and small innovative enterprises were created; decisions such as to privatise and commercialise certain segments of the S&T sector taken and partially implemented;

contract-based system adopted; a number of measures to protect and commercialise intellectual property undertaken, etc.

12. See Gokhberg and Kuznetsova (2009: 30, 32); HSE (2011c).
13. Communication, activities involving the use of computers and ICT, wholesale trade — these industries are subjected to ongoing monitoring by Russian innovation statistics.
14. Measured by a ratio of the number of enterprises engaged in technological or other innovation to the total number of enterprises.
15. Priority S&T areas are deemed to be subject areas of S&T with potential for making a major contribution towards providing the country's security, faster economic growth, greater competitive capacity of Russian companies through development of the technological foundations of the national economy and R&D-intensive production facilities. Critical technologies are considered as sets of technological solutions that create potential for further development of various technological areas, possess a broad range of innovative applications in various sectors of economy and as a whole make the greatest contribution to the resolving of the major problems of implementing scientific and technological priorities.
16. These are relations that are not regulated or are poorly governed by current legislation.
17. A typical science city is a large up-to-date research and industrial complex, including HEIs, research institutions, as well as residential area provided with cultural and recreation infrastructure. The international concept of science cities is to concentrate the scientific potential in advanced and pioneer fields, using a favourable environment for creative R&D activities.

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