This paper was presented at The ISPIM Innovation Conference – Innovation, The Name of The Game, Stockholm, Sweden on 17-20 June 2018. The publication is available to ISPIM members at www.ispim.org.

Innovation Policy in Russia 1992-2017: One step forward, two steps back

Anna Trifilova

University of Exeter, UK Streatham Court, Streatham Campus, Building 1, Business School, Exeter, Devon, EX4 4 ST, United Kingdom & St. Petersburg State University, Universitetskay Nabereshnaya, 7/9, Saint Petersburg, 199034, Russia,
E-mail: a.trifilova@exeter.ac.uk
* Corresponding author

Elena Korostyshevskay

Department of Economics, Saint-Petersburg State University, St. Petersburg State University, Universitetskay Nabereshnaya, 7/9, Saint Petersburg, 199034, Russia
E-mail: lenkor7@mail.ru

Michail Shushkin

National Research University Higher School of Economics, Ulitsa Rodionova, 136, Nizhnij Novgorod, Nizhegorodskaya oblast', Russia, 603093
E-mail: mshushkin@hse.ru

Abstract: Since Russia started its transition from a closed communist state to an open market economy in the 1990s there have been major economical and political changes. The central idea of this paper is to look at what has been done for innovation in the country. Prior to the 1990s Russia outperformed the world in many spheres of science but now the country has lost its leadership position and struggles to compete in innovation. In this paper we study the query of what has happened to Russian R&D sector after the collapse of the Soviet Union? We review publications over the last twenty-five years focusing around Russian innovation policy published both in Russian and English languages. We provide critical statements of interviewees in the area unveiling the transitional issues Russian R&D sector experience for the innovation to happen. We tried to summarise the challenges of the quarter of the century as a bigger picture of Russia and its research policy in an era of open innovation.

Keywords: Innovation in transition; R&D sector; Research policy; Russia

1 Introduction

In Soviet Russia, prior to the 1990s, R&D was given political support and priority due to its perceived strategic significance and importance for the international prestige of a communist country. This period was characterised by few financial limitations in terms of budgetary flows (Watkins, 2003). As a result, this created a unique R&D sector which was highly educated, geographically dispersed, militarily structured, extremely large and functionally segregated (Radovilsky, 1994).

In Russia, at the beginning of the 1990s, the shift from the state controlled R&D system of the Soviet Union to the market-based economy seemed to offer enormous business opportunities. Compared with the time of the Iron Curtain, the prospects of Russian R&D organisations for building international collaboration were significant; however in practice only a limited number of Russian R&D organisations managed to reach the global R&D arena. Equally, it should be pointed out that "[f]orty years ago Finland, Korea, Israel, and China, all started with a relatively underdeveloped enterprise sector **AND** an underdeveloped science and technology base....[including] research capability, technically trained workforce, and technical research universities" (Watkins, 2003, p. 1 [emphasis is in the original]). Thus, the main research question of this study is why Russia lost its leadership?

The paper is organised as follows. First, we look into details of the transition from Soviet to post-Soviet era for Russian R&D organisations trying to understand the challenges shift created. Next, we present the results of studies in the area focusing on literature related to innovation policy during this transition. Particularly, we explore the question of what the transition period implied and how things were organised (or even disorganised). We look at publication in both Russian and English languages. Then, we present the results of qualitative interviews with Russian experts involved into development and implementation of innovation policy in Russia. Finally, we provide conclusions looking at the results through the lenses of the open innovation paradigm and globalisation of R&D processes. It has to be stated here, that we don't go into the specifics of innovation management in a way of the role of science and R&D for the innovation to happen. We also avoid the discussion of what innovation is. Our main focus is the leadership of Russia as a country on the global R&D arena from the perspectives of the results of being innovative or not, and why? We use the notions of R&D and innovation as almost interchangeable assuming that the outcome of R&D is resulted in innovation (new products/services/technology) that brings value.

2 Russian R&D background

2.1 Russian science under the command economy

In Soviet Russia, centralised planning systems allowed devotion of significant resources to R&D paying little attention to economic return. Achievements of Russian scientists in physics, astronomy and space, chemistry and new materials, life and earth sciences, mathematics, new technologies, laser application, high frequency plasma, etc. were gained through "great concentration of labour and material resources, with virtually no financial limitations in the period of the former Soviet Union" (Radovilsky, 1993, p. 46).

> "Before the market reforms R&D was supplied to industrial enterprises as a free good of the centrally planned economy and all inventions were state property. In the USSR, intellectual state property was freely available for anyone to use without licences or royalty payments, provided that such usage was deemed to be in the interests of the state. In the Soviet period, an inventor received public recognition in the form of an Authors' Certificate. Under no circumstances did the Authors' Certificate grant the inventor an exclusive right for patent protection" (Watkins, 2003).

Being centrally directed and totally financed by the Soviet Government, the R&D sector ill-suited liberalisation and market policy of the 1990s (Gokhberg and Shulanova, 2004). Without being targeted to improve the overall health of the economy, the Soviet science sector "may have even contributed to the economic stagnation that was beginning to manifest itself by the late-1970s and early-1980s" (Watkins, 2003, p. 7).

Contrary to the western pattern of research done in universities (Ettlie, 2006) and most innovations grown in industrial companies or start-ups, in the Soviet era, R&D increasingly concentrated in Research Institutes of the Academy of Sciences and Ministries. The collapse of the Soviet Union and the transition to the market economy at the very beginning of the 1990s radically affected R&D in Russia. Among the initial structural shifts that faced R&D organisations in the journey to the market economy were a complete disintegration of hierarchical administrative systems and a tremendous decrease in federal budget expenditure. In addition to the bureaucratic stratification that caused the loss of government-oriented support and most importantly demand, R&D within ex-USSR found itself in the situation of attracting practically no domestic interest in innovation from the enterprise sector.

The major country-specific attributes have been described in a number of publications (Watkins, 2003; OECD, 2004; Gokhberg, 2004; Gokhberg and Shuvalova, 2004; Lachinov, 2005; S&T Overview, 2006, Trifilova *et al*., 2007; Yegorov, 2009) and could be summarised as follows:

- historical – R&D had always been a way of achieving state political objectives and considerations of the former Soviet Union in terms of international prestige and military power rather than a means of addressing internal industrial needs and servicing commercial orientation;
- structural – R&D organisations used to be located in closed or isolated cities for security reasons, and there was no robust system for establishing close direct ties between technology supply and industrial demand;
- entrepreneurial – R&D was characterised by a rather weak focus on innovation, as its primary aim in the Soviet period was stimulating scientific activity and basic research;
- economic – such factors as brain drain, lack of private R&D capital and venture funds, raw material export orientation, high internal credit rates, a non-competitive domestic enterprise sector and slow R&D reforms, retard the development of a modern knowledge economy;
- managerial – R&D, as well as the industrial sector, still lacks a suitable cadre of managers capable of tackling the issues of transferring and adapting new technologies and providing managerial assistance in improving technological absorption and development capacity in the market economy.

2.2. Russian R&D after the transition to the market economy

Since the beginning of the marketing reforms R&D organisations have been trying to narrow the gap between the legacies of the Soviet command system and the market policy. While the government is transforming Russian science and adjusting it to the knowledge economy, R&D organisations are making their own efforts to use their research capabilities (Gokhberg *et al.*, 2001) and technological potential to overcome institutional problems. Adjusting to the demands of the market economy, Russian research institutes search for production and/or marketing partners who can help develop and expand consumer-demanded rather than military-oriented innovations. Older types of R&D organisations, having the mission of achieving governmental political objectives, were rarely intended to address internal industrial demand. Due to the former political reasons, Russian scientists used to concentrate their major R&D efforts on military and defence technologies (space, aircraft, and new materials) and civil innovations (as well as the needs of the consumer market) were out of the scope of R&D sector. They hardly ever had experience in addressing direct market needs, most of R&D organisations seldom engaged in new product development (NPD), and still rarely do. In the Department of Trade and Industry there is an example:

> "Weapon designers at The Russian Federal Nuclear Centre, Sarov, have for decades been manufacturing electric devices from lightweight, high strength alloys and plastic. These are essential for long-range missiles and space-flown devices. During a CNCP UK partnering road show in 2003, an opportunity was identified to apply this technology to western medical equipment markets. This Russian aerospace-derived technology is being used to develop lighter weight drivers, with long battery life, for the rapidly growing market for home healthcare of elderly and infirm" (DTI Report, 2006, p. 71).

The historical predominance of process innovations over NPD in Soviet R&D organisation leads to the present situation that most innovations from Russia are sold directly to producers; and end-users hardly hear of technological breakthroughs with a Russian origin. To illustrate more, the findings of a "Mission to Russia" supported by the UK Department for Trade and Industry (DTI) provide recent empirical evidence for the world-class research capability of the Russian science and for their desire to develop collaborative links. In 2005, the DTI organised a visit to Russian establishments developing research in the area of microwave power. Reporting upon the results of the visit, participants of the mission concluded the following:

> "Russia maintains a significant capability in the design and manufacture of high power microwave devices and systems; the country retains a desire and ability to initiate innovative projects; there are many opportunities for cooperation; and that other nations have taken up many of the opportunities offered better than the UK has" (Global Watch Mission Report, 2005).

Main areas of innovative activity in Russia still remain in defence industry, fuel and nuclear power. To exemplify more, it might be appropriate to refer to the results of the UK mission (Matthews, 2006) to Moscow, Fryazino and Nizhny Novgorod. The UK delegation visited one Ukraine and 13 Russian R&D organisations, nine laboratories, two large microwave and vacuum electronic manufacturing companies, Istok and Toriy:

> "The visits to Istok and Toriy confirmed that they [Russians] make a wider range of devices at different frequencies and power levels than any other country in the world. They also revealed very active exploration of novel industrial applications such as drying Chinese tea, and wood and rope processing. Devices developed include large magnetrons

> for industrial heating and processing, large klystrons for communications, and accelerator applications and more exotic devices like teraherz radiation sources. “The high-power klystrons are particularly impressive”, says Dr Clunie. “The west is many years behind in this technology, which provides power at lower voltages than conventional klystrons” (Matthews, 2006).

If individual R&D organisations can demonstrate leadership in science, why the country doesn’t? At least this is the impression one can get looking at the global R&D.

3 Methodology of the study

To address the research question of this study on how Russian science and technology lost its global leadership position, a two-phase research design was selected: analysis of the secondary and then of primary date.

First, the authors carried out a detailed literature review of publications on Russian R&D policy for the period of twenty one: 1992-2017. The starting point is taken as 1992 for the reason that in the 1990[1], after the collapse of the Soviet Union, no reforms in R&D policy been announced. It was the period of political transition and economic disintegration. We also wanted to look at the quarter of the century period, so, we traced back to 1992 as the starting point for this study.

For this phase an in-depth literature survey was accomplished focusing on such Russian academic journals as Innovation (Инновации), Economic Issues (Вопросы экономики), Foresight (Форсайт), Economist (Экономист), Russian Economic Journal (Российский экономический журнал), Economics & Management (Экономика и управление), etc. The strong economics focus of the journals is explained by the nature of the Russian academic publication system where R&D is a part of economics journals. To address the research question of this study we searched for such keywords in the title of the papers as: innovation policy, R&D policy, science policy and combination of these notions. Due to the word limitation of this paper we cannot present detailed, annual results of all publications. However, these results are available upon request.

Then, literature search was done on publication in English. We looked for the Web of Science publications reviewing for the papers on Russian innovation policy in such journals as Research Policy; R&D Management, Technovation; Technological Forecasting & Social Change; Technology in Science, etc.

Having collected secondary date, in phase two we looked into the primary data and did interviews with Russian policy makers, directors of R&D centres located in Moscow, St. Petersburg and Nizhny Novgorod. We selected those regions being major centres with concentration of political and economical manpower in the European part of the country. Interviews were conducted with experts in the area. For instance, we approached the editor-in-chief of the Russian Journal Innovation (Инновации), the directors of business incubator, or the head of the innovation policy in the Moscow region, etc. resulting in eighteen experts approached. In the next sections we present the data collected.

1 The date of the collapse of the Soviet Union as an disintegration into fifteen countries happened on 25th of December 1991. The process started on 11th of March 1990 with the independence of Lithuania.

4 Finding and results of the study

Following the methodological phases of this study, first, we present the results of the publications in Russia. As the initial point of the articles analyses, we singled out themes that are widely discussed by the authors around innovation policy. These include:

- Outlining the research problem. There is a considerable number of articles where authors are focusing on stating research problems around innovation policy. This is due to the fact, that the topic of innovation policy is new for post-Soviet era.

- Suggesting methodologies. A number of articles are around the issues of methodologies to be applied for understanding of the research problem.

- Reviewing of the official documents issuing by the Government. The journal has become a round-table for discussing legislative and jurisdictional framework around implementation of innovation policy.

- Industrial involvement. Federal innovation policy has been discussed through the lenses of its implementation in different industrial spheres such as transport, shipbuilding, energy, atom, defence, IT, etc.

- Regional experience. A number of regions have been selected for piloting different aspects around implementation of federal innovation policy and those become the cases for upfront practical analysis.

Based on the analysis of the publications accomplished in 1992-2017 it is possible to single out four major areas of focus around the development and implementation of innovation policy in Russia (see below 4.1-4.4). These help explore the issue of why Russia lost its leadership position globally as they highlight the key focal areas over the past 25 years.

4.1 A summary of legislative framework produced to support implementation of innovation policy

In Table 1 we provide overall number of different official documents the Russian Government focused on to supply R&D organisations with rules and regulations so that they could accomplish their activities once the Soviet Union had collapsed and the former legislation could no longer be applicable[1].

Table 1 An overview of legal documents, reflecting the evolution of jurisdictional framework for innovation policy in post-Soviet Russia

Type	*Title of the official document*
Laws	RF Law "On Science and State Scientific and Technical Policy", 1996 RF Law "Science City Status in the Russian Federation", 1999 Model Law "On Innovation Activities", 2006

[1] In Table 1 we provide a brief introduction to all official documents avoiding for the sake of the word limit its formal number, date and other registration details.

	RF Law "On National Research Centre Kurchatov institute", 2010 RF Law "On Innovation Centre Skolkovo", 2010 RF Law Draft "About State Support of Innovation Activities in RF", 2011 RF Law "On the Russian Academy of Sciences, the Reorganization of the State Academies of Sciences and Amendments to Certain Legislative Acts of the Russian Federation" 2013
Strategies	"Strategy of Developing Science and Innovation in RF till 2015", 2006 "Strategy of Innovation Development of RF till 2020", 2011
Concepts	"Concept of Innovation Policy of RF for 1998-2000", 1998 "Concept of Innovation Policy of RF for 2000-2005", draft with no date "Concept of Innovation Policy of RF for 2002-2004", draft with no date
Other documents	Presidential Decree "On Measures for the Development of Science Cities as the Cities of Science and High Technologies", 1997 Programme "Development of Obninsk as a Science City of RF 1999-2004" Presidential Order "Fundamentals of Russian Policy in the Field of Science and Technology for the Period up to 2010 and beyond", 2002 "Major Directions of the Russia Policy in the Area of Development of the National Innovation System for the Period up to 2010", approved by the Chairman of the RF Government, 2005 RF Government Decree " On Approval of the State Program on Creation of Technoparks in the Russian Federation in the Sphere of High Technologies", 2006 Presidential Decree "On Measures of State Policy in the Sphere of Education and Science", 2012
Forecast	"Forecast of the FR Scientific and Technological Development for the Period up to 2030" approved by the Russian President, 2013
Priorities	Presidential Decree "Priority Directions of Development of Science, Technology and Engineering in the Russian Federation and the List of Critical Technologies of the Russian Federation", 2006 Presidential Decree "Priority Directions of Development of Science, Technology and Engineering in the Russian Federation and the List of Critical Technologies of the Russian Federation", 2011

4.2 A summary of institutional management bodies around innovation policy

Here we provide a brief overview of governmental bodies responsible for development and implementation of Russian R&D and innovation policy. We try to indicate how administrative tasks have evolved and when different bodies were involved. Since 1993, state policies are linked to the Ministries. In regard to innovation & R&D these responsibilities been shifted along reorganisation of the Government structure and were shifted with regular turnover (see column 2, table 2)

Table 2 An overview of governmental bodies responsible for development and implementation of Russian R&D and innovation policy

Timescale	*Duration in months*	*Name of the institution responsible for R&D and innovation policy in Russia*
Governmental Bodies		
29.01.1991 – 25.02.1993	*25*	Ministry of Science, Higher Education and Technical Policy of RF
26.02.1993 – 14.08.1996	*41,5*	Ministry of Science and Technology Policy of the Russian Federation

15.08.1996 – 17.03.1997	*7*	Committee on Science of Technologies of RF
18.03.1997 – 20.05.2000	*38*	Ministry of Science and Technology of RF
21.05.2000 – 11.03.2004	*46*	Ministry of Industry, Science and Technology
12.03.2004 – onwards	*166*	Ministry of Science and education
Presidential Councils to advise on innovation and R&D policies		
03.03.1995 – 23.05.1997	*26*	Council for Science and Technology Policy by the President of RF
09.11.2001 – 30.08.2004	*34*	Council for Science and High Technologies by the President of RF
31.08.2004 – 28.07.2012	*95*	Council for Science, Technologies and Education by the President of RF
29.07.2012 – onwards	*65*	Council for Science and Education by the President of RF
19.06.12 – onwards	*71*	Council for Economic Modernisation and Innovation Development by the President of RF

4.3 A summary of critical technologies for innovation policy

Another result of the development of Russian R&D sector has been the so-called priorities of the state innovation policy in the field of science and technology (also known as the list of critical technologies). The list has been developed (reviewed) over the years and now been mainly shortened to[1]:

- Security and counter-terrorism;
- Nanotechnology;
- IT and telecommunication systems;
- Life sciences;
- Weapon, military and other equipment;
- Rational use of natural resources;
- Transport and space systems;
- Energy efficiency, energy saving, nuclear power.

4.4 A summary of introduced infrastructure to support implementation of innovation policy

Another result of the development of Russian R&D sector in the past twenty years is a number of new organisations which been recently introduced to support implementation of innovation policy; they are:

- JSC "Russian Venture Company" (by Governmental Order, 2006);
- Special economic zones of technical-innovative orientation (Federal Law of RF "On Special Economic Zones in RF", 2007);

[1] Presidential Decree NO 899, dated 07.07.2011
http://www.consultant.ru/document/cons_doc_LAW_116178/

- Corporation “Rostech” (Federal Law of RF “On Creation of State Corporation “Rosstechnologii”, 2007);
- Innovation centre “Skolkovo” (Federal Law RF “On Innovation Centre Skolkovo”, 2010);
- Association of Russian innovative regions, 2010;
- JSC “Rosnano”, 2011;
- Agency for Strategic Initiatives to Promote New Projects (by Governmental Order “On Establishment of the Autonomous Non-commercial Organization Agency for Strategic Initiatives to Promote New Projects”, 2011);
- Russian Science Fund (Initiative of Russian President, 2014).

One of the major findings of the literature review is that Russia has been developing new R&D system using ‘learning-by-doing’ approach. Starting from mid 1990s, Russia was ‘busy’ with introducing new Laws for Science and R&D policy (Table 1) resulting in eight different revisions. Two major strategies for science development were introduced in 2006 and in 2011. In 1998, 2002, and 2005 three revisions of the so-called Concepts of the Russian Innovation Policy been issued. There was also a document on Foresight (2013) and Priorities (2006 & 2011) in science and technology. Lastly, the study identified other six documents covering different aspects of R&D mainly issued as Orders (Указ) of Russian President.

The experts in the interviews we carried out for this study pointed that since 1993 “*responsibilities of R&D policy been shifted from one ministry to the other six times*”. To illustrate, in the period of 1997-1996 there was the so-called Committee on Science of Technologies of the Russian Federation (RF). In 2000-1997 there was already a Ministry of Science and Technology of RF. Then, in 2004-2000 R&D was shifted to the Ministry of Industry, Science and Technology, etc. As one interviewee underlined about Ministries’ responsibilities with “*Imagine, those were different people, different departments, different organisations involved and naturally there was no time for R&D policy itself as all the efforts were on shifting the responsibilities from one body of governmental institution to the other*”. This finding is supported by literature. As Yegorov (2009) concludes “Different laws are not properly coordinated as they are prepared by different interest groups. The most vivid examples are related to the almost permanent conflict between the Ministries of Finances and the Ministries that are responsible for S&T”.

Interestingly, a few experts in fact said that in their opinion there is still no innovation policy in Russia. There have been multiple ‘discussions’ about innovation policy but “*those discussions cannot be called a ‘policy’*”. Innovation policy is a part of a number of strategic documents but so far the role of innovation policy as part of other policies, has not been identified. As explained by the experts, in today’s Russia strategic documents are introduced in a chain of “*Strategy-Programme-Projects-Actions*” and “‘*policy’ is not a part of it*”. In other words, “*innovation policy in Russia has no “institutional framework”. The term “policy”, for instance, is missing in the recently introduced Law on strategic planning in RF. As long as this notion will be lacking at that level, “policy’ as such won’t have much of jurisdictional or managerial base*”.

Some of the experts were very critical in evaluating the measures done so far by the Government by saying, for instance, that “*The state evaluates the innovation policy in terms of the areas of constructed square meters for business incubators, or by the volume of investment in the innovation system but not by the number of new technologies, new*

products that bring value. Equally, for the Government it does not matter much who will be a resident of the innovation incubators, and if there is not enough of R&D projects, they are filled with sales business".

Speaking about statistics and numbers one of the interviewees points that "*There is a BIG lie with ALL numbers. None of the figures ... any figure to take, measure or evaluate – is not true. And the reason is in the methods, how these figures are formed, why they are calculated and how they are reported. The mechanism for 'inventing' statistics is a part of the bureaucratic infrastructural system in the country*". In the similar line another experts states that "*We could not build capitalism as it should be. And we already waved farewell goodbye to socialism. We got an incomprehensible system that generates incomprehensible results. As for innovation – this absolutely obvious – that we lost what we had and we built is a joke"*.

Experts also pointed that today for Russian R&D it is "*important to develop tools and institutions. There is, for instance, the law for venture capital, but the venture activities are very weak cause they are not developed to a level of a working tool*". Among other ways to foster innovation and improve Russian R&D, the experts name "*support of innovative SMEs, including stimulation of internal industrial demand and venture investment; development of innovation culture and involvement of ordinary people into innovation activities, known abroad as crowdsourcing; increasing interest in IPRs; foresighting and foreseeing*".

Another comment was about "*a very low "natural" and educational level of entrepreneurial activity*". Most amusingly, of the interviews shared that *"When we have been trying to register the first association of business angels, we were refused and sent to a committee on theology. The registration office believed that we had some sort of religious sect"*. Similar facts were around green technology, open innovation or venture capitalists when other people refused them and didn't believe in such thing while they have already widely discussed overseas.

Interestingly, one experts pointed that "*over the past 15 years the possibility of involving of children and young people in technical creativity been decreased dramatically. Along a reduction in the level of training for scientific subjects at schools, the tendency to knowledge-intensive and technology entrepreneurship is currently minimal. To improve the situation, a long-term state program to stimulate engineering and technical creativity is required*".

To a more summarising question to the experts if and how the marketing economy has contributed for the innovations to happen, some of the experts were puzzled suggesting that in fact "*there is no such thing as a market economy in Russia! What we have is a classic state capitalism, when 70% of the business is state-owned companies. And these companies are not interested in the development of start-ups. They are more interested in buying ready-made innovative products: technologies, plants and ideally from overseas. These companies do not want to mess around with 'growing innovations'. They all live in the past day of closed innovations, they do not understand that open innovation is an established fact. For the sake of the argument, they keep R&D labs, but the output there is close to nothing*".

5 Conclusion

According to Bernstein (1999, p. 5) "[t]*echnology commercialisation cannot be studied without reference to the political and economic conditions in the country in which it*

occurs. This is especially true in Russia, where there have been dramatic changes in government policy, laws, and economic conditions". Most of the reforms started in the 1990s "*have been far from smooth and many of which have not been constructive from the standpoint of encouraging foreign investment or building a strong civilian market economy*" (*ibidem*).

To understand the nature and focus of the reforms accomplished in Russia at the beginning of the 1990s, referring to Bucknall's thought-provoking study titled "Why China has done better than Russia since 1989" is most helpful. In this study economics, administrative and process, political science and interdisciplinary explanations are given to the question of why China has done better than Russia. To exemplify, from the interdisciplinary explanations Bucknall (1997, p. 1028-1029) explains that reforms in Russia involved both "*political and economic change, [which] caused major disruptions and sufferings...the central planning system collapsed before the market mechanism was functioning adequately. This inevitably meant the emergence of shortages in industry and a downturn in industrial production*".

From an administrative perspective Bucknall (1997, p. 1030- 1036) construes "*Russia tackled the political side before the economic one...When Russia abandoned economic control, which encouraged the spread of capitalism and rise of entrepreneurs, it was unfortunately accompanied by a slacking of administrative control*". Finally, Bucknall (1997, p. 1036) concludes that "*gradualism rather than the big bang approach is generally preferable, as it allows time for adjustment, reduced chaos, and probably strengthens the belief that the reform will not subsequently be reversed*".

As a result of 'big bang' approach, "*since 1991 scientific research in Russia has suffered from a major funding crisis in which state-funded science research has reduced from 1 percent to 0.32 of GNP... [when] up to 30,000 scientists have moved to west*" (Roy and Taratoukhine, 2002). To be precise, in the period "*between 1990 and 2002, the number of people involved in research and other academic activities decreased by 55.2%. In absolute figures, this means that Russian science lost 1 072 500 skilled people*"[1]. As concluded by Yegorov (2009) "*Every year the possibilities for the implementation of effective transformation policies are shrinking, as the number of researchers declines and the research centres lose their ability to conduct research*".

Gershman and Kuznetsova (2016) summarise "some of the ambitious science and technology goals set by the [Russian] government will be hard to achieve in the next decade'. As Klochikhin (2012, p. 1624) summarises "*the primary challenge that Russia faces today is deeply rooted in its history and culture, and is not necessarily linked to the general inability to innovate. On the contrary, the past achievements of the Russian S&T have repeatedly proven the capacity of the Russian scientists and engineers to produce break- through innovations that would continuously impress the outer world. Therefore, the main problem that we probably observe today is the inability of the country's government to build up an institutional and network infrastructure that would promote the very decision to innovate and to use those creative resources that are already in abun- dance on the Russian soil*". Our major conclusion is that the Russian R&D sector has only just completed its transition to a 'different' economy by introducing at least new infrastructure for innovation to happen. Recently, the Russian government at least started the first serious attempts to implement longer-term innovation policies. It took the country more than twenty years through 'learning-by-doing' understand the realities of open

[1] '*UNESCO Science Report*' (2005), page 5.

R&D market and it still has some way to go in terms of inserting itself as a player in a wider 'open innovation' system.

References and Notes

Bernstein, D. (1999) *Commercialization of Russian technology in cooperation with American companies*, Stanford University's Center for International Security and Cooperation, CISAC.

Bucknall, K. (1997) 'Why China has done better than Russia since 1989', *International Journal of Social Economics*, 24 (7/8/9): 1023 – 1037.

DTI (2006). *The Global Partnership: Fourth Annual report*. DTI: Ministry of Defence.

Ettlie, J. (2006) *Managing innovation*. Elsevier, USA.

Yegorov, I. (2009) Post-Soviet science: Difficulties in the transformation of the R&D systems in Russia and Ukraine, *Research Policy*, 38: 600 – 609.

Gershman, M., Kuznetsova, T. (2016) The future of Russian science through the prism of public policy, Foresight, 18 (3): 320-339.

Global Watch Mission Report (2005) 'The design, manufacture and application of high-power microwave systems – a mission to Russia', *DTI*.

Gokhberg, L., Kovaleva, N., Kouznetsova, I. (2001) 'Innovation management in Russia: a review of training needs and opportunities for growth', *British Council, Russia*.

Gokhberg, L. (2004) 'Russia's National Innovation System and the "New Economy"', *Problems of Economic Transition*, 46 (9), 8–34.

Gokhberg, L., Shulanova, O. (2004) 'Russian public opinion of the knowledge economy: science, innovation, information technology and education as drivers of economic growth and quality of life', *British Council, Russia*.

Klochikhin, E. (2012) Russia's innovation policy: Stubborn path-dependencies and new approaches, *Research Policy*, 41: 1620–1630.

Lachinov, M (2005) Russia: science and technology framework, accessed from http://www.alwatchservice.com. (14 April 2005).

Matthews, J. (2006) Microwave power: Russia's strength. Global Watch Magazine, Vol. 6, pp.10–11.
OECD (2004) Science, technology and industry outlook. Country response to policy questionnaire. Russia.

Radovilsky, Z. (1994) 'Managing Operations in the Former Soviet Union: Current Situation and Future De-
velopment', *International Journal of Operations and Production Management*, 14 (2): 43–50.

Roy, R., Taratoukhine, V. (2002) Decision Engineering: informed operational and business decision making
within industry, *Granfield University*.

S&T Overview accessed from http: // www.globalwatchservice.com/Pages/Russia/S&T (5 January 2006).

Sokolov, A., Chulok, A., (2016) Priorities for future innovation: Russian S&T Foresight 2030, Futures 80: 17–32.

Trifilova, A., Bartlett, D., Altman, Y. (2007) 'Innovation and technological collaboration: a Russian perspective', In *Proc. 21st Int. BAM Conf.* Managing Research, Education and Business Success: is the future as clear as the past? Coventry: UK.

Watkins, A. (2003) *From knowledge to wealth: transforming Russian science and technology for a modern knowledge economy'*, World Bank.

Yegorov, I. (2009) 'Post-Soviet science: Difficulties in the transformation of the R&D systems in Russia and Ukraine', *Research Policy*, 38, 600–609.

Yukhnov, P.M. (2003) 'Investment Potential of Foreign and Russian Oil & Gas Companies', *Neftyanoye Khozyaystvo,* no. 11, pages 14-16 (in Russian).