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Commercialization of Publicly Funded Research and Development (R&D) in Russia

Scaling up the Emergence of Spinoff Companies

Juan Julio Gutierrez
Paulo Correa

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Abstract

This paper explores fundamental issues affecting technology commercialization of publicly funded research and development (R&D) in the Russian Federation. Despite substantial R&D investments, Russia has experienced a decline in scientific output and employment. Nevertheless, the innovation system remains strong in several technological fields. This paper develops an analytical framework to discuss conditions for technology commercialization, which hinge on the innovation system research base, governance of research institutions, alignment between specialization and sector prioritization, availability and performance of scientists and engineers, intellectual property (IP) regime for publicly funded discoveries, and early stage finance. The paper identifies areas for policy and regulatory improvement to incentivize research institutes and scientists to undertake research with market potential. These include: stronger results-based management that rewards commercialization efforts and focuses not only on high-technology sectors, but also on sectors where Russia has technological comparative advantages. In addition, researchers' career development could consider performance metrics that include entrepreneurial achievements, as well as support for young scientists and for international collaboration. Moreover, the IP regime for federally funded R&D may consider transferring full ownership of research discoveries to research organizations. Finally, to increase deal-flow of new ventures, enhancing the supply of early-stage financing for new technologies may be considered.

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The authors may be contacted at jgutierrez3@worldbank.org and pcorrea@worldbank.org.

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Juan Julio Gutierrez

Paulo Correa

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Contents

Introduction

This paper explores issues affecting technology commercialization of publicly funded research and development (R&D) in the Russian Federation. It focuses on public funding of R&D, because, despite the relatively large role played by the private sector, the bulk of R&D funding (66.5 percent) is provided by the government. Though improved innovation policies have led to the creation of a sizable number of research-based start-ups in the last three years (2009-2011), fine-tuning of policies is needed to scale up the emergence of such companies.

The Russian government has identified innovation policy as a key component for the country's growth and has designed a set of policy instruments to incentivize the commercialization of research results. The efforts to improve the national innovation system include reforming the legal framework for intellectual property rights (IPR), providing public funds for venture capital, and targeting specific economic sectors and industries, while also increasing overall public participation in R&D expenditures.

A focus of the innovation policy has been the commercialization of research stemming from higher education institutions. Accordingly, almost all 973 start-up companies have started from university-based research. Nevertheless, only a third of universities perform research, and those universities only concentrate 6% of both R&D expenditures and number of researchers. Research institutes mostly from the Russian Academy of Sciences (RAS) are better endowed for research; receiving around 40% of resources, however less than 4 percent of the 468 research institutes affiliated with the RAS have initiated spinoffs.

Against this backdrop, this paper develops a novel framework to analyze the constraints and opportunities to scale up the number of spin offs from research funded with public money. The paper builds on the recent reviews of the Russian innovation system (OECD, 2011; UNESCO, 2010; New York Academy of Sciences, 2010). It updates those studies by reporting new evidence on the results of recent changes in the IPR legislation on the creation of research based companies and licensing of IP. As well as, this paper informs on the consistency between Russian technological specialization and the government's sectoral priorities, while presenting unique new survey evidence on the characteristics and role of technology transfer offices in the commercialization process.

The framework to analyze the factors affecting technology commercialization is based on four strands of the innovation literature. First, the state of the research base of Russia's innovation system including the governance of research institutions and the role of performance based budgeting is paramount to: assess the critical mass that may generate discoveries; incentivize commercialization efforts and increase the quality of research (Gianella and Tompson, 2007; OECD, 2003). Second, the availability of human capital for research, the quality of scientists and engineers and the resources at their disposal, as well as incentives for career development are key for increasing the likelihood to successfully bring research to the marketplace (Aldrigde and Audretsch, 2011). Third, the analysis framework relates to the vast literature on market failures for funding of ideas, especially in the early stage of the commercialization process (e.g. Branscomb and Auerswald, 2003). Finally, the IPR legislation is the frame that could incentivize commercialization by regulating the ownership and royalty distribution of publicly funded research (Phan and Siegel 2006). A close related topic is the role of technology brokers in licensing and start-up process (Litan et al 2007; Thursby et al 2001).

The paper is organized as follows: Section I describes the analytical framework as well as provides a review of the related literature. Section II assesses the factors affecting technology commercialization; especially those influencing the emergence of IP based start-ups. First, this section provides an overview of the Russian innovation system research base and shows that despite declining productivity of R&D investments and personnel, Russia has technological comparative advantage in certain sectors. As well, it illustrates the divergence between stated government priorities, allocation of resources among types of research institutions and those sectors where there is technological advantage. Moreover, it points out that research institutions are not properly incentivized to increase their performance as most of their budget is not allocated competitively but based on personnel headcount. Second, this section focuses on the declining numbers and quality of the human capital devoted to research, the relatively few resources and old equipment at their disposal and reveals the need of a system of research career development that supports young scientists and uses the large highly skilled Diaspora through international collaboration. Third, this section provides evidence of the lack of instruments and the inadequacy of existing ones to fund early-stage new ventures, impeding the creation of a “deal flow” for available venture capital investment. And fourth, Section II also provides an analysis of a cross-cutting area that deserves particular attention, the IP regime for federally funded R&D. It finds that, while recent IP legislation, the 2008 Civil Code and 2009 Federal Law 217 have improved the context for research commercialization, there is still uncertainty discouraging licensing.

Section III presents research commercialization results achieved since the implementation of the new IP legislation in terms of start-up creation and patent licensing. The results show the preeminence of universities in this process despite their small share in both R&D expenditures and personnel. In contrast, research institutes affiliated to the RAS show almost negligible results in commercializing their research discoveries, despite their importance in the Russian research base. This section also provides new survey evidence on the role of Russian technology transfer offices (TTOs) in the research commercialization process. As well, it shows that the defense R&D is still a source of inventions with commercialization potential but with limited reach to the marketplace. Finally, Section IV puts forward a set of conclusions and policy recommendations that would help fine-tune innovation policies to scale up the research commercialization process and the emergence of spinoffs.

I. Analytical Framework

Commercialization of publicly funded research usually represents a form of technology push to the marketplace. Those technologies spring from a combination of basic and applied research where many times basic research has been heavily funded by the government. As such, the output intended for commercialization tends to be of relative high technology, the market for it is unknown, and entails a high risk level, but the returns to investments can be relatively high. In countries such as Russia, where an important part of the R&D budget comes from the government and most of the R&D performers are public research institutions, a key issue is to provide incentives and the conditions for the generation of outputs that could be commercialized in the marketplace.

Accordingly this paper is closely related to four strands of the innovation literature. First, the literature on commercialization incentives for research institutions points out to the potential benefits to them, which include increased licensing and royalty revenues, more contract research and greater cross-fertilization between faculty and industry. Equally important, are the intangible benefits to an institution’s reputation and to the quality of its research that closer interaction with the private sector can generate (Gianella and Tompson, 2006; OECD, 2003).

The institutional structure of the Russian innovation system carries a heavy legacy from Soviet times which makes it inefficient in bringing research results into the marketplace. As most of the funding for research institutions is still allocated in a headcount basis, the incentives to increase performance in terms of research productivity (e.g. publications and patents) are not in place (Yegorov, 2009). Moreover, the budgetary organization status of research institutions is not conducive for engaging in joint R&D with private firms, as it is difficult to formalize those partnerships.

Moreover, the literature on university/research institution-based technology transfer is clear to point out that the success of a research institution’s licensing and spinoff program depends on its institutional structure, organizational capability, and incentive systems to encourage participation by researchers (Phan and Siegel 2006). The incentives systems include both pecuniary and non-pecuniary rewards, such as credit towards tenure and promotion.

Second, the literature on human capital for R&D has found that a skilled workforce is a precondition to both the creation of new technology but also to its use since skill biased technological change requires highly trained labor to complement and apply technological advances (Machin, 2001). Because the commercialization of scientific research is particularly risky and uncertain, a strong scientific workforce, in terms of their qualifications, critical mass, age and available equipment provides an important signal of scientific credibility and capability to any anticipated commercialized venture or project (Audrestch, et al 2006).

The academic entrepreneurship literature (Aldrige and Audretsch, 2011; Audretsch, et al 2006) posits that early in their careers scientists invest heavily in human capital in order to build a scientific reputation and in the later stages of their career, the scientist trades or cashes in this reputation for economic return (scientist life-cycle concept). Due to the Soviet legacy, in Russia older scientists are likely to be less familiar with business practices needed to commercialize their research.

At the same time, to ameliorate the negative effects from brain drain, the literature recognizes the importance of highly trained expatriates in terms of their individual embodied knowledge but also of the socio-professional networks in which they are inserted overseas (Saxenian, 2006). It is also pointed out the role that innovation policy can play in shaping the inflows and outflows of highly skilled people considering that international linkages and networking do not require large infrastructure investments, as it consists in capitalizing on already existing resources (Solimano, 2008).

Third, the literature on university/research institution-based technology transfer is closely related to the literature on IPR as the legal framework that could incentivize commercialization (Phan and Siegel, 2006; Thursby et al, 2001). Accordingly, IPRs may encourage private investments to bring publicly funded research discoveries to the marketplace by reducing uncertainty in the ownership of technology and facilitating technology contracting and financing. Inventions stemming from science are often very embryonic and it is therefore risky to invest in technologies with an uncertain market or industrial application. In turn, firms would be more reluctant to invest if the legal framework is unclear about the ownership and commercialization rights of innovations. In addition, the licensing of technology may require exclusive licensing to fully encourage private commercialization (WIPO, 2011). In the US, the 1980 Bayh-Dole Act contributed to significant changes in how universities commercialize and diffuse technologies developed in their research laboratories. As a consequence, all major US research universities have established technology transfer offices focused in increasing the number of academic patents and their subsequent licensing and creation of IP based new firms (Grimaldi, et al 2011). Nevertheless, the development and growing importance of TTOs has been an unintended consequence of the Bayh-Dole Act (Litan et al, 2007).

Another strand of this literature states that technology commercialization needs special organizational arrangements that facilitate industry-science interface ("boundary-spanning") and manage the different stages of the technology transfer cycle. Accordingly, technology transfer offices (TTOs) can provide economies of scale by centralizing R&D commercialization functions while providing experience in patent (IP in general) application and in drafting technology transfer contracts (Dalhman, 2010); among other advantages. Nevertheless, empirical evidence shows that TTOs follow a short term revenue maximization model, by which incentives are created to maximize only revenues earned by the university instead of maximizing the actual numbers of commercialized innovations (Markman et al, 2005). Along with licensing, the other avenue for tech transfer are IP based spinoffs which can potentially create jobs in the local economy but are likely to require additional university services to assist the academic entrepreneur in launching and developing their startup (Phan and Siegel, 2006; Thursby et al, 2001).

Despite their important role the international experience also shows that setting technology-transfer offices is costly, as specialized expertise and infrastructure is needed (WIPO 2011) and revenues from commercialization activities represent only a fraction of TTO's budget on average (AUTM, 2010).

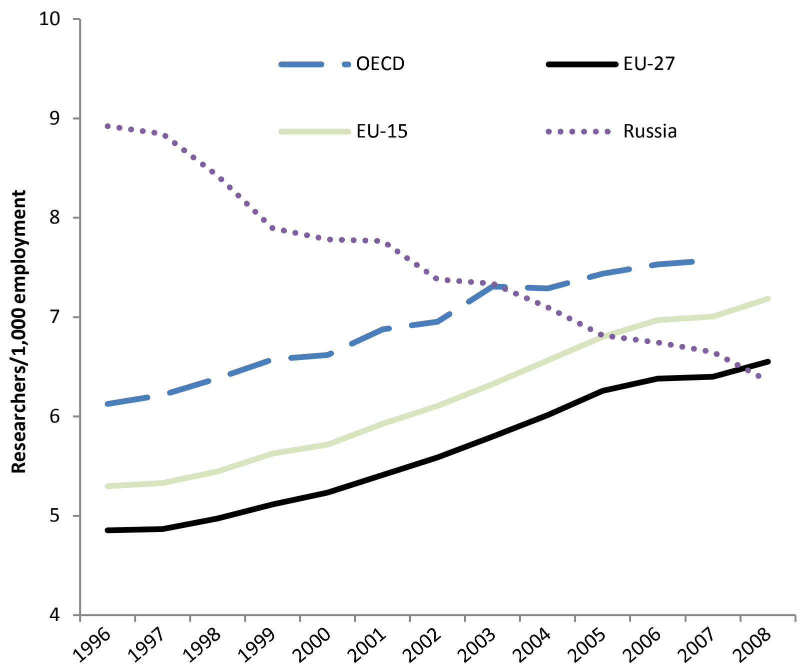
Finally, the literature of financing of early stage innovation deals with funding needs beyond internal resources due to the uncertainty, length and scale of the innovation process. Information asymmetries and the risk associated with innovation tend to generate a "funding gap" for available inventions that require further private investment to be commercialized. This underinvestment in innovation is greatest for early-stage technological development, the phase where the commercial viability of inventions is validated (Branscomb and Auerswald 2003).

II. Factors Affecting Technology Commercialization

II.1. Research Base of the Innovation System

Notwithstanding substantial investments in R&D, Russia has been experiencing a decline in scientific output and employment. In the last few years, Russia has invested US$ 10 billion–US$ 14 billion annually in R&D (Ministry of Science and Technology 2009). This large absolute value surpasses the R&D expenditures in more innovative but smaller countries such as Israel, US$ 8 billion, or Finland, US$ 9 billion. Yet, this falls short of the R&D expenditures in larger advanced economies (e.g., the United Kingdom, US$ 50 billion, or the Republic of Korea, US$ 31 billion), as well as the expenditures in other BRIC countries (e.g., China, US$ 49 billion) and it is less than 5 percent of the top country in absolute R&D expenditures (the United States, US$ 369 billion). Russia's 2008 R&D expenditures as a share of GDP (1.03 percent) is certainly higher than some Eastern European countries (e.g., Poland, 0.6 percent or Romania, 0.54 percent) and comparable to some BRICs (Brazil 1.02 percent or China 1.4 percent). Yet, it is less than half the EU Lisbon Agenda target of 3 percent and much lower than that of economies at the technological frontier (e.g., the United States 2.7 percent, Sweden 3.7 percent, and Israel 4.7 percent).

Figure 1: Total researchers per thousand total employment

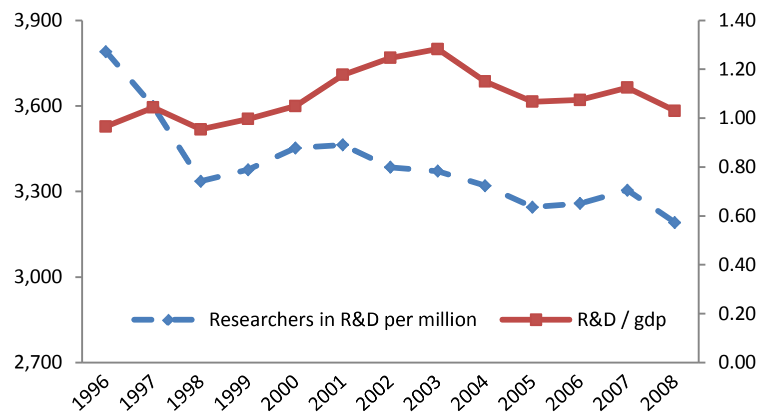


Source: OECD Science and Technology Indicators 2011.

In parallel to declining scientific performance, the proportion of researchers in the workforce has been diminishing. While in the mid-1990s, the proportion of researchers in overall employment in Russia was 1.5 times the OECD average – almost twice the share in EU-27 countries and more than double the EU-15 country ratio – in 2008 it had become lower than in both (Figure 1). At the same time, Russia's proportion of researchers in the workforce has been continuously declining, compared with an increasing trend in Europe and OECD countries. Nevertheless, Russia is among the world leaders, after the United States, Japan, and China, in the absolute numbers of R&D staff. In 2008, it had 761,300 people engaged in R&D, including researchers, technicians, and support staff. The ratio of 3,191 researchers per million people in Russia that year by far surpasses Eastern European country averages (1,600 in Poland and 876 in Romania), as well as BRIC countries (Brazil 628, China 1,070). The relative number of researchers in Russia is, however, much lower than in economies at the technological frontier (e.g., the United States, 4,663, Sweden, 5,214) (UNCTAD 2010).

Despite significant R&D financial resources and human capital, Russia's standing has been eroding in the past 15 years. Russia's relative position is either similar or worse than in the mid-1990s in both R&D spending as a share of GDP and the number of researchers as a proportion of the population (Figure 2). Further limited evidence for 2009 indicates that budgetary expenditure on R&D was cut by around 30 percent that year along with decreases in private sector R&D.

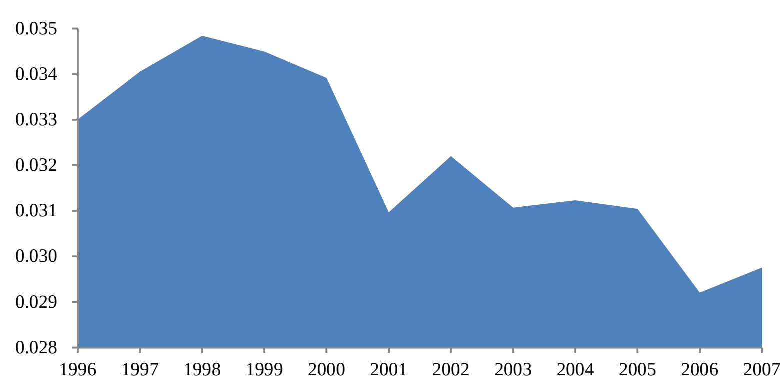
Figure 2: Evolution of R&D investments and number of researchers, 1996–2008



Source: Author's elaboration based on WDI (2011).

The output from Russia's scientific community has been decreasing as the productivity of researchers – published articles in science and engineering journals – has declined (Figure 3).[1] In Russia, academic output has always been low relative to other countries, which is partly related to the performance of R&D in government research institutions rather than in universities. Worryingly, academic productivity has decreased in the last few years of available data, despite the higher R&D investments as a proportion of GDP during the 2000s. Scientific publications are mostly concentrated in physics (30 percent), chemistry (20 percent), and

Figure 3: Science and engineering journal articles per researcher



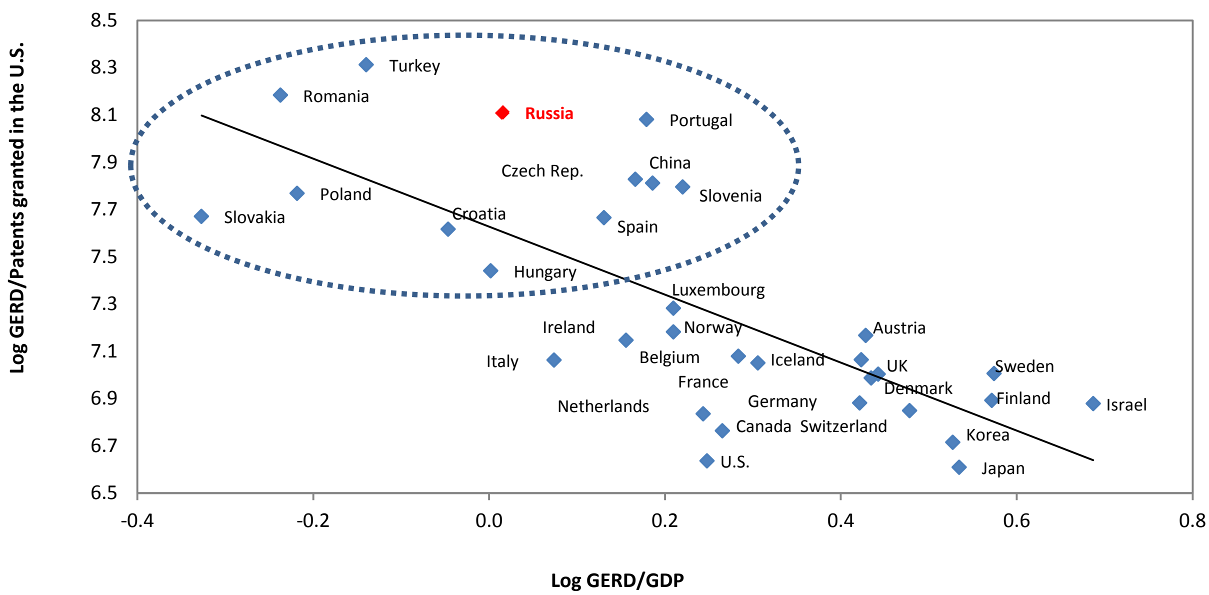
Source: Author's elaboration based on WDI (2011).

[1] Fields considered by the National Academy of Sciences: physics, biology, chemistry, mathematics, clinical medicine, biomedical research, engineering and technology, and earth and space sciences.

engineering and technology (11 percent), while the number of scientific publications with international collaboration has remained stable in the last 9 years (2000–08), around 8,700, compared with a total number of publications of around 27,000 (UNESCO, 2010).

The low productivity of research and development (R&D) limits Russia's supply of "ideas" as the country spends more per patent than countries that are more R&D intensive, implying inefficiency in the innovation process. Even with government R&D expenditures at 66.5 percent of the total, the total share of R&D is relatively low in Russia, alongside a high ratio of expenditures per patent. More advanced economies like Japan and Finland present the opposite situation: it is less costly to patent there, and they spend more on R&D (as measured by lower R&D expenditures per U.S. patent and larger R&D expenditures as a share of GDP) (Figure 4).

Figure 4: Cost of patenting and gross R&D expenditures, 2008



Source: Author's elaboration based OECD (2011), UNESCO (2011), U.S. Patent and Trademark Office (2011), WDI (2011).

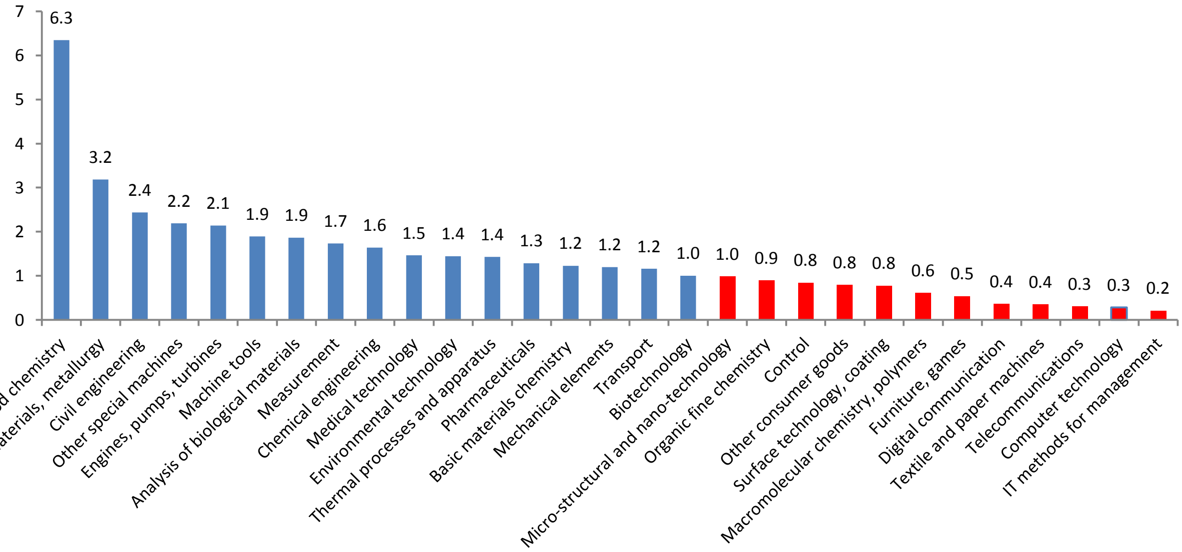
Yet in spite of its inefficiencies, the Russian innovation system is relatively strong in certain sectors, as measured by technological advantage (Figure 5). Even with overall low patent productivity, there are niches where Russia's patent production is concentrated. Russia has a revealed patent advantage (RPA)[2] in four out of five fields of technology – instruments, chemistry, mechanical engineering, and other fields (See Annex II). The sub fields with technological advantage represent the best opportunities for starting up IP based companies as well as developing a market for technology licensing.

Within fields of technology, Russia has a technological/patent advantage in some sub-fields but not in others. Efforts to commercialize research then should concentrate on technologies where Russia has a global comparative advantage. Out of 30 subfields of technology, the two with the highest RPA in Russia are Food chemistry, and Materials and Metallurgy, both from the Chemistry field. The third highest RPA in Russia is in Civil Engineering, the only technology sub-field in the Others field where Russia has a comparative advantage. The fourth to sixth subfields of technology with the highest RPA belong to the Mechanical Engineering field and are: Special Machines, Engines, Pumps, Turbines and Machine tools. The seventh and eighth subfields of technology with the highest RPA are Analysis of Biological Materials

[2] The revealed *patent* advantage (RPA) = log(RTA). Revealed *technological* advantage (RTA) is defined as the share of a country in patents in a given field of technology filed, divided by the country's share of all patents across all fields of technology in the world

and Measurement, which are part of the Instruments field of technology. On the other hand, there is no Russian comparative advantage in chemistry sub-fields such as Micro-structural and Nano-technology or Furniture, Games and Consumer Goods. As well, there is no RPA in Instruments sub-fields such as Optics and Control. Finally, none of the 8 sub-fields of Electrical engineering Russia show a RPA. However some sub-fields of Electrical engineering are part of government priorities such as Computer Technology, Telecommunications and Digital Communications. (The complete RPA/RTA is in Annex II.)

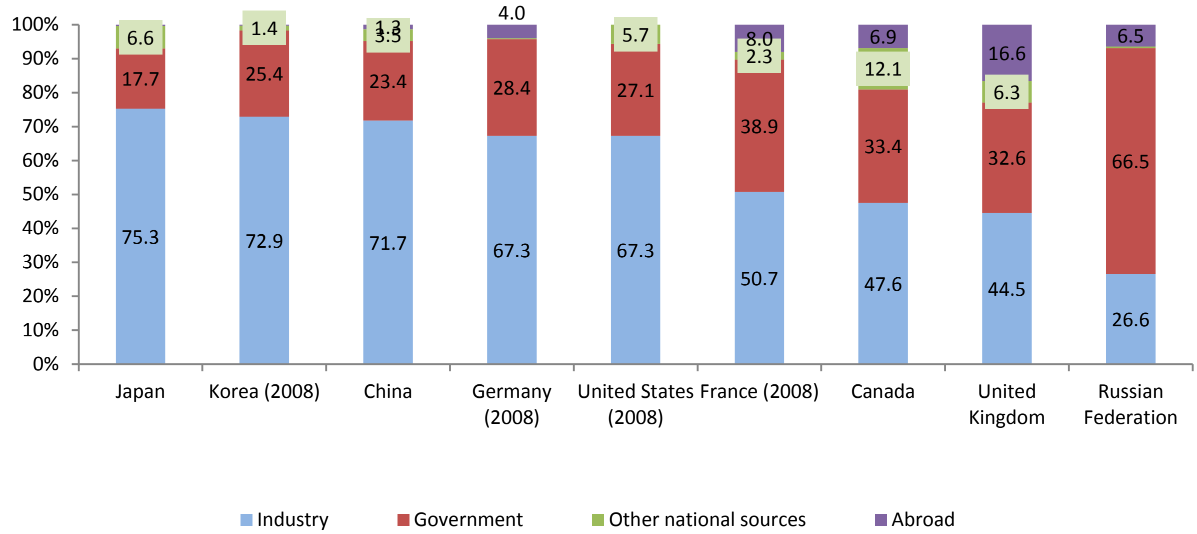
Figure 5: Russia's RTA in Sub-fields of Technology, 2002–07



Source: Authors' elaboration using WIPO 2011 data (http://www.wipo.int/ipstats/en/statistics/patents/).

Contrary to more advanced economies where the business sector plays a leading role, the bulk of R&D expenditures in Russia is funded by the public sector (66.5 percent in 2009) (Figure 6). This share has continuously increased in the last few years, while that of both private and foreign sources has decreased to 27 percent and 6 percent respectively, probably as a result of the global financial crisis. It is estimated that the number of small, innovative enterprises fell by around half. Many of them were working under contract to large firms that had outsourced R&D activities and cut their R&D spending in the wake of the recession (Gaidar Institute 2010).

Figure 6: R&D expenditures for selected countries by source of funds, 2009



Source: OECD MSTI (2011).

The federal contribution to R&D is not homogeneous across strategic sectors, nor is private sector participation. The federal contribution to R&D is by far the largest in industry nano-systems and material systems as well as in living systems (78 percent), and is also high in ICT (58 percent) and transport, aviation, and space systems (53 percent). On the other hand, private funding of R&D (extra-budgetary funds), including foreign R&D, varies within strategic sectors, from 18 percent in living systems to 48 percent and 63 percent in rational use of natural resources and energy and energy efficiency, respectively (see Table 1).

Table 1: Gross domestic expenditure on R&D in priority areas of science, technology, and engineering by source of funding, 2007 (thousand US$)

	Total	ICT	Nano-technology and materials	Life sciences	Natural resources	Energy and energy efficiency	Transport, aviation, and space systems
Gross domestic expenditure on R&D in priority areas of Science, Technology and engineering	6,570,375	1,026,233	465,476	279,025	520,033	533,353	3,392,642
Sources of funding							
Federal budget	3,584,383	591,761	362,885	217,878	246,696	192,164	1,784,651
Regional and local budgets	147,631	18,984	6,596	9,785	23,946	3,286	86,617
Extra budgetary funds	2,838,361	415,487	95,995	51,362	249,391	337,903	1,521,374

Source: Indicators of Science (2009) – MoES, ROSSTAT, and the Higher School of Economics.

Strategic sectors accounted for around 44 percent of all R&D expenditures. Among the strategic sectors, the majority of resources – 52 percent – were employed by the transport, aviation, and space systems sector, followed by ICT at 16 percent, in 2007 (Table 1). The heavier expenditures in transport may guarantee Russia's place at the technological frontier in the field, especially in space and aircraft technology. Additionally, the relatively large resources devoted to ICT may partly explain the emergence and growth of software start-ups and software exports in recent years. Formal investments in R&D in ICT may tilt Russia's technological advantage to ICT-related fields of science, such as computer technology and information technology methods for management. In those fields Russia did not have technological strength (see Figure 5).

Russia has a technological advantage only in some of the sectors designated by the government as strategic. The Long Term Social and Economic Development Plan until 2020 of the Russian Federation (Concept 2020), identifies six sectors as strategic for the future development of the country[3]. Russia, however, has a technological advantage in only four of these, i.e., aviation and engine building, space industry, shipbuilding, and nuclear power. Neither is Russia particularly strong in the radio-electronic industry nor information and communication technology (ICT), also deemed strategic by Concept 2020. Moreover, the nanotechnology sector, which has been given extensive policy attention and funding,[4] does not show technological advantage according to the patent analysis.

The most qualified R&D personnel are concentrated in fields that, though considered strategic, receive small proportions of R&D expenditures. The most skilled researchers among R&D personnel (those with PhD and Candidate of Science degrees) are concentrated in the natural science field (Table 2). However, the strategic sectors that may intensively use these researchers (life sciences and natural resources) do not receive large shares of allocated resources (see Table 1). Both areas together only account for 12 percent of total R&D spending in strategic sectors.

Table 2: R&D personnel by educational attainment and field of science, 2007

Field of science	Total researchers	%	PhDs	%	Candidates of Science	%
Total	**392,849**		**25,213**		**78,512**	
Natural	94,668	24	11,479	46	33,359	42
Technical	244,475	62	4,809	19	23,552	30
Medical	16,734	4	3,934	16	7,540	10
Agricultural	13,743	3	1,478	6	5,100	6
Public	13,740	3	1,632	6	5,008	6
Humanities	9,489	2	1,881	7	3,953	5

Source: Indicators of Science (2009) – MoES, ROSSTAT and the Higher School of Economics.

The public sector is not only the main funding source, but is also the main performer of R&D. The business sector apparently "performs" 64 percent of total R&D (Table 3). However, the following categories are classified as business entities in the business sector of official Russian statistics: state owned-companies and branches of research institutes that form part of the RAS. These institutions – conduct many of the publicly financed innovation activities (MoES 2009). Gokhberg and Kuztnetzova (2010) assess using Rosstat data that the number of publicly owned R&D performing units in Russia is over 70% which in turn perform the bulk of R&D in the country.

In line with the proportion of government R&D funding, the Russian government owns around 70% percent of the around 4,000 institutions performing R&D. As of 2009, the state owned around 2,600 R&D organizations, including research institutes affiliated with the RAS and state-owned enterprises performing R&D (Gokhberg and Kuztnetzova, 2010), which are classified as business entities in official statistics (Table 3). The number of research institutes has risen in recent years, mainly as a result of splits and spinoffs rather than any increase in the country's overall research capacity. Thus, the structure of

[3] The sectors prioritized in the Concept 2020 development plan do not correspond one to one with the patent technological fields. However they are composed of a series of sub-fields of technology. For example ICT is composed of the following sub-fields of the Electrical field: Telecommunications, Semiconductors, Computer technology and Audio-visual technology

[4] Though later reduced, in 2007, the government invested $5 billion into a new state corporation in nanotechnology, RUSNANO.

government R&D may be both too large and too fragmented; with many institutions performing little if any research and others conducting research that does not need to be in the public sector.

Though universities are at the core of Russia's current policies for commercializing publicly funded research, higher education institutions only conduct 6 percent of total R&D. This ratio is well below that in other advanced economies. As a share of GDP higher education institutions represent 0.07 percent in Russia, against an average for OECD countries of 0.39 percent, over five times as high. Moreover, as of 2008 only a third of universities conducted R&D, down from 52 percent in 1996. Historically, research has been mostly in the hands of the research institutes affiliated with the RAS, with universities having teaching as their main mandate (UNESCO 2010).

Table 3: R&D by funding source and performer, 2007

R&D funding source				R&D performer			
SECTOR	Rub (million)	US$ (million)	%	SECTOR	Rub (million)	US$ (million)	%
State	232,365	9,294.6	63	State	107,985	4,319.4	29
Business sector	109,265	4,370.6	29	Business sector	238,386	9,535.4	64
Foreign sources	26,796	1,071.8	07				
Other sources	2,654	106.2	01				
				Higher education	23,472	938.9	06
				Non-profit orgs.	1,237	49.5	003
Total		**14,843.2**		**Total**		**14,843.2**	**100**

Source: Indicators of Science – MoES, Higher School of Economics, 2009.

The institutional structure of the Russian innovation system carries a heavy legacy from Soviet times. Public research organizations, led by research institutes affiliated with the RAS, receive a high proportion of public resources devoted to R&D. The RAS has generally received around 40 percent of government funding to science[5] (Gianella and Thompson, 2007), which it allocates among its 468 institutes (with 76 percent going to natural sciences in 2009). The Russian Academy of Medical Sciences received another 6 percent for 69 institutions. All these research institutes are counted as part of the business sector (Table 4). Higher education institutions (621 of them) received 6.6 percent of government funding.

Table 4: Number of institutions, personnel by performing sector

	Number of organizations			Number of R&D personnel, headcount			% in intramural R&D expenditure		
	2006	2007	2008*	2006	2007	2008*	2006	2007	2008*
Government sector	1,341	1,483	1,480	274,802	272,255	274,515	27	29.2	29.8
Business sector	1,682	1,742	1,663	486,613	478,401	467,144	66.6	64.2	63.2
Higher education	540	616	621	44,473	49,059	49,363	6.1	6.3	6.6
Private non-profit sector	59	116	138	1,178	1,420	1,741	0.3	0.3	0.4
Total	3,622	3,957	3,902	807,066	801,135	792,763	100.0	100.0	100.0

Source: Indicators of Science – MoES, Higher School of Economics, 2009.

*=Estimated

[5] The RAS performs for two thirds of basic research (New York Academy of Sciences, 2010)

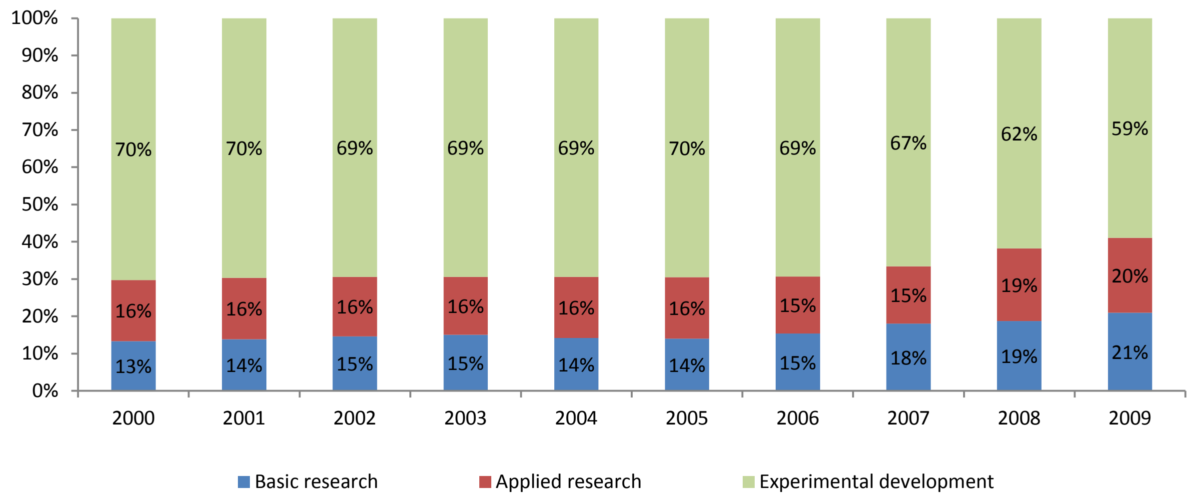
Only a small proportion of the government budget for research institutions is allocated competitively, unlike the more advanced economies. Though there is a government desire to allocate more government R&D funds competitively, the government budget apportioned only 14.6 percent of all civil science funding competitively. Half of that was channeled through the Russian Foundation for Fundamental Research and the Russian Humanities Science Fund (MoES 2009). More developed economies have higher shares of competitively allocated funding. Most public financial support for R&D in the United States is awarded by mission-oriented agencies and other research bodies (such as the National Academy of Sciences) in response to individual demands. In Israel, around 30 percent of government-funded R&D is allocated competitively through universities or the Ministry of Industry, Trade and Labor (ERAWATCH 2010).

Most of the budget for research institutions, including universities, is apportioned based on personnel headcount. The government allocates budgets to public research organizations and higher education institutions in amounts it deems sufficient to cover anticipated costs. The financing system takes into account the number of employees. Thus, if research institutes' directors were to have fewer employees, they would receive less from the state budget.

As a result, there are incentives to inflate payrolls and many "researchers" have other jobs, affecting the quality of research. Even though still formally associated with research institutes, the number of specialists working in more than one job grew steadily in the 2000s. At least at the start of the decade, about 40 percent of researchers had R&D as a part-time job (Yegorov 2009). The headcount financing system creates incentives to inflate costs and fails to establish a link between resources and outputs.

Russia's investment in research, both basic and applied, has risen over the years. However, development expenditures have fallen. This may diminish the capabilities to commercialize research results by bringing innovations to the marketplace. The development side of R&D fell to 59 percent in 2009 from 70 percent in 2000, while basic and applied research grew by 8 and 4 percentage points, respectively (Figure 7). Russia's structure of R&D differs from that in more advanced economies, where R&D expenditures are concentrated in the development side, with Israel devoting as much as 82 percent in development. Russia's R&D structure also differs from that of Eastern European countries, which devote higher proportions of R&D to basic research and less to development. For example, the proportions of basic research in Poland and the Czech Republic are 38 percent and 30 percent, respectively, while development amounts to 39 percent and 46 percent (OECD 2011).

Figure 7: Russian R&D by character of work, 2000–09



Source: OECD 2011.

II.2. Human Capital for R&D

Despite universities being the focus of the research commercialization policy, university researchers represent the smallest proportion among total researchers in institutions conducting R&D. While university-based researchers account for 5.3 percent of the total, research institutes (mostly under the RAS) account for 59.9 percent of the total, design bureaus (linked with ministries, such as interior or defense) 22 percent, and industrial enterprises 6.8 percent (Higher School of Economics 2010).

Moreover, the number of university researchers has not kept pace with the increase in total faculty staff. Thus, the share of faculty engaged in research has fallen, from 24 percent in 1996 to 19 percent in 2008. The number of university-based researchers climbed by only 10 percent from 26,300 to 28,900 between 1996 and 2008, while the number of faculty increased from 243,000 to 341,100, a 40 percent rise. This trend is worrisome for the policy objective to increase the number of spinoffs from university publicly funded research, because the critical human mass to create a deal flow of inventions is small or stagnant at best.

Despite the relative decline in the number of researchers, Russia may have too many researchers given its level of R&D spending. While U.S. R&D expenditures are two times Russia's and Sweden's is three times, the number of researchers in the United States is only 1.2 times Russia's and Sweden's is 1.5 times. In other words, the average R&D resources available for each researcher fall short of those in more advanced economies. Furthermore, over 70 percent of researchers in Russia hold no advanced scientific degree (UNESCO 2010).

The composition of R&D personnel in Russia reveals an unhealthy imbalance, with too few researchers relative to auxiliary personnel. Unlike many other countries, researchers in Russia account for less than half of R&D personnel: 375,800 (or 49 percent) in 2008. The rest are mainly support and auxiliary staff (43 percent), rather than technicians serving the scientific process (8 percent). As a result, Russia ranks 10th globally in the number of people engaged in R&D per 10,000 employees but 19th in researchers.

Russian R&D human capital is aging, while the share of middle-career researchers, the ones most likely to publish, is decreasing. Among R&D personnel, 57 percent or more of researchers with the highest skills, proxied by a PhD degree, have passed the official retirement age (Table 5).[6] In 2008, researchers were 49 years old on average, against an average of 40 for those working in the national economy as a whole (UNCTAD 2010).

Table 5: Age of researchers by educational attainment

		Year		
Age category (years)		2002	2004	2006
Researchers	70 and older	3.8	4.6	5.9
	60–69	17.9	17.4	17.2
	50–59	27	27.8	27.8
	40–49	23.9	21.9	19
	30–39	13.8	13	13.1
	Under 29	13.5	15.4	17
PhDs	70 and older	20.3	22.2	24.7
	60–69	36.1	34	32.4
	50–59	28.1	29.7	29.9
	40–49	13.5	12.3	11.3
	30–39	2	1.6	1.8
	Under 29	0.2	0.1	0.1
Candidates of Science	70 and older	5.9	7.4	9.7
	60–69	26.4	25.1	23.8
	50–59	28.5	28.9	29
	40–49	23.5	21.4	18.8
	30–39	12.1	13	14.3
	Under 29	3.5	4.1	4.5

Source: Indicators of Science (2009) – MoES, ROSSTAT and the Higher School of Economics

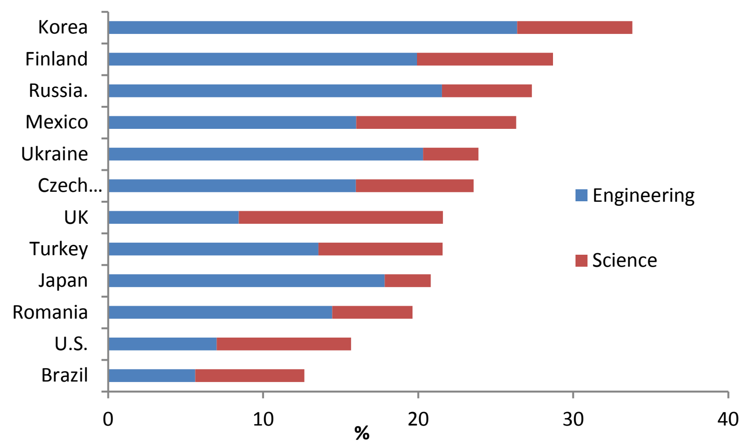
Average wages for researchers are low and uncompetitive in the international market. Researchers working in public research institutions, the private sector, or higher education institutions cannot expect to earn more than US$ 600 a month. Though there is a large variance in salary levels within the

[6] 55 years for women and 60 for men.

Russian scientific community, it is acknowledged that the opportunity costs to be a scientist are high as other occupations, such as finance or real state are more profitable and carry a higher social status. Moreover, survey data shows that, at least at the beginning of 2000s, about 40% of researchers had R&D as a part time job (Yegorov, 2009).

Nevertheless, the rate of engineers (and scientists to a smaller degree) graduating from Russian universities is very high. The share of engineers among new university degrees in Russia (27.3 percent) is lower only than in Korea (Figure 8). Ukraine, Mexico, Japan, the United Kingdom, and the United States all had lower rates than Russia. By contrast, the equivalent figure for science degrees (5.8 percent) was lower than most comparators, at roughly half the share in Mexico and less than half the share in the United Kingdom.

Figure 8: Share of all new university degrees awarded in science or engineering, 2007



Source: UNESCO.

There is evidence of a brain drain from Russia to the West, with a large share of science and engineering graduates studying abroad and not returning. Russia had the eighth-largest number of science and engineering graduates receiving PhDs in the United States in 2002 (Table 6). By 2007, less than one-fourth of those graduates had returned to Russia. The share of Russian graduates remaining in the United States is higher than graduates from other economies such as Korea and Turkey (and above the all-country average of 62 percent). Russia may better leverage the skills and knowledge of those graduates who remain in the United States and other countries where they study, through stronger and wider business and research Diaspora networks, similar to those established by China and India.

Table 6: Foreign science and engineering PhD recipients in the United States and share staying there

Country of origin	Foreign doctorate recipients in 2002	% remaining in the United States				
		2003	2004	2005	2006	2007
China	2,139	97	93	92	92	92
Korea	814	61	53	47	44	41
India	615	91	89	85	83	81
Turkey	315	53	49	46	44	42
Canada	258	65	64	58	52	55
Mexico	173	36	34	28	28	32
Germany	164	58	58	54	51	52
Russia	161	83	85	82	80	77
Japan	144	44	38	36	32	33
Romania	121	88	88	89	87	86
Brazil	119	32	34	32	30	31
United Kingdom	89	68	65	64	68	64
France	83	54	50	50	49	45
All countries	7,850	69	66	64	62	62

Source: Oak Ridge Associated Universities, 2010.

R&D researchers do not work with appropriate equipment or facilities. Even with recent replacements, much R&D equipment is obsolete and of declining value. UNESCO (2010) reports that 25 percent of machinery and equipment used in R&D is more than 10 years old and 12 percent is more than 20 years old, with a degree of wear and tear for R&D equipment of 55 percent. This is particularly problematic for high-tech sectors where depreciation of equipment is higher and faster than in other less technology-intensive sectors. Also, between 1998 and 2005 the value of capital assets used in R&D declined by more than 50 percent, in constant prices. The lack of adequate replacement of R&D equipment forced some research institutions to discontinue regular scientific experiments (Yegorov 2009). UNESCO (2010) also reports that only 7 percent of installations where research is carried out were specifically designed for R&D.

Old equipment is prevalent, even though growth in machinery investment has surpassed GDP growth to become the most important innovation-related expense. In 2007 the purchase of machinery and equipment accounted for 58.5 percent of total spending on technological innovation, R&D itself 16.5 percent (MoES 2009). Between 1998 and 2008 the accumulated growth in investment in machinery and equipment was higher – at around 210 percent – than overall GDP growth of 100 percent (Crane and Usmanov 2010). In that regard, Russia's innovation expenditure structure is similar to that of countries like Korea during its catch-up phase, when it relied heavily on acquiring machinery and equipment to gain access to foreign-embodied knowledge.

One upshot of these negative trends among the Russian R&D workforce can be seen in the low and falling number of publications. Besides what was presented in Figure 2, case study evidence corroborates the fall in R&D human capital performance. For instance, within the Siberian branch of the RAS – generally reckoned one of the more active and successful branches – an estimated 20–25 percent of researchers have published nothing for at least three years (Yegorov 2009).

II.3. Early-stage Financing

Firms view lack of access to financing as the major impediment to commercializing R&D outputs. Among firms polled in an enterprise survey conducted by the Interdepartmental Analytical Centre in Moscow in 2006, 57 percent cited funding difficulties as the major impediment to such commercialization.

In Russia, a large majority of firms rely on retained earnings to finance R&D. However, the shortage of own funds and the cost of borrowing are the principal barriers to investment and innovation, notably affecting small and medium-sized enterprises (SMEs). R&D activities in Russia are highly concentrated in large firms, while the gap between desired and actual levels of R&D activity, as a share of turnover, is much higher for smaller firms (Gianella and Tompson, 2007). Access to finance appears to be much more constraining for SMEs and start-ups.

The Russian government has taken steps to address the lack of funding through the creation of the Russian Venture Company (RVC).[7] RVC was established in accordance with Resolution No. 838-p of 7 June 2006 to stimulate the creation of the venture investment industry and considerably increase funding for such venture foundations, development of innovation industries, and access to world markets for Russian science–intensive technological products and services (Box 1).

[7] Other government funds include the Investment Foundation of the Russian Federation; Open Joint Stock Company Russian Band for Development; and the Open Joint Stock Company Russian Investment Foundation for Information-Communication Technologies. RVC is the biggest.

Box 1: The Russian Venture Company

The sole shareholder of OJSC RVC possessing 100 percent of its equities is the Russian Federation represented by the Federal Foundation for Promotion of Small Enterprises in Science and Technology. As a result of two competitions conducted by OJSC RVC in 2007 and 2008 7 venture foundations were established with a total capitalization of Rub 19.98 billion (US$ 670 million):

1. VTB Venture Foundation (net asset value of Rub 3.09 billion, US$ 104 million);
2. Bioprocess Capital Ventures (net asset value of Rub 2.9 billion, US$ 102 million);
3. OJSC Alliance ROSNO Assets Management (foundation size of Rub 3.06 billion, US$ 102 million);
4. LLC Maxwell Asset Management (foundation size of Rub 3.06 billion, US$ 104 million);
5. CJSC Leader (foundation size of Rub 3 billion, US$ 102 million);
6. LLC Managing Company North Asset Management (foundation size of Rub 1.8 billion, US$ 60 million);
7. CJSC Managing Company CenterInvest (foundation size of Rub 2 billion, US$ 67 million). [8]

As of July 1, 2009, two foundations (CEIF VTB-Venture Foundation and CEIF Bioprocess Capital Ventures) financed 14 innovation companies with a total amount of Rub 1.74 billion (about US$ 60 million) while the total number of projects reviewed by all foundations exceeds 1,500. As of August 2010, 10 RVC–backed funds ran a portfolio of 31 companies, with invested capital totaling Rub 4.5 billion (about US$ 150 million).

Among the main areas for investments are biomedical technologies, power engineering and energy saving, ICT systems, software manufacturing technologies, and "critical technologies."

Venture capital investors are forced to invest in mature and/or foreign companies. They are particularly affected by the lack of viable exit strategies due to the underdevelopment of the market for initial public offerings and the lack of depth of financial markets. Statistics from the Russian Venture Capital Association show that 80 percent of investment capital is dedicated to financing restructuring or business expansion and only 20 percent is earmarked for early-stage financing of new companies. Several of the leading Russian funds have searched for an answer by investing in international projects or by copying Western projects, but without any real technological innovation. The best example of this is the fund Digital Sky Technologies, investing in Facebook, ICQ, Vkontakte, Mail.ru, and others.

The problem with investing in Russian start-ups is the lack of investment projects that fit the investment criteria, rather than an absolute lack of sufficient volume of investment capital. Also, Russian technology start-ups lack experience in developing business plans that reflect the fundamentals required for equity investment, and lack access to affordable legal, accounting, and consulting services that are required to prepare an "investable" business plan and to properly protect their IP.

[8] OJSC: Open Joint Stock Company
LLC: Limited Liability Company
CJSC: Closed Joint Stock Company
CEIF: Closed Equity Investment Fund

There is an almost total absence of early-stage venture capital (or "angel" investors) in Russia, because venture capital is aimed at assisting business growth at a later stage. Though FASIE[9] provides funding up to Rub 3 million (about US$ 100,000), companies assess the funding gap in the range of Rub 10 million to Rub 150 million (US$ 330,000 to US$ 5 million). Moreover, FASIE's budget is very limited: it receives 1.5 percent of the federal civilian R&D budget, which amounted in 2009 to Rub 1.34 billion (around US$ 45 million) and in 2010 to Rub 2.55 billion (about US$ 85 million).

Early-stage financing through business angels does not cover the financing gap and is not widely used due to mistrust and lack of an entrepreneurial culture. Though the financial gap can be covered on certain occasions by business angels, their requirement is to acquire control of the spinoff, which from the point of view of the entrepreneurs is often not desirable. The idea of becoming a serial entrepreneur – one who funds a company based on IP, nurtures it and sells it, and later starts again with a new company – is not an idea that Russian entrepreneurs seem to like.

RVC's seed capital to fund early-stage ventures is not used because the 25 percent co-financing required is hard to obtain for the start-up. RVC launched its RVC Seed Fund in October 2008. Its mission is to invest in Russian innovation-based start-ups promising high-growth opportunities in Russian and foreign IT markets. This Rub 2 billion (about US$ 68 million) vehicle is assisted by a network of venture partners – special entities that have access to academic, technological, and financial resources required for their activities. As of August 2010, the RVC Seed Fund had awarded venture partner status to 58 companies from different regions of Russia. By late 2010, the network included about 100 venture partners. Nevertheless, companies implementing innovation projects at the earliest stages would receive up to 75 percent of the investment required from the Seed Fund, meaning they have to match the remaining 25 percent, which often proves difficult.

II.4. Intellectual Property Legal Framework

Patent applications by Russian scientists – a prerequisite for subsequently commercializing research through licensing and start-ups based on intellectual property (IP) – increased from 2005 to 2009. However, the ratio patent per researcher is much lower than in more advanced economies. The number of patent applications averaged, in 1999–2007, only 0.05 per researcher. The average for the same period in the United States, for example, was almost three times as high, at 0.14.

Patent applications by Russian scientists are often made solely in Russia, that is, there is no protection in global markets which reflects a lack of an international commercialization strategy. In Russia only 4 percent of total applications are registered abroad, against, for example, 26 percent in Korea (calculations based on WIPO 2010[10]). The large Russian home market, at least in certain product categories, may not push companies to foreign markets, and therefore they feel no need for IP protection abroad (Kaartemo 2009). Yet, truly groundbreaking inventions may indeed have an international market. The proportion of patents filed by foreigners in Rospatent[11] has steadily increased between 2005 and 2009, reaching 34% of total patent applications. While the success in getting the patent granted has increased for foreigners, reaching 67% in 2009, Russian applicants have an even higher and increasing success rate, reaching 92% in 2009 (Table 7). Annex III provides a regional breakdown of patent applications in Russia. Half of the applications are concentrated in the Central Federal District (Moscow), followed by the Volga district (15%). While at the national level most patent applications are filed by

[9] FASIE is a non-profit state organization, set up in 1994 by the Government of Russia, to implement state policy for the development and support of small innovative businesses

[10] http://www.wipo.int/ipstats/en/statistics/patents/

[11] Russian Patent Office

legal entities (61%) compared to natural persons (39%), the reverse occurs in the Central Federal District where natural persons file 54% of total patent applications.

Table 7: Patents filed and granted in the Russian Federation, 2005–09

	2005	2006	2007	2008	2009
Filed with ROSPATENT, total	32,254	37,691	39,439	41,849	38,564
by Russian Applicants	23,644	27,884	27,505	27,712	25,598
by Foreign Applicants	8,610	9,807	11,934	14,137	12,966
Number Granted, including:	24,916	25,382	28,212	29,903	32,144
to Russian Applicants	20,749	20,323	22,066	22,668	23,502
to Foreign Applicants	4,167	5,059	6,146	7,235	8,642

Source: ROSPATENT Annual Report 2009.

Weaknesses in the IPR regime have been cited as a major impediment to commercializing R&D outputs in Russia. In an enterprise survey conducted by the Interdepartmental Analytical Centre in Moscow, 50 percent of respondents cited IPR as a major impediment to bring research results to the marketplace, citing only lack of access to financing (57 percent) more frequently (Gianella and Thompson 2007).

The Russian government has made improvements in the IPR legal framework. However, there is still uncertainty, discouraging both patenting and licensing. Two major pieces of legislation govern IP in Russia: Part IV of the Civil Code from 2008 provides a foundation to treat the IP generated with public funding; and Federal Law 217 (2009) deals exclusively with the use of IP generated with public funds to form start-up companies by universities and research institutes under the RAS. We analyze them one by one.

Part IV of the Civil Code[12] establishes the conditions under which the right to technology belongs to the state. IP belongs to the state in defense-related research and, potentially, any discovery registered in any stage of the innovation process funded by the government. The Civil Code protects most forms of IP (patents, designs, trademarks). The state becomes the owner if a technology is developed for needs of defense or security, and if the state assumed the financing before the development of the technology or later to bring the technology to the stage of practical application. In addition, the right to the technology belongs to the state if after six months of completion of work on creation of the technology; the developer has not made all provisions for all legal actions necessary for recognition of the IPR. In all other cases, the right to the results of intellectual activity must belong to the organization − the R&D executor. The Civil Code language is rather vague, especially when defining IP from publicly funded research that is not defense related. The bottom line is that the state retains rights to the IP generated with public funds in defense-related research and in any other case it deems necessary. In the words of a Russian IP expert, the government's rights never end.

The benchmark in regulation of IP stemming from public funds is the U.S. Bayh-Dole Act, which standardized IP treatment, assigned clear ownership and transfer rights, and regulated the distribution of gains from commercialization. In the United States, the insignificant commercialization of research by universities motivated the adoption of the Bayh-Dole Act in 1980. The act transfers to the universities the IP rights resulting from publicly funded research, establishes a minimum amount of royalties to be shared with the researcher, and greatly simplifies the process of IP management (which had been subject to more

[12] Clause 1 of Article 1546 of Chapter 77 "Rights of the Russian Federation and Subjects of the Russian Federation to Technology."

than 20 different laws. These changes enabled more universities to afford the investment required for effectively monitoring, protecting, and marketing IP, and encouraged academic researchers to engage in the related activities. Legislation inspired by the Bayh-Dole Act has thus far been adopted in around 20 OECD countries.

In July 2009, Federal Law 217 (FL 217) was enacted to regulate the use of IP generated with public funds to form start-up companies by universities and RAS research institutes. The FL 17 states that the creation of a new firm has to be notified to the federal government, specifically to the MoES. Universities and public research institutions can be sole founders or cofounders of start-ups based on IP. The participation of the university or research institute cannot be less than 25 percent in the case of a joint stock company and 33.3 percent in the case of a limited company.

III. Technology Commercialization Results

As of June 2011, 973 start-ups had been created, based on IP produced by publicly funded research under Federal Law 217 and those are geographically concentrated. Annex IV provides a regional breakdown of the start-up creation process. More than half of the start-ups are concentrated in two regions. The Siberian Federal District accounts for 30% of the new firms created after FL 217, with Tomsk State University of Systems of Management and Radio-electronics and the National Research of Tomsk Polytechnical University being the most important institutions. The Central Federal District accounts for 23% of the start-ups created, with the Belgrod State Technical University (V.G. Shuhov) being the main institution. The Volga Federal District is also an important region for start-up creation, accounting for 18% of all new ventures under FL217, with the Kazan State Technological University being the main institution for start-up creation.

The participation of universities in the commercialization process far exceeds that of research institutes, though the latter receive the bulk of both financial and human capital resources in R&D. The great majority of these new firms (97 percent) stemmed from university research and very few from research institutes (3 percent) (Table 8). Nevertheless, research institutes concentrate the bulk of R&D resources, around 60 percent of both government funding for R&D and number of researchers. Almost a third, 29 percent, of the 621 universities in Russia have spinoffs based on research. In contrast, less than 4 percent of the 468 research institutes affiliated with the RAS have initiated spinoffs (Table 8). By number of start-ups, 943 have been initiated in 181 universities – an average of 5.1 – but only 30 from 25 research institutes – an average of 1.2.

Table 8: Enterprises created by universities' academic departments and research and development institutes (RDIs) related to the Federal Law 217 dated August 2009

	Number of start-ups, November 2010	Number of start-ups, June 2011
Number of enterprises, organized by academic departments	602	943
Number of enterprises, organized by RDIs	12	30
Number of enterprises by RAS RDIs		21
	Number of institutions, November 2010	**Number of institutions, June 2011**
Number of academic departments that created enterprises	145	181
Number of RDIs that created enterprises	10	25
Number of RAS RDIs that created enterprises		16

Source: MoES 2010, 2011.

The MoES has provisions on start-ups' ownership proportions for the university/RDI, the research team, and (as the case may be) private investors. Most universities are affiliated with the MoES, and spinoff companies from universities adhere to MoES rules. Those rules state that a third of the ownership can be private; the university may own the above minimums (either 25 percent or 33.3 percent depending on the start-up legal status) and the rest of the new company can be the property of the research team.

A spinoff finds it difficult to sublicense the IP since the company does not own the patent that supports the company, and the universities do not grant licenses of IP to the companies on an exclusivity basis. In consequence, the IP may not be resold (sublicensed) to third parties by the spinoffs unless this is stipulated by Federal Law. However, according to the MoES, a planned amendment to Federal Law 217 would change this situation (Kolesnikov 2011). As a matter of fact less than 10 percent of patents granted are contracted away either in patent assignments or licenses (Tables 7 and 9) and exclusive-license contracts represent less than one fifth of patent assignments or nonexclusive license contracts (Table 9).

Table 9: Registration of license contracts and patent assignment contracts

	2005	**2006**	**2007**	**2008**	**2009**
Patent assignment contracts	**1,281**	**1,451**	**1,674**	**1,524**	**1,054**
Exclusive license contracts	**167**	**212**	276	215	228
Nonexclusive license contracts	674	751	902	1,005	1,083
Total	**2,122**	**2,414**	**2,852**	**2,744**	**2,365**

Source: ROSPATENT Annual Report 2009.

Besides the right to transfer the IP, the distribution of royalties is a key aspect to guarantee greater efficiency in technology transfer. However, further improvements in Russian legislation are needed to define royalty distribution. The evidence implies that shifting the royalty distribution formula in favor of faculty members (e.g., allowing faculty members to retain 75 percent of the revenue, instead of 33 percent) would elicit more invention disclosures and greater efficiency in technology transfer (Phan and Siegel 2006). Indeed, Markman et al. (2005), using data on 113 U.S. technology transfer offices, found that universities allocating a higher share of royalty payments to faculty members tend to be more efficient in technology transfer activities.

The inclusion of intangibles such as IPR as an asset of the start-up is a welcome development, but skilled independent valuation of high-value IP is nonexistent. According to Federal Law 217, items like equipment and facilities can be considered assets of the new company. The IP can be considered an intangible asset and its value can be decided by the start-up founders up to about US$ 17,000 (Rub 500,000) but would need an independent evaluator if the IP value is higher. This requires skilled valuation of high-value IP, but expert opinions consider that the Russian market does not provide this service.

As IP is an intangible asset in the start-up's balance sheet, it could be considered part of the start-up capital for financing entities like Rusnano and the Russian Venture Company's venture capital funds. Federal Law 217 also states that IP may not only reach the marketplace through spinoffs but also through license sales. IP belongs to the university, not to the department where the inventor or research team is hosted, but the latter gets the larger part of the royalties. Usually, the contract is between the professor (inventor) or the research team and the university, and they then sell the IP. Registration of license agreements is mandatory by law.

All national research and federal universities have been directed to become autonomous institutions.[13] However, start-ups from such not-budgetary institutions lose the special privileges and government support under Federal Law 217. Start-ups that fulfill MOES requirements[14] to belong to the Register of Notifications on Established Companies can use, for example, the Simplified Taxation System and get a potential reduction of the insurance contribution from 34 percent to 14 percent. This reduction would help start-ups lower costs to hire skilled labor.

The Russian legal regime for IP and technology transfer is developing incrementally as the Ministry for Economic Development and the MoES work on amendments to address inconsistencies and imprecision. According to government officials, Federal Law 217 is seen as a test to gauge the demand for publicly funded IP to start new companies. Yet according to experts, the market for IP in Russia is very small, there is no expertise for IP valuation and there is virtually no demand for IP from the market.

III.1. Research Commercialization through Technology Transfer Offices

International experience shows that technology transfer offices (TTOs) may play a central role in accelerating the commercialization of public research. Their main role is to match the "universities' supply" of potentially commercial ideas with businesses' "demand" or needs. As such, TTOs are responsible for managing the IP that emerges from public research – evaluating its commercial potential, identifying potential users in the business community, and defining the best form of research commercialization (spinoffs, licensing, etc.).

To address the lack of information on the particularities of Russian TTOs, the World Bank and the MoES engaged in a joint initiative to survey existing TTOs in the Russian Federation. The survey was conducted between January and May 2011 covering the 112 registered TTOs by the MoES, with a response rate of 61 percent of the TTOs providing accurate contact information. The following paragraphs present the survey results.

The majority of TTOs were created between 2003 and 2008 and their emergence is not a consequence of IPR legislation, unlike the U.S. experience. Most of the surveyed TTOs, 81 percent, started operating before 2008[15] (i.e., before the main new IP laws were enacted). TTOs were initially established in 2003 on the basis of RAS institutions, universities, and public research centers in six federal districts. TTO creation is not a stated goal of the Russian IPR legislation (Part IV of the Civil Code and Federal Law 217). Unlike the United States where the initiative came from universities as an unintended consequence of the Bayh-Dole Act, in Russia TTOs have been set up by the MoES.

The average staff size of Russian TTOs is in line with comparable institutions in other countries. Russian TTOs had an average of 5.6 full-time employees in 2010. In the United States, TTOs are relatively small, often at most with five full-time equivalent staff (Phan and Siegel 2006).

The Russian TTO staff's professional background is roughly a third each of businesspeople, university faculty, and university administrators. These proportions may indicate a healthy balance of the TTOs workforce. Several factors influence the success of TTOs, including finding a personnel mix with the appropriate scientific and business skills.

Inventors take full part in the licensing process, as reported by 75 percent of the TTOs. An important challenge for commercializing public research is balancing the interests of researchers and research

[13] According to the Federal Law on Autonomous Institutions (No. 174, dated November 3, 2006).

[14] The selected criteria of compliance with Federal Law 217, dated August 2009 including: 1.Completeness of information on companies as required by MOES Executive Order No. 718, dated December, 2009. 2. Results of ROSPATENT's review. 3. Compliance with legislation (Civil Code, Part 4; Federal Law on LLC; Federal Law on Registration of Legal Entities).

[15] TTOs around the world are relatively young institutions. For example in Japan over 90 percent were established after 1990 and even in the United States the TTO median age was only 12 years in 2006 (Phan and Siegel 2006).

organizations. The process of commercialization often requires an additional engagement from the researcher that is inconsistent with his or her career objectives. Researchers in faculties and public institutes are traditionally rewarded based on academic accomplishments, such as publication of scientific papers, more than, for example, obtaining or licensing patents or collaborating with the business sector. However, in Russia scientists seem to massively engage in a (limited) commercialization process.

More than half of Russian TTOs pay their personnel using the university/research institution pay scale and incentives, bonuses, and success fees related to performance. Research in other countries has shown that career opportunities for university technology licensing officers are limited and often short, which implies difficulties in recruiting and retaining appropriate talent (Phan and Siegel 2006). This is especially true for technology transfer officers with broad-based commercial skills that may be better used elsewhere. In Russia, a significant share of TTOs declares to give their personnel performance-related payment to complement the institutional pay scale, even though they are public employees (Figure 9).

Russian TTOs perform several other activities besides technology transfer. Only 40 percent of TTOs had technology transfer as their main activity. Other main activities are coordination of R&D (13 percent), consulting (11 percent), and training (11 percent).

As a result, proceeds from technology transfer are marginal. Russian TTOs' budgets come mainly from the parent institution, averaging 40 percent. Other important sources are consulting fees (18 percent) and fees received as a broker for university/research institution contract research (10 percent). License royalties and equity in new companies represent 7.3 percent and 3.6 percent of the average TTO budget, respectively (Figure 10).

Figure 9: TTO personnel payment system, 2010

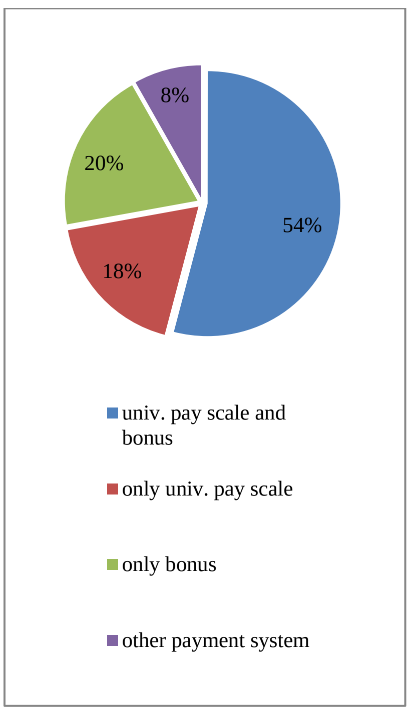


Figure 10: Sources of TTO income, 2010

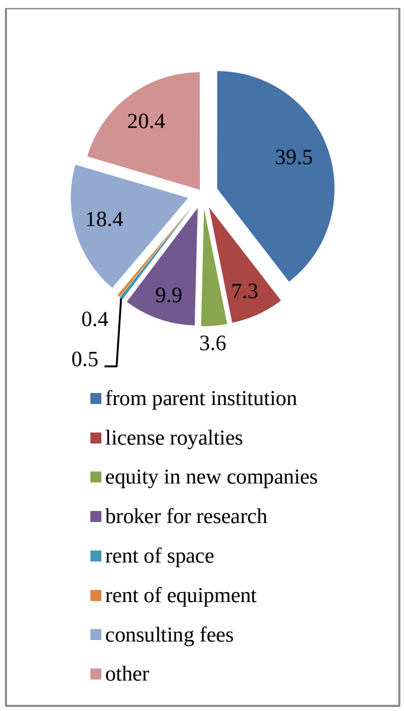
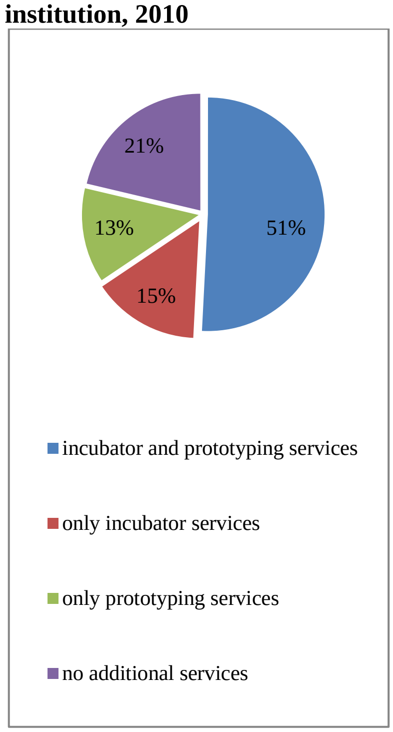


Figure 11: Additional services provided by TTO or parent institution, 2010



Source: World Bank/MOES survey, 2011.

Russian TTOs reliance on public support is not unusual but the income from technology transfer activities should increase in the future. Some level of public support to the TTO in the initial years may be necessary, because fixed and operational costs are not negligible while returns tend to be small, and the licensing to patenting ratio is very low. Moreover, returns from spinoffs need time to mature and contract research only develops in gradual steps. Despite evidence that specific TTO activities that favor new venture creation include early-stage technology and licensing for equity, such a strategy is the least likely to be favored by the university and thus unlikely to be used. Evidence from the United States confirms that TTOs are concentrated in short-term cash maximization, because the main mechanism favored by most TTOs was licensing for cash (72 percent), with licensing for an equity stake and sponsored research less popular at 17 percent and 11 percent, respectively (Markman et al. 2005).

Russian TTOs and/or their parent institution tend to provide accompanying innovation services. Half of TTOs report offering both incubation and prototyping services. The presence of auxiliary innovation services is welcome (Figure 11), as most research results need further development before they reach a phase where they can be commercialized. In the United States, from inventions licensed in a five-year period, TTOs reported that 45 percent were at the proof of concept stage, 37 percent were laboratory prototypes, 15 percent were manufacturing-ready technologies, and 12 percent were market-ready inventions (Thursby et al. 2001).

Patent applications through TTOs are made mostly in Russia but patenting abroad is negligible. On average, each TTO surveyed applied for 34 local patents. The estimated total of 1,715 patents represents around 5 percent of total patent applications made in Russia. Patent filing in the European Patent Office and U.S. Patent and Trademark Office is almost nonexistent – on average, not even 1 patent is filed annually.

The TTOs surveyed helped initiate around a fifth of all the start-ups based on research discoveries. Out of the 973 IP-based start-ups reported by the MoES, 200 were founded using licenses of the TTOs' parent institution technology, an average of 3 start-ups per TTO.

III.2. Technology Transfer from R&D in Defense

Russian R&D discoveries in defense could be a major source of civilian innovation, but their use remains limited. The Soviet industrial base is still the core of Russia's high-tech industries: advanced materials, nuclear power, aerospace, and other sectors of the defense industry. In Soviet times, the connection between military-oriented industries and R&D institutions was intense. R&D institutes were integral parts of the organizations of line ministries, which coordinated all stages of innovation (Yegorov 2009). However, there have not been major spillovers of technology to the civilian sector, because most of the discoveries in defense R&D have remained secret and are inaccessible to the private sector, and because much of the technology developed, especially in Soviet times, falls in the category of know-how as opposed to patents, making difficult commercialization based on codified knowledge.

The government still owns a large proportion of defense firms, and sector consolidation efforts are under way (Box 2). Nowadays 40 percent of firms in the defense sector are fully government owned, 40 percent are mainly private (with the government having 25 percent or less ownership), and the rest have significant government participation. Russian defense firms are relatively small and there are government efforts to consolidate the industry by creating large holding companies (Crane and Usanov 2010).

Box 2: Commercializing the discoveries of Russian weapons scientists

In 2007, LARTA, a U.S. non-profit, private corporation devoted to accelerate the market readiness of early-stage enterprises, worked with several Russian companies on a very small-scale program funded by the U.S. Department of Energy – GIPP (Global Initiative for Proliferation Prevention). The objective was to get the start-ups ready to present at a LARTA-produced conference to penetrate the U.S. market. They were essentially provided with "pitch session" training. The short-term program focused on supporting former Soviet Union weapons engineers and scientists who were leveraging their skills for the development and marketing of commercial products or services.

The program aimed to increase the capacity of the supported institutions and businesses through:

- Initial assessments of the Russian companies to identify capacity-building needs.
- Remote group training and short-term individualized mentoring sessions, where U.S.-based experts and principal advisors worked with Russian companies on preparing their business presentation.
- Two web seminars provided to participants to familiarize them with issues of importance to commercialization, including one focused on building a market-ready presentation tailored to specific audiences relevant to the companies.
- Support in networking with U.S. partners.
- Participation in LARTA's venture forum in the United States, where companies presented to investors, industry leaders, and potential customers.

The program included six companies from among 34 applicant companies in a broad range of sectors. The technology commercialization stemming from discoveries of scientists formerly engaged in the defense sector were:

- *Kinetic Technologies*. It entered a joint R&D project with a large U.S. aerospace products manufacturing company. Kinetic was founded in 1998 by scientists and engineers from Moscow State University and the Russian research center, Kurchatov Institute. The leading specialists from the top Russian federal research laboratories collaborate with KINTECH in a wide range of high-tech applications – plasma science, nuclear science, hydrogen energy, aerospace, and chemical industries.
- *Attometrix.* It received a follow-up discussion from a U.S. venture fund. The firm was founded in 2004 and specializes in building bio-analytical devices and nano-biotechnology.
- *BIOCHIP-IMB.* It reported an engagement in a business partnership with a company that it met through LARTA, thus saving it over half a year of business development. It builds biochips for medical diagnostics and other applications.
- *International Center for Electron Beam Technologies (ICEBT).* It signed a business deal with a large U.S. coatings company. ICEBT offers medical substances, electron beam technology, heterogeneous solid-phase or liquid-phase colloid systems, and nano-particles of metals and/or oxides for the medical, pharmaceutical, and food additives/nutrients industry.

Foreign companies have been interested in commercializing Russia's research discoveries through joint ventures and IP acquisition Foreign investment in Russia's R&D has been highly correlated with the defense-conversion strategy pursued by Western countries both through multinational enterprises as well as government agencies in the 1990s, an approach that continues today. The strategy focuses on acquiring Russian R&D outputs or engaging in joint R&D in sectors where Russia had technological leadership. Several authors show that the types of relations established at that time are still used (Crane and Usmanov 2010; Bernstein 1999).

The main Russian counterparts for foreign R&D investment have been research institutes affiliated with the RAS and their scientists and, less importantly, design bureaus and universities. These institutions – where much of the most advanced technology resides – do not produce any final product or service, as they were established to do research for state owned enterprises that designed and produced military equipment (Yegorov, 2009; Bernstein 1999). In turn, R&D intensive FDI has targeted the manufacturing of R&D based products through both large-production joint ventures and small spinoff joint ventures. On the other hand, the main channels through which foreign companies have invested in R&D in Russia are research subcontracting, wholly owned R&D laboratories, and funding research done by academic laboratories or academic institutions.

IV. Conclusions

This paper has shown that even though the Russian innovation system is experiencing a declining performance, it is still strong in some technological fields. These fields could be the base for a successful strategy to scale up the number of spin offs based on publicly funded research.

Government priority sectors can be better aligned to the technological potential of the Russian economy. For instance, agricultural research should have a renewed emphasis, which could leverage Russia's technological advantage in Food chemistry. Policy-makers should not see innovation as only connected to high-tech sectors, which are the strategic sectors currently chosen by the government. Not only Food chemistry, but Materials and Metallurgy as well as other sectors with identified technological advantage could be prioritized to expand commercialization efforts.

There is room for improvement in the governance of the research institutions. On one hand, it is imperative to continue the strengthening of results-based management of public research organizations, especially in RAS institutes and universities. The allocation of public funding should be based on scientific output, and include metrics that acknowledge commercialization efforts. This is a way to incentivize research institutions to increase scientific efficiency and to undertake research with market potential. On the other hand, not only higher education institutions but the RAS institutes which receive the bulk of public R&D funds should undertake commercialization efforts. Institutes affiliated with the RAS encompass more than 60 percent of both R&D expenditures and researchers, but their contribution to research commercialization through start-ups is minimal.

The incentives for the human capital devoted to R&D could be reformulated; the career development for researchers in either the higher education institutions or RAS affiliated research institutes, should be based on performance not only on seniority, and support for young scientists should be a priority. In terms of developing incentives so scientists and engineers work towards the commercialization of research, their career development should include entrepreneurial achievements related to commercialization as part of the criteria for career advancement, with sabbatical years for initiating research based new ventures discoveries an option. The scientists' brain drain can be addressed through "brain circulation," securing international research collaboration with Russian researchers based abroad.

Important steps to foster technology commercialization have been taken by reforming the IP legislation through the Civil Code Section IV and Federal Law 217. However, technology transfer can be further encouraged by assigning full ownership (not only use) to public research organizations including transferability rights (with minimum royalty payment to research team). This can be accomplished for all research institutions by amending the mentioned legislation pieces as they apply both to RAS affiliated research institutes and higher education institutions.

While TTOs are an important channel for research commercialization in Russia, their performance could be improved by making mandatory the disclosure of inventions to the TTO. As of now only half of the TTOs declare that such disclosure is mandatory for their scientists. At the same time, incentives to scientists can be strengthened by shifting the royalty distribution formula in favor of faculty members and researcher (e.g. by allowing faculty members to retain larger shares of the revenue, instead of the current average of 29 percent).

In terms of early stage financing, the main policy recommendation is to enhance the supply of funding and services (including mentoring) to innovative start-ups. This can help prepare a pipeline of potential investments for venture capital funding that is already available. Financing – including matching grants – has to focus on early-stage technology development to address the financing gap between the funding from the FASIE program and venture capital funding by the RVC and private organizations.

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Annex I: Persons Interviewed

Name	Title	Company
Oleg V. Dobrynin	Director	Federal Service for Intellectual Property
Natalia I. Larionova	Deputy Head of the Department	Ministry of Economic Development of the Russian Federation
Natalia I. Zolotkh	Director General	Transtechnology
Yury Simachev	Deputy of General Director	Interdepartmental Analytical Center
Thomas D. Nastas		Innovative Ventures Incorporated
Aleksander E. Karpov	Senior Deputy Head of the Department	Moscow City Government Dep. Of Support and Dvlp. Of small and medium-sized business
Alexander V. Naumov	Director	Ministry of Education and Science of the Russian Federation
Peter Lindholm	PFSD – Consultant	The World Bank
Ivan V. Oskolkov	Head of Depart. of Corporate Governance	Ministry of Economic Development of The Russian Federation
Brian A. Cummings	Executive Director Assistant VP	Technology Commercialization Office –University of Utah
Leonid Grigoriev	President	IEF – Institute for Energy and Finance
Sergey N. Leshchenko	Head of Division of Legal and analytical support of institutes of development	Ministry of Economic Development of the Russian Federation
Roman Jarkoi	Entrepreneur	ISS – Intelligent Security System
Maxim V. Shekhovtsov	Asset Management	Allianz – Venture Capital Fund
Igor Shabanov	Head of Export Finance	VNESHECONOMBANK
Petr Fradkov	Deputy Chairman	VNESHECONOMBANK
Tatyana Ponomareva		The World Bank
Igor V. Korelskiy	Head, International Cooperation Division	Ministry for Economic Development of the Russian Federation
Oleg V. Movsessian	CEO	Moscow State University Science Park
Dmitri Simonenko	President	Innalabs
Vladmir Rudashevsky	Adviser of Chairman of the board	SISTEMA
Khabib Abdullaev	Head department of SEZ Investors relations	Ministry for Economic Development of the Russian Federation
Alexander Temkin	Deputy CEO	Ministry for Economic Development of the Russian Federation
Suren O. Vardanian	Director General	Moscow Investment and export Promotion Agency
A. Lipov	Director	Ministry of Communications and Information

Annex II: Revealed Technological Advantage in Russia

Table A3.1: Russian patent specialization and patent applications by field of technology, 2002–07

Field of Technology	Russian Federation	World	RTA	RPA
I – Electrical engineering	**14064**	**2,582,349**	**0.32**	-0.5
Electrical machinery, apparatus, energy	4723	474,119	0.60	-0.2
Audio-visual technology	1296	441,817	0.19	-0.7
Telecommunications	2214	334,899	0.30	-0.5
Digital communication	1228	245,161	0.34	-0.5
Basic communication processes	1022	85,487	0.68	-0.2
Computer technology	2474	546,606	0.27	-0.6
IT methods for management	336	112,943	0.20	-0.7
Semiconductors	771	341,317	0.13	-0.9
II – Instruments	**26524**	**1,212,212**	**1.09**	0.0
Optics	1084	367,138	0.17	-0.8
Measurement	9107	307,721	1.65	0.2
Analysis of biological materials	2361	58,802	1.77	0.2
Control	2112	139,646	0.80	-0.1
Medical technology	11860	338,905	1.39	0.1
III – Chemistry	**49738**	**1,768,549**	**1.48**	0.2
Organic fine chemistry	4088	257,437	0.85	-0.1
Biotechnology	3354	187,534	0.96	0.0
Pharmaceuticals	7002	328,605	1.22	0.1
Macromolecular chemistry, polymers	1606	138,371	0.58	-0.2
Food chemistry	10662	101,093	6.03	0.8
Basic materials chemistry	4176	186,013	1.17	0.1
Materials, metallurgy	8220	145,844	3.03	0.5
Surface technology, coating	2230	139,863	0.74	-0.1
Micro-structural and nanotechnology	217	9,814	0.94	0.0
Chemical engineering	5370	165,810	1.56	0.2
Environmental technology	2813	108,165	1.38	0.1
IV – Mechanical engineering	**37609**	**1,728,722**	**1.31**	0.1
Handling	2619	226,632	0.73	-0.1
Machine tools	5405	184,470	1.80	0.3
Engines, pumps, turbines	6748	208,496	2.03	0.3
Textile and paper machines	1127	197,196	0.34	-0.5
Other special machines	8659	235,865	2.08	0.3
Thermal processes and apparatus	2780	125,068	1.36	0.1
Mechanical elements	4320	222,780	1.14	0.1
Transport	5951	328,215	1.10	0.0
V – Other fields	**13155**	**666,419**	**1.29**	0.1
Furniture, games	1746	227,979	0.51	-0.3
Other consumer goods	2079	168,680	0.75	-0.1
Civil engineering	9330	269,760	2.31	0.4

Source: Author's elaboration based on WIPO Statistics Database, July 2009 (http://www.wipo.int/ipstats/en/statistics/patents/)..
RTA = revealed technological advantage.

Annex III: Patent filings of Russian applicants by federal district, 2009

	Total	Legal persons	Natural persons
Central Federal District			
Belgorod Region	132	94	38
Bryansk Region	64	39	25
Vladimir Region	119	76	43
Voronezh Region	423	332	91
Ivanovo Region	614	101	513
Kaluga Region	133	66	67
Kostroma Region	43	34	9
Kursk Region	301	135	166
Lipetsk Region	80	52	28
Moscow	8480	3464	5016
Moscow Region	1228	708	520
Orel Region	205	185	20
Ryazan Region	133	97	36
Smolensk Region	78	29	49
Tambov Region	96	85	11
Tver Region	108	76	32
Tula Region	207	144	63
Yaroslavl Region	158	116	42
Total for the District	12602	5833	6769
Northwest Federal District			
Arkhangelsk Region	42	30	12
Vologda Region	96	61	35
Kaliningrad Region	74	38	36
Republic of Karelia	24	6	18
Republic of Komi	33	17	16
Leningrad Region	100	33	67
Murmansk Region	27	22	5
Novgorod Region	20	15	5
Pskov Region	31	9	22
St. Petersburg	1648	1247	401
Total for the District	2095	1478	617
South Federal District			
Republic of Adigea	20	3	17
Astrakhan Region	136	115	21
Volgograd Region	406	212	194
Republic of Dagestan	621	595	26
Republic of Ingushetia	1	0	1

Republic of Kabardino-Balkaria	71	56	15
Republic of Kalmykia	2	0	2
Republic of Karachaevo-Cherkess	17	6	11
Krasnodar Territory	443	279	164
Rostov Region	758	450	308
Republic of North Ossetia – Alania	101	62	39
Stavropol Territory	307	135	172
Chechen Republic	16	13	3
Total for the District	2899	1926	973
Volga Federal District			
Republic of Bashkortostan	592	426	166
Kirov Region	95	75	20
Republic of Mary-El	141	107	34
Republic of Mordovia	42	36	6
Nizhniy Novgorod Region	386	284	102
Orenburg Region	117	88	29
Penza Region	162	116	46
Perm Region	440	336	104
Samara Region	501	315	186
Saratov Region	313	223	90
Republic of Tatarstan	660	512	148
Udmurt Republic	107	55	52
Ulyanovsk Region	260	204	56
Chuvash Republic	125	68	57
Total for the District	3941	2845	1096
Ural Federal District			
Kurgan Region	64	51	13
Sverdlovsk Region	534	407	127
Tyumen Region	127	91	36
Khanty-Mansyisk Autonomous District – Yugra	39	18	21
Chelyabinsk Region	367	244	123
Yamalo-Nenets Autonomous Area	14	8	6
Total for the District	1145	819	326
Siberian Federal District			
Republic of Altai	4	1	3
Altai Territory	218	137	81
Republic of Buryatia	60	39	21
Zabaikal Territory	47	34	13
Irkutsk Region	233	189	44
Kemerovo Region	273	188	85

Krasnoyarsk Territory	439	319	120
Novosibirsk Region	523	397	126
Omsk Region	225	164	61
Tomsk Region	385	315	70
Republic of Tuva	3	3	0
Republic of Khakassia	8	1	7
Total for the District	2418	1787	631
Far East Federal District			
Amur Region	116	107	9
Jewish Autonomous Region	1	0	1
Kamchatka Region	8	1	7
Magadan Region	6	3	3
Primorskiy Territory	167	116	51
Republic of Sakha (Yakutia)	73	50	23
Sakhalin Region	9	5	4
Khabarovsk Territory	108	87	21
Total for the District	488	369	119
District not Defined	10	2	8

Source: ROSPATENT Annual Report 2009.

Annex IV: Start-ups related to the Federal Law 217, dated August 2009

Name of the institution, that had created the enterprise and that is registered in BD CISN		Number of enterprises created	Number of planned employees	Number of RDIs, that created enterprises	Number of enterprises, created by RDIs	Number of enterprises after the Federal Law 217
Central Federal District						
1	Belgrod State Technical University (V.G. Shuhov)	29	62			6
2	Belgrod State University	8	21			8
3	Vladimir State University of Humanities (city of Vladimir)	1				1
4	Vladimir State University (city of Vladimir)	6				2
5	Military Academy of military air defense of the Russian Federation, in honor of Marshall of the Soviet Union, A.M. Vasilevsky	5				0
6	Voronezh State Academy of Forestry	3	28			0
7	Voronezh State Academy of Technology	5	2			4
8	Voronezh State University of Architecture and Construction	2	14			0
9	Voronezh State University of Technology	4	48			0
10	Voronezh State University	7				7
11	Ivanovsk State University of Chemistry and Technology	1				1
12	Institute of Molecular Biology in honor of V.A. Engelgradt, IMB RAN (Moscow)	1		1	1	1
13	Institute of General Physics in honor of A.M. Prohorov, RAN (Moscow)	1		1	1	1
14	Institute of System Analysis RAN (Moscow)	1		1	1	1
15	Kovrov State Technology Academy (Valdimir region, city of Kovrov)	2	23			0
16	International University of Nature, Society, and People "Dubna" (Moscow region, city of Dubna)	1				0
17	Moscow State Automotive Technical University (MADI)	3				0
18	Moscow State Academy of Fine Chemical Technology in honor of M.V. Lomonosov	3				0
19	Moscow State Institute of Radiotechnology, Electronics and Automatics (technical university MIREA)	1	1			0
20	Moscow State Institute of Electronic technology (technical university)	3				3
21	Moscow State Open University	2				2
22	Moscow State Textile University in honor of A.N. Kosygin	1	24			0
23	Moscow State Technical University in honor of N.E. Bauman	4				3
24	Moscow State Technical University (MAMI)	1				0
25	Moscow State University in honor of M.V. Lomonosov (MSU)	1				0
26	Moscow State University of Arts and Culture (Himky city)	1				0
27	Moscow State University of Technology and Management	1				0
28	Moscow Institut of Physics and Technology (state university)	2				2
29	Moscow Institut of Energy (technical university) city of Moscow	1				1
30	Moscow State Construction University	3				3
31	Institute of Scientific Research of biomedical chemistry, in honor of V.N. Orehovich	1		1	1	0
32	Scientific Research of Nuclear Physics in honor of D.V. Skobeltcyna, of the Moscow State University M.V. Lomonosov	1				0
33	National Research Technological University "MISiS" city of Moscow	2				1
34	National Nuclear Research University "MIFI" city of Moscow	7				6
35	Orlov Regional Academy of State Service	1	4			0
36	Orlov State Technical University	2	52			2
37	Russian State University of Humanities (city of Moscow)	4				4
38	Russian State Technological University in honor of Tsiolkovskiy-MATI	2				0
39	Russian State University of Innovational Technologies and Entrepreneurship (city of Moscow)	2	8			2
40	Russian State University of Oil and Gas in honor of I.M. Gubkin (city of Moscow)	5				0
41	Russian State University of Tourism and Service (city of	1				1

	Moscow)					
42	Russian Part-Time Institute of Textiles and Light Industry (city of Moscow)	1	10			0
43	Russian University of Friendship of Nations (city of Moscow)	5				0
44	Russian University of Chemical Technologies in honor of D.I. Mendeleev (city of Moscow)	4				2
45	Rybin State Academy of Aviation Technology, in honor of P.A. Soloviev (Yaroslavl Region)	5	84			5
46	Ryazan State University of Radiotechnology	1	4			0
47	Tambov State University in honor of G.R. Derzhavin	2	8			1
48	Tver State University	2	12			2
49	Tula State Pedagogical University in honor of L. N. Tolstoy	3				0
50	Tula State University	5	22			2
51	The Institute of Russian Academy of Sciences "Center of Bioengineering" RAN (city of Moscow)	1		1	1	1
52	Shuya State Pedagogical University (city of Shuya)	1				1
53	Yaroslavl State Pedagogical University in honor of K.D. Ushinskiy	1	25			0
54	Yaroslavl State Technical University	4	3			4
	TOTAL	**167**	**455**	**5**	**5**	**80**
Northwest Federal District						
55	Baltic State Technical University "Voenmah" in honor of D.F. Ustinov (city of St. Petersburg)	1				0
56	Vologda Sate Technical University	2				2
57	Novgorod State University in honor of Yaroslavl the Wise	2				0
58	Petrozavodsk Pedagogical State University (Republic of Karelia, city of Petrozavodsk)	2				0
59	Pskov State Polytechnic Institute (city of Pskov)	1				1
60	Russian State Pedagogical University in honor of A.I. Gertsin (St. Petersburg)	1	3			1
61	Russian State University in honor of Immanuel Kant (city of Kaliningrad)	2				2
62	St. Petersburg Forestry Academy in honor of S.M. Kirov	2				2
63	St. Petersburg State Polytechnic University	5	9			5
64	St. Petersburg State Technological University (technical university)	1	2			0
65	St. Petersburg State Technological University of Natural Polymers	4				1
66	St. Petersburg State University of Water Communication	2				2
67	St. Petersburg State University of Information Technology, Mechanics, and Optics	11				3
68	St. Petersburg State University of low-Temperature Food Production	2				0
69	St. Petersburg Electrotechnical State University "LETI"	4	15			2
70	Uhtin State Technical University	3				3
	TOTAL	**45**	**29**			**24**
South Federal District						
71	Astrakhan State Technical University	15	46			12
72	Astrakhan State University	19				16
73	Volgograd State Medical University of the Federal Agency of Healthcare and Social Development	1				0
74	Volgograd State University	1	3			0
75	Kuban State Agrarian University (city of Krasnodar)	1				1
76	Kuban State Technological University	5				5
77	Kuban State University (city of Krasnodar)	2	6			1
78	North-Caucasus Academy of State Service (city of Rostov-na-Donu)	2				2
79	Sochino State University of Tourism and Vacationing Business (Krasnodar Krai)	5				2
80	South-Russian State University of Economics and Service (Rostov Region, city of Shahta)	1	9			0
81	Southern Federal University (Rostov Region, city of Rostov-na-Donu)	7				0
	TOTAL	**59**	**64**			**39**
North Caucasus Federal District						

82	Dagestan State University (city of Mahachkala)	2				1
83	Dagestan State Technical University (city of Mahachkala)	10	40			0
84	Karachevo-Cherkessia State University in honor of U.D. Aliyev (city of Karachaevsk)	2	24			0
85	Pyatigorsk Linguistic State University (Stavropol Krai, city of Pyatigorsk)	2				2
86	North-Caucasus Institute of Mining and Metallurgy (state technological university) (Vladikavkaz)	1	9			0
87	Stavropol State University (Stavropol Krai, city of Stavropol)	4	12			2
	TOTAL	**21**	**85**			**5**
Volga Federal District						
88	Bashkir State Pedagogical University in honor of M. Akmullah (city of Ufa)	1	1			1
89	Bashkir State University	1				1
90	Volga State Academy of Water Transport (city of Nizhniy Novgorod)	1				1
91	Izhevsk State Technical University (Udmurt Republic)	7	94			2
92	Institute of Organic and Physical Chemistry in honor of A.E. Arbuzov of the Kazan Science Institute RAN (Republic of Tatarstan, city of Kazan)	1		1	1	0
93	Kazan State Technical University in honor of A. N. Tupolev	8	90			1
94	Kazan State Technological University	20				12
95	Kamsk State Academy of Mechanical Engineering (city of Naberezhnye Chelny)	1				1
96	Mariisk State Technical University (Republic of Mariy-El, city of Yoshkar-Ola)	6	32			5
97	Mordovsk State Pedagogical Institute in honor of M.E. Evseveev (Republic of Mordovia, city of Saransk)	1	1			0
98	Mordovsk State University in honor of N.P. Ogareva (Republic of Mordovia, city of Saransk)	6				4
99	Nizhegorod State Technical University in honor of R.E. Alekseev	7	80			2
100	Nizhegorod State University in honor of N.I. Lobachevsky	4				4
101	Orenburg State Agrarian University	1				0
102	Penza State Technological Academy	1				1
103	Penza State Technical University	3				3
104	Perm State Technical University	1				1
105	Samara State Medical University of Roszdrav	4				4
106	Samara State Technical University	2	10			0
107	Samara State Air and Space University in honor of Acad. S. P. Korolev	4				2
108	Saratov State Technical University	2	8			1
109	Saratov State University in honor of CH. G. Chernyshevskiy	1				0
110	Tolyatti State University	10				9
111	Ulyanovsk State University	1				1
112	Ufim State University of Petroleum (Republic of Bashkorstan, city of Ufa)	2				2
113	Chuvash State Pedagogical University in honor of I. Ya. Yakolev (city of Cheboksary)	1	5			0
114	Chuvash State University in honor of I. N. Ulyanov (Chuvash Republic, city of Cheboksary)	4	16			4
	TOTAL	101	337	1	1	62
Ural Federal District						
115	Ishim State Pedagogical Institute in honor of P.P. Ershov (Tyumen Region, city of Ishim)	1	20			0
116	Tobol State Social-Pedagogical Academy in honor of D.I. Mendeleev	1				0
117	Tyumen State University of Oil and Gas (Tyumen Region, city of Tyumen)	1				0
118	Tyumen State University (Tyumen Region, city of Tyumen)	19	102			8
119	Ural State Mining University (Sverdlovsk Region, city of Ekaterinburg)	1	28			0
120	Ural State Forestry University (Sverdlovsk Region, city of Ekaterinburg)	3	13			3

121	Ural State University in honor of A.M Gorky (Sverdlovsk Region, city of Ekaterinburg)	3				3
122	Chelyabinsk State University	7				0
123	Southern-Ural State University	11				11
	TOTAL	**47**	**163**			**25**
Siberian Federal District						
124	Altai State Technical University in honor of I.I. Polzunov (Altai Krai, city or Barnaul)	4	15			1
125	Altai State University (Altai Krai, city or Barnaul)	2	4			0
126	Trans-Baikal State University of Humanities and Pedagogy in honor of N.G. Chernyshevskiy (Transbaikal Krai, Chitin Region, city of Chitin)	1	2			0
127	Institute of Geology and Minerals in honor of V.S. Sobolev, of the Siberian Division RAN, IGM SO RAN (city of Novosibirsk)	1		1	1	0
128	Institute of Earth's Crust of Siberian Division RAN (city of Irkutsk-33)	1		1	1	0
129	Institute of Oil, Gas and Geophysics in honor of A.A. Trofimuka of Siberian Division RAN, (Novosibirsk Region city of Novosibirsk)	3		1	3	1
130	Irkutsk State Technical University (city of Irkutsk)	3				3
131	Kemerovo State Medical Academy of Roszdrav (city of Kemerovo)	1				0
132	Kemerovo State University (city of Kemerovo)	7	11			3
133	Kemerovo Technological Institute of Food Processing (city of Kemerovo)	3				3
134	Kuzbask State Technical University (city of Kemerovo)	6	59			6
135	Scientific Research Institute of Clinical Immunology of the Siberian Division RAMN (city of Novosibirsk)	1		1	1	1
136	National Research of Tomsk Polytechnical University	18	43			17
137	Novosibirsk State Pedagogical University (Novosibirsk Region)	1				1
138	Novosibirsk State Technical University (Novosibirsk Region)	6				6
139	Novosibirsk State University (Novosibirsk Region)	1				0
140	Omsk State Technical University	9				5
141	Omsk State University in honor of F.M. Dostoyevsky	8				7
142	Omsk State University of Communication Ways	3				0
143	Sibirsk State Automotive Academy (CibADI) (city of Omsk)	2	7			2
144	Sibirsk State Air and Space University in honor of Acad, M.F. Reshetnikov (city of Krasnoyarsk)	13	5			12
145	Sibirsk State Industrial University (city of Novokuznetsk, Kemerovo Region)	3	14			0
146	Sibirsk Federal University (city of Krasnoyarsk)	31	51			0
147	Tomsk State University of Architecture and Construction	3	4			2
148	Tomsk State Pedagogical University	1				1
149	Tomsk State University	8	20			8
150	Tomsk State University of Systems of Management and Radioelectronics	19				19
151	Tyvinsk State University (Republic of Tyva, city of Kyzyl)	1	10			1
152	Chitinsk State University (Trans-Baikal Krai, Chitinsk Region, city of Chitin)	3	9			3
	TOTAL	**163**	**254**	**4**	**6**	**102**
Far East Federal District						
153	Far-East State Technical University (DVPI in honor of V.V. Kuybyshev) (Primorskiy Krai, city of Artem)	8				7
154	Komsomolsk-na-Amure State Technical University	3	10			0
155	Pacific Ocean State University of Economics (Primorskiy Krai, city of Vladivostok)	2				1
	TOTAL	**13**	**10**			**8**
	Overall Total	**616**	**1,397**	**10**	**12**	**345**

Source: Kolesnikov, 2011