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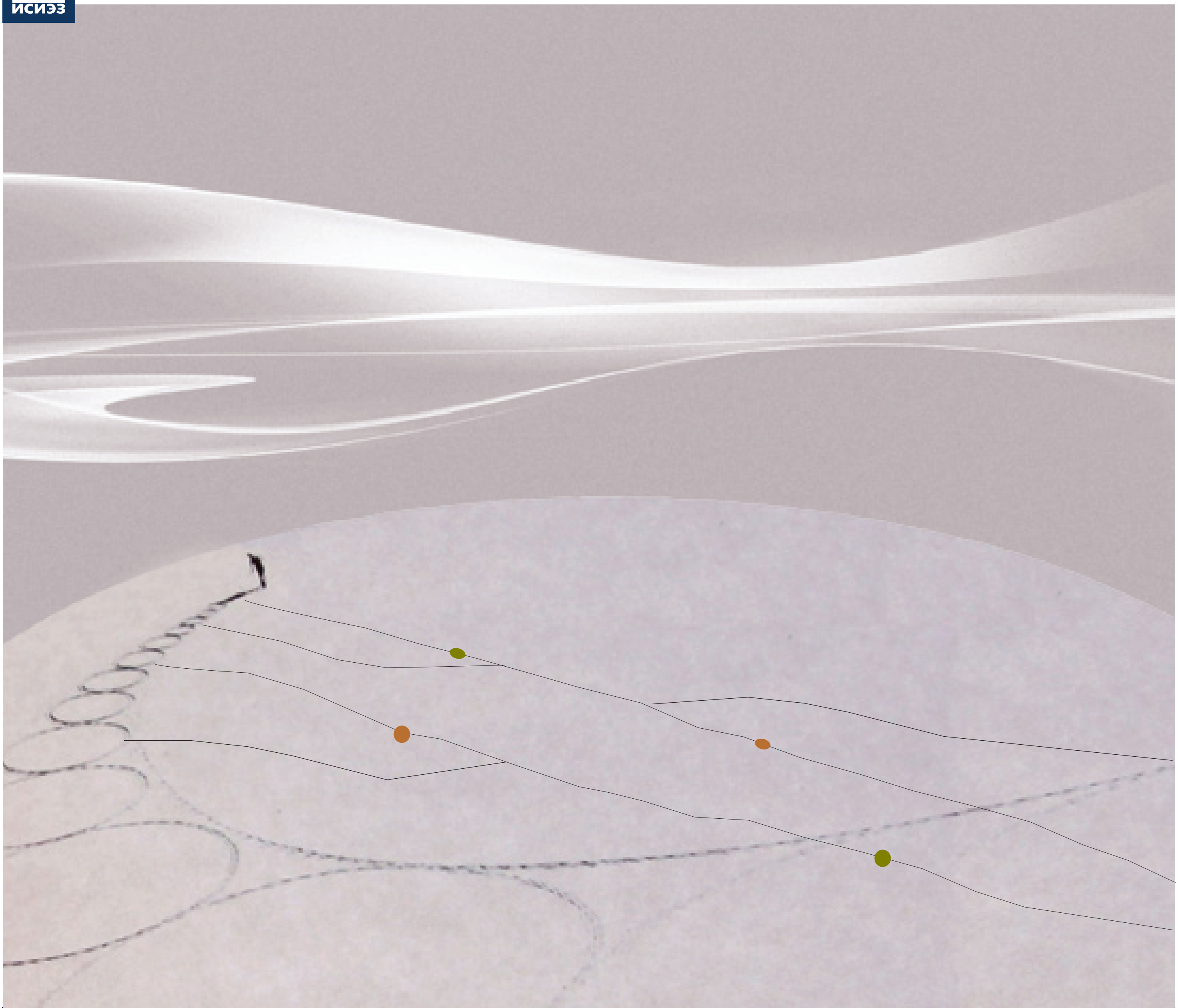
HIGHER SCHOOL OF ECONOMICS



IN THIS ISSUE

Foresight-Russia

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Higher School of Economics

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About the journal

Foresight-Russia — a research journal established by the National Research University — Higher School of Economics (HSE) and administered by the HSE Institute for Statistical Studies and Economics of Knowledge (ISSEK), located in Moscow, Russia. The mission of the journal is to support the creation of Foresight culture in Russia through dissemination of the best Russian and international practices of future-oriented innovation development. It also provides a framework for discussing S&T trends and policies.

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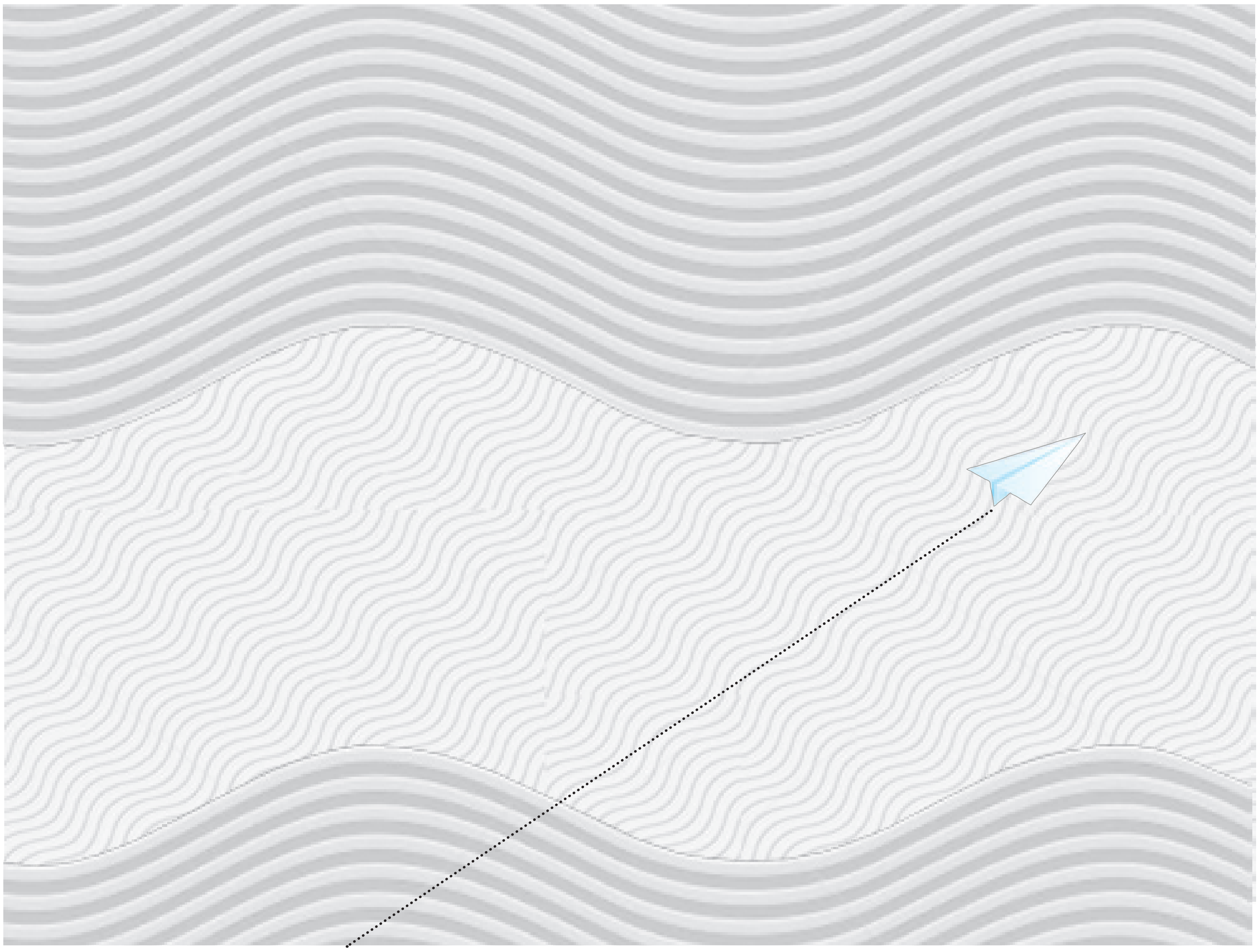
Vol. 8 No 3 2014

Participation of the 'New' EU Member States in the European Research Programmes — A Long Way to Go

Klaus Schuch



On start of integration into the European Research Area Central European countries faced numerous challenges related to the legacy of previous governance systems and a lack of focus on developing S&T. It was supposed that the association of these countries with the European Framework Programmes for RTD (FPs) could contribute to internal reforms provided that local scientific communities are proactive. However 15 years after the first full association the level of participation of the EU13 in FPs is still low.

The paper considers the reasons for the current state of affairs and proposes steps towards a way out.

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Keywords

framework programme; HORIZON 2020; European Union; 'new' Member States; EU-13; EU-15; co-operation; project management

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Statistics show that stakeholders from the 'new' EU member states (EU13)[1] have benefitted less in absolute terms from their participation in Europe's 7th Framework Programme for Research and Technological Development (henceforth FP7) than those from EU15[2] countries. This is not a new observation. Since the association of the former Central European Candidate Countries (all now regular EU member states) with the 5th European Framework Programme for Research and Technological Development (RTD), many have argued that within the competitive European Framework Programme for RTD, Central European cohesion countries are at risk of 'subsidising' the more competitive, mostly Western European, countries, for various reasons to do with competitiveness [CORDIS, 2002; *Havas*, 1999, 2002; *Le Masne*, 2001; *Mickiewicz, Radosevic*, 2001; *Nedeva*, 1999, *Reid et al.*, 2001].

This paper discusses the participation of the EU13 countries in European research, mainly in the European Framework Programmes for RTD. It briefly reflects on the structural challenges of the then Central European candidate countries during the transformation period in the 1990s to recall their starting points at the time when they first became associated with the European Framework Programme for RTD. Almost 15 years after the first full association with the European Framework Programme for RTD, the actual participation situation of the 'new' EU member states is analysed. Next, the European Union's measures to enhance widening participation of organizations in the ongoing European Framework Programme for RTD with the name 'HORIZON 2020' are concisely described. Finally, conclusions are drawn as to why — despite several efforts — participation of the EU13 is still low. It is argued that structural deficiencies of national innovation and research systems have to be further eliminated, that a sustainable enhancement of participation has to be based on increasing excellence adopted for the national and local context, and that smaller corrective measures like upgraded NCP systems may be necessary but not sufficient.

Structural challenges and the association of Central European Countries to the European Framework Programme for RTD

The structural challenges which the Central European Countries (CECs) faced during the 1990s were mainly caused by:

a) *the inherited institutional set-up of the communist hegemonic research system*, characterised by some basic features such as: the **Academies of Sciences** which had almost the status of ministries for science and technology and often had underdeveloped internal competitive research funding mechanisms; a **bureaucracy, centralization and compartmentalization** never shared to any comparable degree by market economies [*Biegelbauer*, 2000]; **politically dominated universities** with weak research links; domination of **military-industrial complexes** which limited a functioning technology transfer to the civil sector due to its secretive character [*Josephson*, 1994; *Gaponenko et al.*, 1995]; and **industrially oriented branch research institutes** geared towards the collapsing centralized economies of individual ministries [OECD, 1994];

b) the severe *transformation process* towards a capitalist market economy in which science and technology — despite some lip service — were not treated as a preferential policy areas in any of the relevant countries during the 1990s [*Bucar, Stare,* 2002; *Havas,* 1999, 2002; *Mickiewicz, Radosevic,* 2001].

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[1] EU13 abbreviation = Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, and Slovenia.

[2] EU15 abbreviation = Austria, Belgium, Denmark, Germany, Greece, Finland, France, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the UK.

> The downturn in economic activity during the first phase of the transformation process was accompanied by an accelerated winding down of research capacities [Coopers and Lybrand et al., 1999]. Partly because industry had to face the most disruptive adjustment processes, which resulted in a collapse of industrial demand for R&D, the sharp decline in applied research capabilities was greater than for basic research. Industrial R&D entities laid off between two thirds and three quarters of their R&D personnel [*Biegelbauer*, 2000]. As a consequence, the share of business expenditure on R&D (BERD) to the general expenditure on R&D (GERD) almost collapsed in most Central European transition countries. It also has to be noted that even studies on foreign direct investment (FDI)-induced knowledge spillovers in the Central European Countries produced mix results, which are often described as *'Janus shaped'* structures [*Biegelbauer et al.*, 2001]. Although foreign-owned firms did spend more on R&D in general than indigenous ones [*Inzelt*, 1999], they did not develop broad R&D capacities during the 1990s [*Biegelbauer,* 2000; *Dyker*, 1999] and the few R&D activities carried out by multinational companies in their Central European host countries were usually not closely connected to the local knowledge base [*Biegelbauer et al.*, 2001].

In addition to these problems caused by a collapsing industrial R&D during the transformation phase, the science system itself was strongly affected during the transformation process. The effects on the science system are exemplified by the following two elements: de-capitalisation of the physical research infrastructure and the ageing of the human research base. Many Central European countries (CECs) faced a de-capitalisation of the physical research infrastructure [*Schuch*, 2005]. The prevailing inferiority of the physical research infrastructure compared to Western standards was considered to be one of the most pressing structural problems in the CECs science systems. The physical research infrastructure situation improved, however, considerably with the accession of the CECs to the European Union and the transfer of structural funds. Another important issue was the human resource base, which was characterised by low salary levels for researchers, leading to both internal and external brain drain [Bulgarian Ministry of Education and Science, 2002; *Gächter*, 2001; *van der Lande*, 1998]. These developments have negatively affected the research sector's attractiveness for newcomers and contributed to the ageing of the research sector in the countries concerned.

Finally, the policy making and delivery systems were not always properly organized and, thus, negatively affected the execution of S&T policies, which was usually distributed over several ministries and had insufficient links with industrial policies and realities [*Reid et al.*, 2001]. Moreover, newly elected governments, tending to restructure the elements of their S&T systems with the stroke of a pen, provoked situations in which personal communication became difficult and even institutional memory was negatively affected [ICCR, 1997]. The incipient decentralized 'agency-fication' process in an already weak administrative environment amplified the lack of policy skills and possibilities for networking, clustering, coordination and long-term planning rather than addressing such problems [*Suurna, Kattel*, 2010].

Against this background, a need for restructuring the inherited research structure became evident. Based on the general alignment of the former Central European candidate countries' R&D priorities alongside those of the EU and with financial and technical support by the EU [*Suurna, Kattel*, 2010; *Schuch*, 2005; UNESCO, 1999, 2000], a period of institution and capacity building and structural reform began, which resulted in:

- the reform of public R&D systems including the university sector;
- the creation of research programmes of national significance;

- the availability of mostly bottom-up operated funds for applied research to stimulate R&D and innovation relevant to industry;
- the implementation and upgrading of technology transfer systems and institutions;
- the establishment of institutional infrastructure and bridging institutions to support innovation in SMEs (e.g. technology parks, business innovation centres, incubators, innovation agencies, etc.); and
- the establishment of new institutions with strategic R&D relevance such as the Zoltan Bay Institutes in Hungary or the Foundation for Polish Sciences.[3]

Most of these activities simply represented the start of what was required [*Nauwelaers, Reid,* 2002]. Some analysts even argue that some countries delivered only limited progress to restructure their NIS and elements thereafter [*Svarc,* 2006]; other scholars argue that some countries were not sufficiently responding to local needs by adequate policy experimentation but instead focused on the application of tools developed for other contexts [*Radosevic,* 2011]. In any case, the implementation of structural reform activities did not happen in isolation, but was mostly embedded in a comprehensive European integration and enlargement process involving the step-by-step adoption of the *acquis communautaire* by the former candidate countries. In addition, the EU's role in the formation of innovation policies in the CECs became significant [*Suurna, Kattel,* 2010]. After the intermediate stages had successfully been reached (such as the COST and EUREKA membership and limited participation in the European Union's 4th Framework Programme for RTD), full association with the 5th Framework Programme for RTD became the next milestone for participating in European research and the European research area [*Schuch*, 2005].

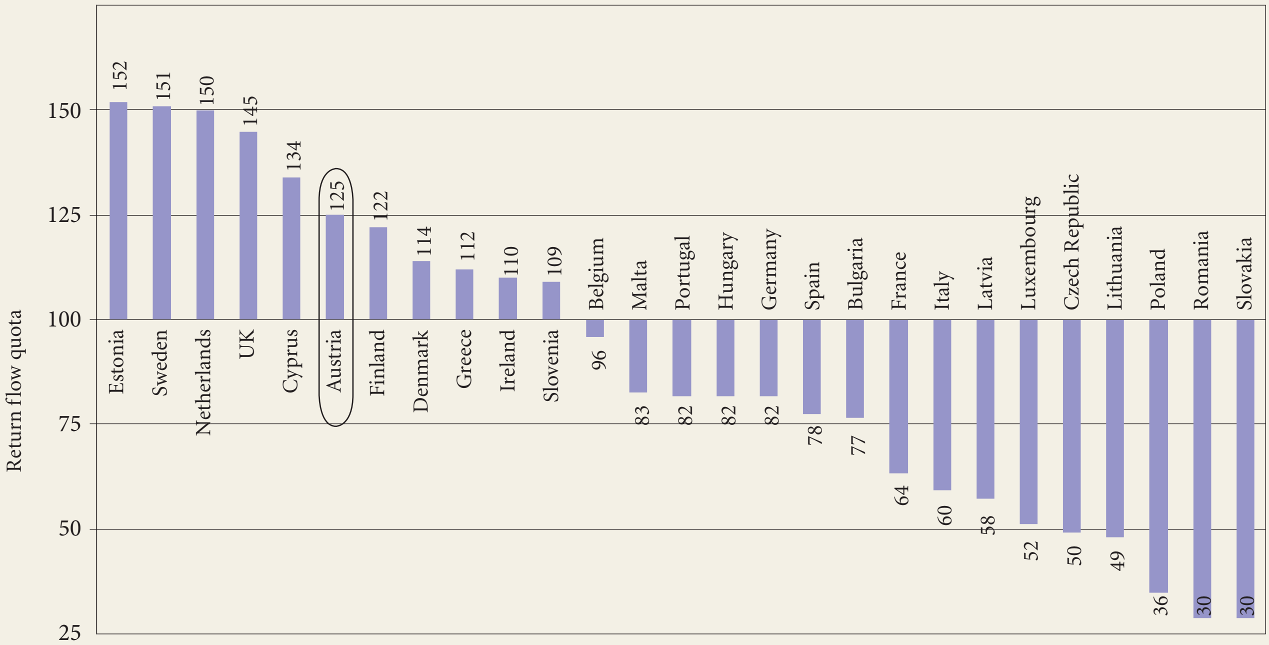
Despite the attempts at modernizing the innovation systems in these countries and introducing structural changes during the 1990s, the evaluation of the project proposals submitted under the first calls for proposals launched under FP5 in 1999 had a sobering effect on the optimists who believed that research in the Central European Countries could compete at a Western European level. The reasons why these countries came off badly in terms of successful participation in the European Framework Programmes were manifold, but were mainly rooted in structural weaknesses [*Andreff et al.,* 2000]. Analyses have shown that both the size and the quality of the economy as well as the research system influence the mobilisation of research communities to engage in FP proposals, and that 'quality' factors rather than 'size' factors have a distinctive influence on competitiveness measured in terms of success rates [*Schuch,* 2005]. GNP per capita as a proxy for a country's economic development level showed the highest influence, but other factors also proved to be highly relevant. GERD as a percentage of GDP, the proportion of researchers in the total labour force, as well as the absolute gross expenditure on R&D allocated to each individual researcher (which are all proxies for a country's research orientation) had a distinctive influence on the competitiveness of the Central European Countries under FP5 (measured in terms of success rates) [*Schuch*, 2005]. In general, economically more advanced countries tended to outperform their economically weaker neighbours in terms of European RTD competitiveness.

Participation of the 'new' EU member states in FP7

Almost 15 years later, the situation has only gradually improved. Given the importance which innovation policy has gained in the 'new' EU member states in

[3] Text taken mainly from [*Schuch,* 2005] referring to [UNESCO, 2000; Coopers and Lybrand et al., 1999; *van der Lande,* 1998].

Figure 1. **Ranking of EU Member States according to their theoretical FP7 *juste-retour* rate (%)**



Explanation: the y-axis shows the theoretical FP7 *juste-retour* ('net recipients' are above 100% and 'net contributors' below 100%). Data provided as of November 2013.

Source: [PROVISO, 2014, p. 58].

the 2000s as compared to the 1990s — as evidenced by for example, the availability of much structural funding, the adoption of innovation tools from more developed countries (facilitated by an organized community of practices, the ERAWATCH repository or STI policy mix peer reviews), and the organizational system changes implemented (such as the 'agencyfication', the adoption of the Bologna process etc.) — this might come as another sobering hiccup.

By measuring the '*juste retour*' share of a country in FP7 through its relative contribution to the EU budget – assuming that this EU budget share is also the theoretical FP7 budget share of the country – only Estonia, Cyprus and Slovenia are FP7 'net recipients' (together with the high-R&D performing countries Sweden, the Netherlands, the UK, Austria, Finland, as well as the two FP7-savvy cohesion countries, Greece and Ireland) [PROVISO, 2014]. The most affected 'net contributors' (in relative terms) are Slovakia, Romania, Poland, Lithuania and the Czech Republic (see Figure 1).

In terms of total absolute figures of successful beneficiaries, statistics also show that all EU13, with the exception of Poland, which mobilised more successful beneficiaries than Ireland and Portugal, performed poorly in comparison with EU15 countries. However, even a small country such as Austria had almost 50% more beneficiaries in FP7 than Poland, one of the largest countries in the EU. In total, ten times more EU15 organizations have been awarded FP7 funding compared to EU13 organizations. In terms of the numbers of participants, the EU13 countries Poland, Hungary and the Czech Republic together have 51% of the EU13 total.

By comparing the 'market share' of the EU13 — measured in terms of FP7 participation — with the four 'old EU' cohesion countries (i.e. Greece, Ireland, Portugal, Spain) included in the EU15, the three countries (i.e. Austria, Finland and Sweden) that joined last to form the EU15[4] and the 8 remaining EU15 countries

[4] As a reminder, the key dates of EU enlargement as of the 1980s were: 1981 — Greece; 1986 — Spain and Portugal; 1995 — Austria, Finland and Sweden; 2004 — Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, and Slovenia; 2007 — Bulgaria and Romania; 2013 — Croatia.

(i.e. Belgium, Denmark, France, Germany, Italy, Luxembourg, the Netherlands and the UK) across time from FP5 to FP7, one can see that the share of the EU13 has increased most but starting from a rather low level and still only amounting to roughly 10% (see Table 1).

All EU13 countries, except Slovakia, have increased their 'market share' in the European Framework Programmes from FP5 to FP7 (e.g. Poland, the country with the largest 'market share' of the EU13, has increased its market share - measured in terms of relative participation — from 1.84% in FP5 to 2.16% in FP7)[5]. The share of the EU13 within the different FP7 programmes varies considerably between 5% for the Health priority and 16% for Social Sciences and Humanities. In relative terms, the EU13 are lagging behind the EU28 average, in particular in 'Health' and 'ICT', the two most frequented and largest 'thematic programmes' in FP7.

As far as coordinators are concerned, the EU13 combined have a 'market share' (number of coordinators from EU13 as a percentage of all FP7 coordinators) of only 4.74% in FP7 (compared to 4.07% in FP5) and are therefore bottom of the league in Europe. PROVISO data show that the smallest share of coordinators in all FP7 participation by country is to be found in the Czech Republic (3.0% share of Czech coordinators out of all Czech participation in FP7), followed by Romania (3.9%), Slovenia (4.0%) and Bulgaria (4.1%) [PROVISO, 2014, p. 19]. This indicates insufficient technical and managerial coordination capacities.

According to statistics published by DG Research and Innovation on August 2013 [European Commission, 2013], no single EU12 country[6] was above the EU15 average of 21.91% in terms of success rate (compared to an average success rate of 18.48% of the EU12). Latvia, Estonia, Hungary, Lithuania and the Czech Republic were closest to the EU27 average, ahead of Spain, Luxembourg, Portugal, Italy, and Greece. Malta, Poland and Slovakia were still ahead of Italy and Greece, while Bulgaria, Slovenia, Cyprus and Romania clearly lagged behind.

By correlating the number of participations in FP7 per 1,000 researchers[7] by country, which measures the **efficiency of the national research communities in acquiring FP7 projects**, a slightly different picture emerges. We see a trend towards a negative correlation for the larger EU countries (size effect).[8] In this respect [PROVISO, 2014][9], Greece – a cohesion country – is tradition-

Table 1. **FP 'market share' development of selected country groupings from FP5 to FP7**

Country Grouping	Percentage of FP 'market share'			FP7/FP5
	FP5	FP6	FP7	
EU13	7.61	14.41	10.25	1.35
4EU15	15.59	15.20	16.70	1.07
3EU15	9.48	10.13	9.67	1.02
8EU15	67.31	60.51	63.36	0.94

Explanation: Market share is defined as the share of participation from EU MS x out of the total number of participation from all EU MS.

Source: [MIRRIS, 2014, p. 18].

5 For comparison and positioning purposes: Austria increased its respective share from 2.88% in FP5 to 3.30% in FP7.

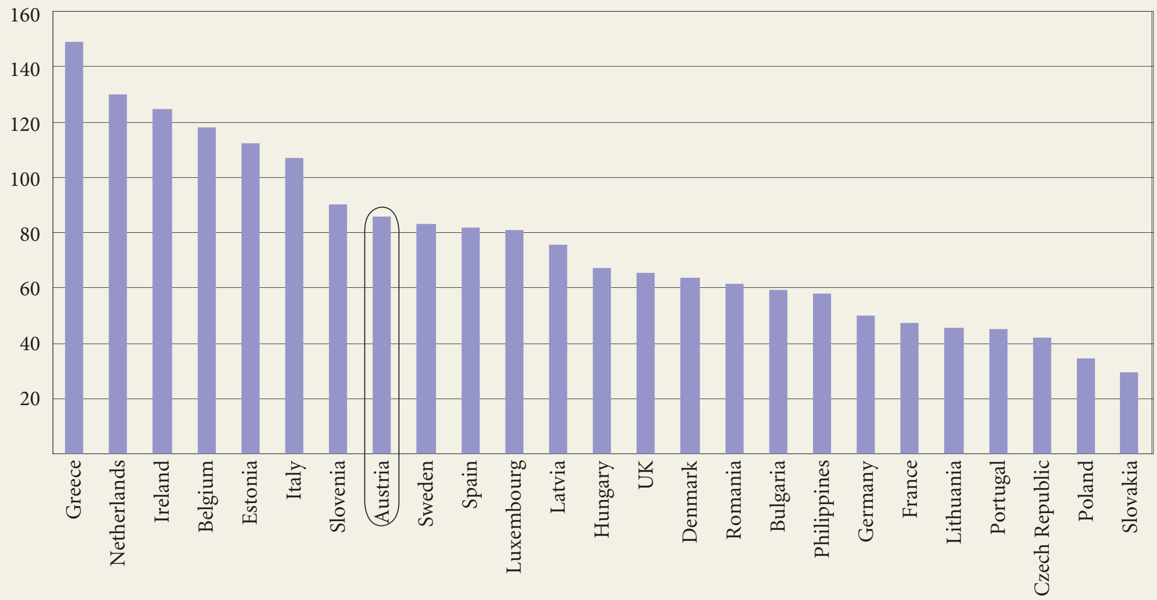
6 EU12 = the 10 Central European Member States, plus Cyprus and Malta but without Croatia

7 According to the Frascati Manual [OECD, 2002].

8 This negatively correlated size effect might be due to larger domestic research markets and a more differentiated national research system. It is comparable to business-based export quotas, where smaller countries also usually show higher export quotas than large countries which have more absorptive domestic markets in scope and scale.

9 June 2014.

Figure 2. **Number of approved FP7 participations per 1,000 researchers by country**



Source: [PROVISO, 2014, p. 16].

ally in the lead with 149.1 participations per 1,000 researchers, followed by the Netherlands and Ireland (see Figure 2). Estonia is ranked 5th and Slovenia 7th, just before Austria. Among the five 'least efficient' research communities, however, are four EU12 countries, namely Lithuania (ranked 21st), Czech Republic (ranked 23rd), Poland (24th) and Slovakia (25th). With the exception of Poland, these are countries with limited domestic (research) market sizes. This points again towards structural problems, because the 'size effect' cannot be used as a justification for these smaller countries.

The EU contribution received on an aggregated level also shows that the EU12 countries have been awarded significantly fewer funds than the EU15. Only Luxembourg — the smallest of the EU15 — did worse in absolute budgetary terms than any EU12 country, with the exception of Malta. At the applicant level, EU12 applicants receive EUR 167k per beneficiary on average, while the average for EU15 beneficiaries was EUR 340k.

EU measures to Enhance 'Widening'

Despite serious efforts deployed at the national and at European level during the last few years (especially through the use of European Regional Development Fund (ERDF) funding in the EU12 since 2004), there are still striking internal EU disparities in terms of research and innovation performance, as also identified in the Innovation Union Scoreboard. These trends are further exacerbated by the continuing severe financial crisis, and the subsequent adverse effects on public research and innovation budgets.[10]

To address these disparities, the EC has introduced a number of targeted, comparatively small, activities within the competitive framework of the European Framework Programme, such as the 'REGPOT' approach in FP7, aiming at 'unlocking and developing existing or emerging excellence in the EU's convergence and outermost regions.' HORIZON 2020 introduces further specific measures for spreading excellence and widening participation. These measures are tar-

[10] Taken from http://ec.europa.eu/programmes/horizon2020/en/h2020-section/spreading-excellence-and-widening-participation, accessed 16.06.2014.

geted at Member States[11] and countries that are associated with HORIZON 2020 and low-performing in terms of research and innovation; the measures will be implemented by the states most in need of a new cohesion policy for the 2014–2020 programming period.[12]

- The **Teaming** action (associating advanced research institutions with other institutions, agencies or regions for the creation or upgrading of existing centres of excellence) is a new feature under HORIZON 2020. It provides new growth opportunities for the involved parties, by tapping into new collaboration and development patterns, including the establishment of new scientific networks, links with local clusters and opening up access to new markets. Teaming actions offer new possibilities for exploitation and value creation for national and local research, aiming to boost the innovation potential of the countries involved.
- **Twinning** aims to strengthen a defined field of research in a knowledge institution by linking it to at least two internationally leading counterparts in Europe.
- The **ERA Chairs** scheme is designed to provide support for universities and other research institutions by attracting and maintaining high quality human resources and implementing structural changes necessary to achieve excellence on a sustainable basis.
- The **Policy Support Facility** aims to improve the design, implementation and evaluation of national/regional research and innovation policies. It offers expert advice to public authorities at the national or regional level on a voluntary basis, covering the need to access a relevant body of knowledge, benefit from the insights of international experts, use state of the art methodologies and tools, and receive tailor-made advice.

In addition, established measures from previous Framework Programmes which were not specifically designed to promote the widening agenda but which can be used for that purpose, are continued. Examples of these are **COST**, which supports access to international thematic networks, or support provided by the European Commission (EC) to **National Contact Points (NCP)**, whose administrative and operational capacities will be further strengthened to ensure a better flow of information between researchers and HORIZON 2020. An innovative example of this is the targeted COST network **BESTPRAC**[13], which aims to advance the state of the art work via excellent administration of transnational research projects by creating a network of research administrators. Several coordination and support actions also aim to overcome research and innovation disparities in the EU. An example of a support project explicitly dedicated to the widening participation agenda is **MIRRIS**[14], which aims to mobilise institutional reforms in the research and innovation systems of the EU13 by implementing a structured policy dialogue in each EU13 country. The tangible outcome of the policy dialogue should be an action plan with a roadmap, as well as a list of prioritised interventions designed to increase the participation of researchers,

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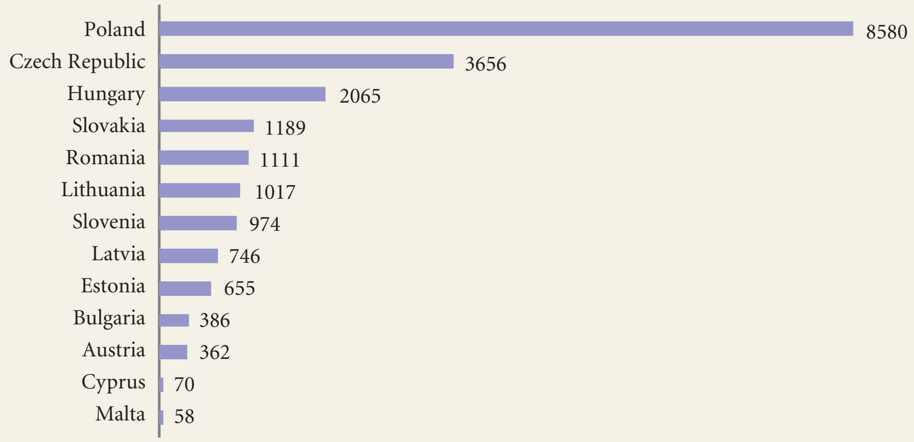
[11] As outlined in the work programme [European Commission, 2014a] applicant organizations for the 'Spreading Excellence and Widening Participation' programme of HORIZON 2020 will be organizations from Member States as well as Associated Countries ranked below 70% of the EU27 average of a composite indicator on Research Excellence, which actually defines a different set of Member States (The EU13 Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia but also Portugal and Luxembourg from the EU15) and — based on the association agreements signed so far — also Albania, Bosnia and Herzegovina, Former Yugoslav Republic of Macedonia, Moldova, Montenegro, Serbia and Turkey [European Commission, 2014b]. Research organizations from these Associated Countries (as well as Faroe Islands and Liechtenstein subject to future association agreements) are eligible to submit proposals.

[12] The following paragraphs are taken from http://cordis.europa.eu/programme/acronym/FP7-REGPOT_en.html, accessed 16.06.2014.

[13] Available at: http://www.cost.eu/about_cost/strategy/targeted_networks/bestprac, accessed 17.06.2014.

[14] Available at: http://www.mirris.eu/SitePages/default.aspx, accessed 17.06.2014.

Figure 3. **ERDF budget earmarked for R&D 2007-2013 (in million euros)**



Source: DG Research and DG Regional Policy – Cohesion Policy 2007–2013: Research and Innovation; quoted in [MIRRIS, 2014, p. 36].

research organizations and enterprises from the above-mentioned countries in HORIZON 2020 [*Schuch et al.*, 2013].

Having said that, the potentially most significant EU support measure for modernising research and innovation in the cohesion countries which can positively impact both the widening agenda and the excellence creation agenda comes from outside the Framework Programme and covers the ERDF budget earmarked for R&D. Synergies between FP and ERDF funding have been on many stakeholders' agenda for many years, but problems in strategically using or even aligning these schemes also have a long tradition. Figure 3 shows the planned[15] ERDF budget for R&D for the EU12 countries compared to Austria.

It is worth noting that countries such as Denmark, Belgium, Ireland, the Netherlands, Sweden, and also Austria have received more money from FP7 than from ERDF R&D supporting activities. Not surprisingly, all these countries belong to the best-performing countries in terms of research and innovation in Europe. On the part of the EU12, the relation between FP7 funding and ERDF funding for R&D is most imbalanced in Lithuania, Latvia, Poland, Slovakia, and the Czech Republic, the latter having the greatest divide between a high ERDF budget and a low amount of FP7 funds received. Given how high ERDF spending for R&D activities in these countries is in absolute terms, substantial increases in R&D capacities can be expected in these countries in the coming years, provided that they also manage to supply (or attract) the necessary excellent human capital.

However, some experts even argue that the comparatively 'easily' accessible, national administered, but EC co-financed, ERDF funding might — at least initially — distract the attention of universities and research institutes in the cohesion countries away from the more competitive HORIZON 2020 programme.

Conclusions and Recommendations

As evidenced by previous research [*Schuch*, 2005; *Andreef et al.*, 2000], the 'widening approach' cannot be separated from the 'excellence creation approach' because excellent organizations are needed to compete and perform successfully in HORIZON 2020. This holds true not only for the cohesion countries but also for FP frontrunners such as Austria, especially given the assumption that competition in HORIZON 2020 will become even more severe compared to the already high level of competition in FP7. This is due to austerity policies in the EU member states which also affect public R&D spending at the national level, and the increased diversion effect towards HORIZON 2020 this entails.

[15] The current final data are not yet available.

Excellence, however, is structurally and even culturally embedded in established local and national research and innovation systems [*Loudin, Schuch,* 2009; *Reith et al.,* 2006] which only change slowly and need critical mass. Moreover, 'excellence' is not an abstract, externally defined standalone category, but needs to be translated into national and local environments, absorption capacities and absorption needs. Excellence should not be confined to academic benchmarks but coupled with economic and social relevance [*Radosevic,* 2014]. One can be excellent at different levels, but the emphasis of the EU13's innovation policies in the last 15 years was highly oriented towards high-tech and over-emphasised linear linkage policies from lab to market [*Suurna, Kattel,* 2010], the results of which were meagre '*due mainly to an uncritical application of conventional policy in the context of 'catching up' and 'laggard' economies*' [*Radosevic*, 2011, p. 378].

Greenfield investments, if not properly embedded in usually complex networks, transaction and support systems, will hardly pay off in the short and medium term, if at all. Additionally, it seems essential to nurture and provide a high level of qualified human capital and provide sufficiently attractive conditions for the human capital to stay in the country; otherwise the most modern research infrastructure will generate only limited impact. According to the Times Higher Education World University Rankings 2013–2014,[16] there is not a single university from the EU13 among the top-listed 300 universities worldwide. Thus it is not surprising that to date, no EU13 university ranks among the Top 50 universities to have participated in FP7 projects, and only one EU13 research organization (Institut Jozef Stefan in Slovenia, which was involved in 114 projects) appears in the Top 50 list of research organisations that have participated in FP7 projects. In addition, only one Top 50-ranked large enterprise originates from the EU13 ('Ustav Jaderneho Vyzkumu Rez. A.S.' in the Czech Republic).

Investments in R&D and innovation, with or without ERDF, or in the future with European Structural and Investment Funds, have to be carefully conceptualized. To put more money into 'old' structures which have already underperformed in the past seems to be a waste of resources. Investments have to be accompanied by structural institutional reforms in research and innovation systems at national and local levels. When analysing the National Reform Programmes, it seems, however that EU12 countries are focussing less on the reform of their R&D activities than EU15 countries [MIRRIS, 2014].

Another approach to prepare for advanced competition at EU level, especially in HORIZON 2020, could be by participating in joint initiatives such as ERA-NETs, JPIs, JTIs and Article 185. Participation in joint initiatives can be seen as a means for international networking and co-creation and as an important step on the 'stairway to excellence'. However, participation from the EU12 in such activities remains low (see Table 3).

In the 9 JPIs for which data were available in mid-July 2013 (Table 2), only a few EU12 countries were represented in the governance of these JPIs. Two JPIs even had no participation from the EU12. In the two joint undertaking projects taken into account, only six EU12 countries are involved. The Czech Republic and Poland participate in both projects. As for the Ambient Assisted Living initiative managed under Article 185, only five EU12 countries are involved but not even each year. All EU12 are members in Eurostars, but SME participation in Eurostars is particularly low in Bulgaria and Malta compared to their SME potential [MIRRIS, 2014].

The impact of structural investments takes time, and supposed quick-fixes[17] are not sufficient. However, even within less structural but simpler short-term

[16] Available at: http://www.timeshighereducation.co.uk/world-university-rankings/2013-14/world-ranking/region/europe, accessed 19.06.2014.

[17] Such as additional remuneration (bonuses) of up to EUR 8,000 per year to be reimbursed in HORIZON 2020 projects as part of personnel costs, if this is the normal practice of an organization; this instrument is heavily in demand by the newer Member States' governments.

Table 2. **EU12 participation in FP7 joint initiatives**

Initiative	Country											
	Bulgaria	Czech Republic	Cyprus	Estonia	Hungary	Lithuania	Latvia	Malta	Poland	Romania	Slovakia	Slovenia
Alzheimer and other neurodegenerative diseases (JPND)		X			X				X		X	X
Agriculture, food security and climate change (FACCE)		X	X	X					X			X
Healthy diet for a healthy life												
Cultural heritage and global change		X	X			X			X	X	X	X
Connecting climate knowledge for Europe												
Anti-microbial resistance		X							X	X		
Healthy and productive seas and oceans							X		X	X		
More years, better lives												
Urban Europe		X	X					X				
TOTAL	0	4	3	1	1	1	1	1	5	3	2	3
Joint undertakings												
Artemis		X					X		X			X
Fuel cells and hydrogen		X				X			X	X		
Article 185 Initiative												
Ambient Assisting Living			X		X				X	X		X
Eurostars: Eureka/FP7	X	X	X	X	X	X	X	X	X	X	X	X

Source: [MIRRIS, 2014, p. 24].

awareness raising and information provision activities, a more systematic approach is often needed to help potential or strategic stakeholders access HORIZON 2020 funding. The MIRRIS project identified several actions which can inspire the EU13 to mirror their own current practices, or to develop some equivalent tools, such as:

- signposting pre-information regarding future potential calls
- awareness-raising, information and advice on accessing HORIZON 2020 funding;
- the creation of sectoral or cross-sectoral interest groups;
- the promotion of local academia-industry cooperation and their cross-border networking;
- advice and quick checks of project ideas;
- support in searching for international partners;
- grants for exploring project feasibility and validation of project ideas;
- grants to seek advice from specialized consultants;
- the provision of training to potential EU project managers;
- support for ERA-Net projects on strategic topics. These projects are excellent springboards for regional actors' participation in HORIZON 2020;
- the provision of mentoring and coaching to potential EU project partners (taken from MIRRIS, 2014).

Such activities are often performed by NCP systems. They can help to mobilise 'dormant' research communities, and perhaps upgrade a proposal from one level to the next through professional advice. Nonetheless, they can neither generate excellent ideas nor write outstanding research proposals which are needed to successfully compete in HORIZON 2020. NCP systems can neither balance structural deficiencies of national innovation and research systems, nor replace forward-looking STI policy-making.

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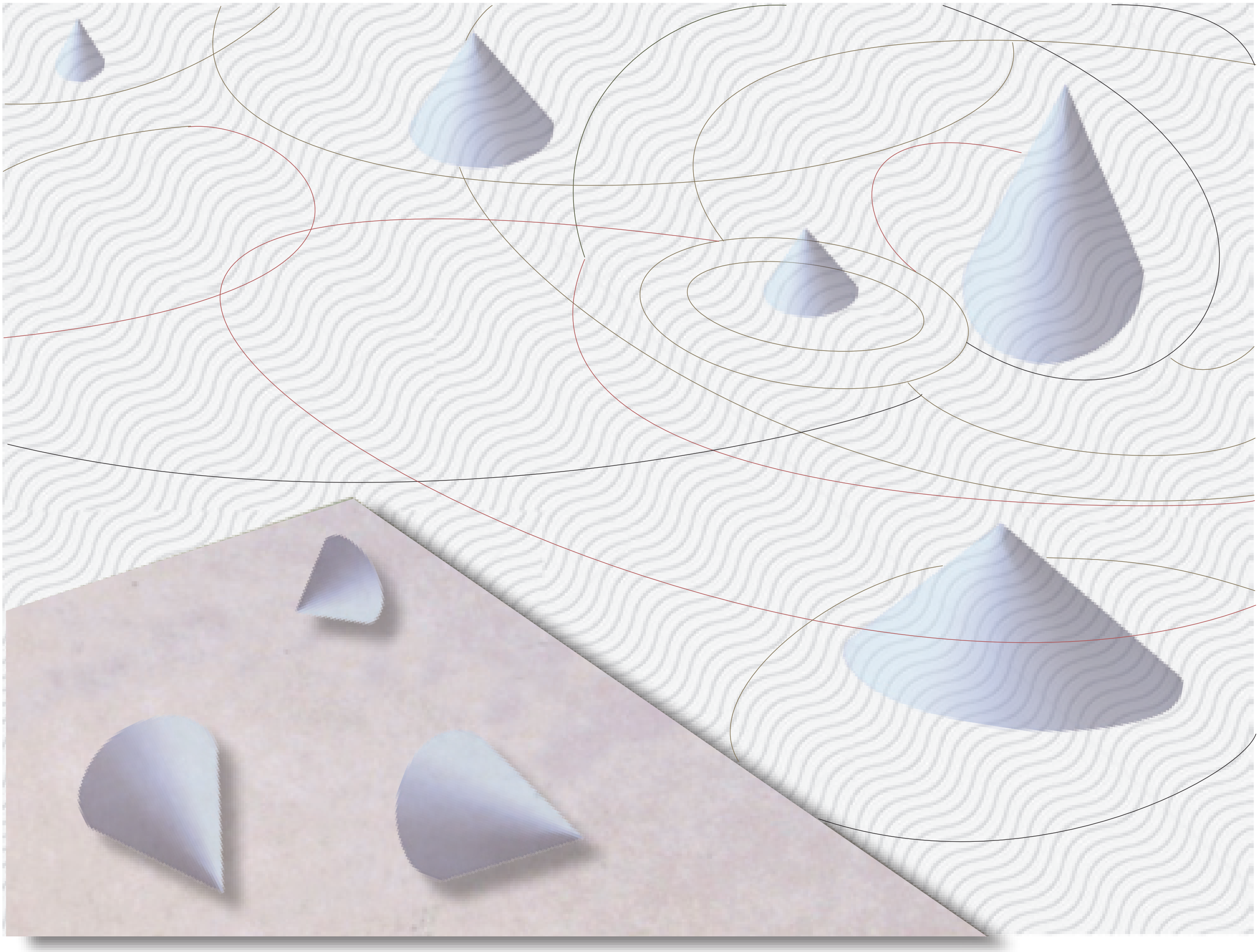
Tax Incentives for R&D and Innovation: Demand versus Effects*

Leonid Gokhberg, Galina Kitova, Vitaliy Roud



Tax incentives have proven effective as a tool used by governments to support science, technology and innovation, and are used by many countries striving for sustainable economic growth and enhanced global competitiveness. There is international evidence on the demand for and effectiveness of tax incentives as part of science, technology and innovation policy. Fiscal stimuli are increasingly combined in a more flexible manner, thus contributing to attaining a wider spectrum of objectives; means of international comparison and evaluating impact of these tools are actively evolving.

Based on the results of a specialized survey, this article analyses the demand for research and innovation tax incentives from Russian manufacturing enterprises, research institutes and universities performing research and development (R&D).

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Keywords

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Global trends

One obvious sign of the increasing importance of tax incentives for R&D in government policy in recent years is the significant increase in the countries that are using them. While in 1995 only 12 OECD member states used such incentives, in 2013 as many as 27 incorporated tax incentives into their policies, in addition to Brazil, China, India and Russia. At the same time, some countries do not offer special indirect support for R&D, refuse to provide incentives on the grounds that they are not effective (Mexico and New Zealand) [OECD, 2010c, 2011a, 2011b, 2013a, 2013c], or prefer to foster a favourable tax environment as a whole (for instance, Estonia, Germany, and Sweden).

The growing popularity of tax incentives for R&D is reflected in the dynamics of national spending on tax incentives. From 2006 to 2011, expenditure on incentives rose in one in three OECD countries (in some cases by 25%), and as a percentage of all OECD member states' support for R&D it reached one third (two thirds excluding the USA) [OECD, 2013a, 2013b]. It is interesting that while this figure increased in countries such as France (from 37.5% to almost 70%) and Turkey (from 29% to 52%), it actually fell in Hungary, Italy, the USA, Japan and other states. As a result, the relationship between direct and indirect incentives for research varies between countries very widely [OECD, 2010e; OECD, 2013c].

The most widespread R&D tax incentive tools — used in varying combinations to support the development of small and medium-sized (including innovation) businesses, start-ups, certain priority R&D areas, economic industries and other segments of the national innovation system — include [*Köhler et al.*, 2012; OECD, 2002b, 2011b, 2012, 2013e; *Palazzi*, 2011]:

- tax credits, allowing companies to reduce their tax liabilities depending on the level of R&D expenditure or growth;
- accelerated depreciation of R&D fixed assets (including machinery and equipment, buildings, structures and intangible assets);
- tax exemption for some R&D expenditure (including over 100% of the amount);
- reduced income tax or social taxes (or total exemption from these taxes) for staff carrying out R&D (or certain categories of staff);
- reduction of or exemption from companies' income tax for income generated using R&D results.

Motivation

Market failures can, as a rule, explain the need for government support for R&D (direct or indirect). Market failures prevent companies from blocking the dissemination of new knowledge obtained as a result of scientific investment and the use of this knowledge by society (in particular, by other economic actors), meaning that companies do not make a full return on their investment [OECD, 2002b, 2011b; *Palazzi*, 2011; *Köhler et al.*, 2012].

It is assumed that government intervention in this sphere through R&D funding, intellectual property protection and other developmental measures can compensate those developing new knowledge for any short-fall in income and stimulate growth in R&D expenditures.

Other rationales for government support for R&D include:

- the specific nature of research activity (delays, risks of not achieving the desired result or increased costs; the skewing of information between producers and consumers of knowledge, among others);
- the complexity and high costs involved in attracting external funding, due to the specific nature of research activities [OECD, 2011b];

- the importance of certain types of R&D in terms of fulfilling the government's aims (defence, safety, health care, energy, etc.) [*Köhler et al.*, 2012];
- the need for cooperation between knowledge producers and between knowledge producers and users [OECD, 2002c; *Köhler et al.*, 2012];
- the key role of investment in R&D in terms of competitiveness and long-term growth [*Köhler et al.*, 2012].

While the requirement for government R&D support and the need to expand support is undisputed, the choice of the various forms of support and balancing these types is down to each individual country based on, among other factors, best practices, the potential effects and costs, national challenges and constraints.

Advantages and disadvantages

The generally accepted advantages of tax incentives for R&D include [OECD, 2002b, 2010a, 2013a; *Palazzi*, 2011; *Köhler et al.*, 2012]:

- the nature of the market i.e. non-intervention in market mechanisms and relations;
- access for all companies and relative neutrality towards R&D areas, the parameters of the companies carrying out R&D etc.;
- a more effective approach to identifying R&D types that require support as research is carried out directly by companies, while in the case of direct funding, the government carries out the research;
- the economics of government and business spending through the 'imposition' of corporate taxes on the existing system;
- autonomy from the budgetary process, which simplifies decision making.

Moreover, as shown from recent experience, tax instruments are renowned for their relative stability in the light of fluctuations in the global economy and their effectiveness in terms of overcoming the negative consequences of such shifts (as seen, in particular, during the global economic crisis of 2008–2009). It is also important that international regulation does not set any restrictions on the use of tax instruments, which would be fraught with accusations of protectionism. On the other hand, such measures help to bring transnational companies' research divisions into the country.

However, tax incentives for R&D are not without their disadvantages, as often cited by critics. First, there is the risk of significant (and unforeseen) growth in government spending, which some countries try to avert by introducing tax incentives for companies that increase their R&D expenditure or by limiting the maximum amount of support per company. Government spending on the administration of tax privileges is increasing, something which is becoming especially complex and even problematic with the advent of globalization (due to transnational monetary flows, the geographical distribution of research and production divisions within companies, the dilution and diversion of profits due to taxation, etc.) [European Commission, 2009; OECD, 2013a, 2013f, 2013g]. One cannot fail to note the limitations placed on the scope of these mechanisms by industry in particular, ignoring the marked increase in the role of the services sector in developed countries over the last decade [European Commission, 2009]. There are also limitations on the range of beneficiaries, which are mostly major transnational companies (1,500 of such companies account for roughly 90% of global R&D expenditure [OECD, 2013a]). As a result R&D tax support contributes not only to higher R&D expenditure by national companies, but also a flow of foreign investment into this sphere. The situation is complicated by the fact that no widely recognized appraisal of the value and effectiveness of tax privileges for research and innovation activity has yet been carried out, despite several positive results from the development of international measurement standards in this field [OECD, 2010b, 2011a, 2012, 2013c].

Shifting aims

The range in aims of tax incentives for R&D is ever increasing, although, as we will see, there is still some uncertainty surrounding R&D tax incentives' contribution to R&D performance. Nonetheless, historically, the first and foremost aim of such support — increasing private business sector spending on R&D — is still just as important and there is now much, persuasive evidence on the subsequent effects [OECD, 2002b 2010a 2013a; *Köhler et al.*, 2012; KPMG, 2012].

Over the last decade, tax incentives for R&D have also been used to achieve the following pressing aims for the majority of countries [OECD, 2002c]:

- long-term growth and increased competitiveness of the national economy;
- increased labour productivity and innovation activity;
- structural progress in the national innovation system and enhanced collaboration between participants;
- support for the development of small and start-up innovation companies;
- foreign investment for R&D.

This list reflects both Russian practices in tax incentives for R&D (including the declared aims and instruments used, expected costs and results, etc.) and the areas of analysis. These areas of analysis can be divided into two groups, one of which is linked to surveying and comparing tax privileges for R&D (on an international level), and another with assessing the effects of incentives.

Experience of surveys and international comparisons

Studies to survey and compare various countries' tax incentive measures for R&D look to analyze spending on incentives or their intensity.

The B-index is generally used to survey and compare the intensity of R&D tax incentives [*Warda*, 1996, 1997, 2001, 2006]. The methodology (developed in the 1980s) has been steadily improved and it has increasingly been used in practice [OECD, 2002b, 2007, 2009, 2013c; European Commission, 2008; *Palazzi*, 2011].[1] In essence, the B-index, valued between 0 and 1, reflects a company's pre-tax income allowing it to break even for every one dollar of expenditure on R&D. All things remaining equal, the higher the tax incentives for R&D, the lower the value of the B-index should be, and its deviation from one is simply an assessment of the size (intensity) of these incentives.

To date, four rounds of studies have been carried out internationally to collect data on R&D tax incentive schemes and the costs of these programmes (2007, 2009, 2011 and 2013). The surveys used were accompanied by the necessary explanatory notes and commentaries [OECD, 2013f] and the results obtained were presented in various publications by the OECD [OECD, 2007, 2011a, 2012, 2013c among others]. It is also worth noting the round-ups of key trends and the design of R&D tax incentives in various countries, including the comparison of the intensity of indirect incentives for companies in OECD member states [OECD, 2003]. In 2011, the OECD again offered an assessment of global tax incentive schemes for R&D, the advantages and disadvantages of such schemes, their intensity in certain countries, as well as other parameters [OECD, 2011b]. The study [OECD, 2010d] not only systematized current approaches to collecting, classifying and analysing data on tax incentives for research and innovation activity, but also outlined the main areas for the optimization and development of corresponding international standards. The analysis of government spending

[1] Thus, the first release of the OECD's regular analytical report on science, technology and industry indicators (*OECD Science, Technology and Industry Scoreboard*), published in 1999 [OECD, 1999], set out the results of a B-index calculation for 22 OECD member states, as well as various methodological explanatory notes. Subsequent releases of the report, issued every two years, offer both developments of the B-index methodology and a wider range of countries taking part in the comparative analysis of R&D tax incentive intensity. The 2007 and 2009 reports featured tax expenditure on R&D following specialist OECD surveys, and the 2013 report covered tax expenditure alongside the B-index itself [OECD, 2007, 2011a, 2013c].

on R&D tax incentives is a relatively new area of research in the field of international comparisons [OECD, 2007, 2010c, 2011a, 2013c], while the calculation of the total amount of tax expenditure has a much longer history [OECD, 2010b, 2011a, 2013c].[2]

The development and approval of approaches to internationally compare tax expenditure on R&D was accompanied by a gradual reduction in the number of tax privileges included in the calculation and the generalization of the formulae. In practice, indirect R&D incentives are characterized by growing diversity in the tools used and in the distribution not only for 'proper' R&D in line with international standards defining these terms [OECD, 2002a] but also for operations involving intellectual property, software development, researcher pay, public-private sector partnerships and collaboration in the research sector [OECD, 2010d, 2012]. However, surveys tend on the contrary to be growing simpler and cruder [*Burman*, 2003; *Burman et al.*, 2008; *Weisbach*, 2006; OECD, 2010b].

Evaluation of effects

Studies into the effects of tax incentives for R&D (dating back over 30 years) are extremely numerous, heterogeneous, largely empirical, and are often restricted to the manufacturing industry (sometimes in combination with the services sector) [OECD, 2002b, 2010a; *Köhler et al.*, 2012; *Vartia*, 2008; *Palazzi,* 2011]. The majority of these studies are based on data from the 1980s–1990s, when tax incentives for R&D were only used by certain countries and the list of tax incentive instruments supporting only certain positions remained unchanged for a number of years.

Research has confirmed the impact of tax incentives on growth in R&D spending in the short-term [*Bernstein*, 1986; *Mansfield*, 1986; *Mansfield, Switzer*, 1985] and has shown significant variation in this impact depending on the support instrument, country, time frame, methods used etc. In particular, studies have demonstrated that R&D tax incentives are more effective for profitable companies and science-intensive industry sectors, while the impact of these incentives on the aggregate productivity of factors of production and innovation activity is on the whole insignificant and only appears in the long-term. Such a fact does not detract from their contribution to development in the R&D sphere (including through foreign investment) [OECD, 2002b; Taxand, 2011–2012].

On the whole, results from the assessment of R&D tax incentives' effectiveness and their impact on companies' spending dynamics in this area, on innovation activity, labour productivity and other indicators have been extremely heterogeneous, ambiguous and often disparate. Recently, however, there has been a shift in emphasis of such research: from detecting and measuring the impact of indirect R&D support instruments on certain indicators to studying the potential for integrating these instruments into recipes for stable growth amid global challenges and restrictions on development [OECD, 2013a, 2013b, 2013c, 2013d].

At the same time, as mentioned, existing empirical data have not yet made it possible to confirm or refute the now extremely popular hypotheses relating to the positive effects of tax incentives for R&D on companies' innovation activity, labour productivity, population well-being, economic growth, countries' competitiveness, flows of 'pro-scientific/pro-innovation' foreign investment or other special developmental reference points.

[2] The notion of 'tax expenditure' was introduced by Stanley Surrey in the 1960s–1970s to analyse privileges and other preferences on income tax in the USA [*Surrey, McDaniel*, 1985]. The development of this concept was complicated by including in tax expenditure not only income tax but other taxes, and by discussions of the criteria for reflecting preferences in tax expenditure (for example, only those which deviate from the standard tax system can be 'converted' into a direct government support programme) [IMF, 2007; *Weisbach*, 2006; *Burman et al.*, 2008; *Rogers, Toder*, 2011; OECD, 2010d].

Research to date into tax incentives for R&D can be grouped into the following topics:

- channels to integrate instruments into recipes for sustainable growth [OECD, 2013a, 2013b, 2013c, 2013d];
- the effects of incentives under globalization (including foreign investment in R&D) [*Taxand*, 2011–2012; OECD, 2011b];
- the expediency of limiting R&D benefits to transnational companies and establishing a priority taxation scheme for R&D carried out by non-transnational domestic companies [OECD, 2013a; *European Commission*, 2009];
- designing tax benefits for R&D which would make it possible to avoid a reduction in tax income 'not offset' by growth in private investment in R&D, or income from the marketing of R&D results [OECD, 2013a; *Köhler et al.*, 2012];
- the balance between tax and direct support for R&D among private companies taking into account small companies' preference for direct investment, the allocation of which must take place on a competitive basis with objective and transparent criteria and with the involvement of international experts [OECD, 2010a, 2013a; *Köhler et al.*, 2012].

Russian practice

Research and innovation in tax policy

In recent years, Russia has seen greater attention paid from government to tax preferences, including for innovation activity. This is down to stricter budget restrictions, demands for more effective budget spending and, at the same time, a desire to find instruments capable of achieving extremely ambitious specialist socio-economic development targets set by the so-called 'May decrees' issued by the President of the Russian Federation[3] and other documents.

The change in the level of innovation orientation of Russia's policies can be detected in the country's Taxation Policy Priorities, which, from 2007, have been developed alongside the federal budget and define the outlook of the tax policy for a three-year period (Table 1) [Ministry of Finance, 2011, 2012, 2013, 2014, 2015]. While in 2011–2013, incentives for innovation were included in the corresponding tax policy agenda (in particular, in the list of aims, directions, and instruments), the 'Policy Priorities' for 2014–2016 and 2015–2017 contained no such provisions (Table 1).

The 'Policy Priorities' for 2012 make provisions for monitoring the effectiveness of tax stimuli. The priority for 2013 sets out cut-backs in ineffective preferences, while the draft of taxation policy for 2015–2017 is geared towards monitoring tax expenditure [Ministry of Finance, 2015]. The first official publication providing information on this for 2010–2012 backs this up (in the section on benefits in force during this period for certain tax types).[4] The draft also setting out the most pressing issues for the majority of countries, such as counteracting the erosion of the tax base and the taking of profits through taxation [OECD, 2013f, 2013g], the abolition of certain incentives (regional and local) and revision of the rules for their introducing (only on a temporary basis, etc).

[3] Decree of the President of the Russian Federation 'On measures to implement government policy in the field of education and research' no 599, dated 07.05.2012 (http://www.kremlin.ru/news/15236, accessed 29.08.2013), and decree no 596 'On long-term government economic policy' (http://www.kremlin.ru/news/15232, accessed 29.08.2013).

[4] In the absence of an universally recognised definition of the concept 'tax expenditure' [Ministry of Interior Affairs, 2007; *Weisbach*, 2006; *Burman et al.*, 2008; *Rogers, Toder,* 2011; OECD, 2010d] and the incomplete nature of international standards to calculate tax expenditure, we have used here the simplified, though still operational, interpretation, namely the income shortfalls in the Russian Federation budgetary system which are down to the application of tax benefits and other instruments (preferences) established by laws on taxation and duties [Ministry of Finance, 2015].

Table 1. **Russian tax policy 2009-2017: declared priorities, aims and directions**

	2009–2011	2010–2012	2011–2013	2012–2014	2013–2015	2014–2016	2015–2017
	Priorities						
Effectiveness of the tax system	+	+	+	+	+	+	+
A balanced budgetary system	+	+	+	+	+	+	
Stabilization of the tax burden	+	+					+
Stability of the tax system				+	+	+	
De-offshorisation							+
	Aims						
Unification of rates	+						
Growth in administration quality	+						
Neutrality of key taxes	+						
Effectiveness of key taxes	+						
Counteracting the negative effects of a crisis		+	+				
Creating conditions for a transition to economic growth		+	+				
Incentives for innovation and modernisation			+	+	+		
Supporting investment in education and health care				+			
Supporting investment					+	+	+
Development of human capital						+	
Rise in entrepreneurial activity						+	+
Budget stability							+
Tax competitiveness							+
	Directions						
Tax administration	+	+	+	+	+	+	
Innovation activity			+	+			
Human capital				+	+	+	
Monitoring the effectiveness of tax tools				+			
Investment					+	+	
Cutting back ineffective incentives					+		
De-offshorisation						+	+
Priority development areas							+
Small businesses							+
Foreign organizations							+
Regional/local taxes (refusal to introduce new ones, repeal, etc.)							+
Effectiveness of tax stimuli and tax expenditure							+
Indicating the 'source' when introducing new incentives (including repealing ineffective incentives)							+
Introduction of temporary incentives							+

Source: compiled by the authors based on the Taxation Policy Priorities of the Russian Federation for the corresponding periods.

An analysis of Russia's tax policy measures planned for implementation in 2013–2015 (Table 2) [Ministry of Finance, 2013] confirms the gradual removal of the innovative focus from the country's policy. The list of measures has been organized into two groups: those linked to stimulating economic growth (predominantly through support for investment) and those aimed at increasing budget income (including by repealing ineffective preferences). Tax guidelines for 2014–2016 [Ministry of Finance, 2014] set out the support for investment, entrepreneurial activity and development of human capital, which does not rule out mediated incentives for innovation activity. However, the majority of instruments (as in the tax policy for 2015–2017 [Ministry of Finance, 2015]) aimed to balance the budget by increasing income and optimizing spending.

Thus, the analysis of Russian tax policy declarations for 2009–2017 (see Tables 1 and 2) shows that the peak — in terms of being geared towards increasing innovation activity — was in 2011 [Ministry of Finance, 2011]. After this year, the focus shifted to assessing the effectiveness of tax benefits and budgetary spend-

Table 2. **Pro-innovation instruments in the Russian Federation's tax policy planned for implementation in 2009–2016**

Name	2009–2011	2010–2012	2011–2013	2012–2014	2013–2015	2014–2016
Income tax: increasing expenditure on some R&D (factor of 1.5 from 2009; according to the Government list)	+					
Income tax: clarifying the list of R&D for application the factor of 1.5)		+				
Tax incentives for innovation activity: • temporary reduction in insurance contributions for engineering companies and businesses set up under Federal Law no 217, dated 02.08.2009; • defining a list of R&D expenditure items; • option of creating provisions for forthcoming R&D expenditure; • exemption from tax on fixed assets (machinery, equipment, etc.) acquired by educational and research (innovation) organizations to fulfill a science/technology production contract (order); • increasing the amount of investment tax credit and delegation of powers to offer tax credits to Russian regions; • exemption from income tax for non-profit organizations in socially important fields; • exemption from income tax up until 2020 for commercial organizations operating in the education and health care sector; • exemption from tax on property remaining at the end of a grant agreement; • Skolkovo benefits package			+			
Monitoring the effectiveness of tax benefits: • optimizing tax benefits; • analyzing their use (demand, performance, tax expenditure)				+		
Tax incentive measures: supporting investment and human capital (including exempting Russian Presidential grants awarded to young researchers from personal income tax; exemption from property tax for machinery and equipment)					+	+
Measures to increase Russian budgetary income: • repealing ineffective tax benefits and preferences (developing a normative base to assess their effectiveness, regulations, criteria and indicators); • preparing reports on budgets' tax expenditure and effectiveness					+	

Source: compiled by the authors based on the Taxation Policy Priorities of the Russian Federation for the corresponding periods.

ing for this purpose, which in turn can be explained by the increasing pressure of budget restrictions.

Assessment of Russia's volume and effectiveness of tax support for research and innovation

The decision taken by the Government of the Russian Federation to monitor the effectiveness of its instruments [Government Commission, 2010b] served as an impulse to develop approaches to measure and assess the results of tax incentives for research and innovation in the Russian Federation. Implementing this monitoring meant tackling a wide range of methodological, information, organizational and other problems.

According to the first official assessment of tax expenditure on innovation activity in Russia, based on tax statistics data, tax expenditure was 12.2 billion roubles in 2010 i.e. less than 2% of total tax expenditure on incentives for economic development [Ministry of Finance, 2014]. The calculation method for these figures is, admittedly, somewhat vague.

Based on information provided as part of efforts to update the strategy for social and economic development of Russia for the period up to 2020 [Government of the Russian Federation, 2008] at the decision of the Russian Government [HSE, RANEPA, 2013], tax expenditure on civilian innovation activities from the federal budget was estimated to be approximately 800 billion roubles in 2011, while direct expenditure was valued at 500 billion roubles.[5] Thus, up to 2020 the relationship varies between stabilization and growth of the share of tax expenditures depending on the country's social and economic development scenario [*Gokhberg, Kuznetsova*, 2011].

In 2014, official summary data were published on the amount of tax expenditure by the Russian Federation in 2010-2012, broken down according to tax and benefit type [Ministry of Finance, 2015]: 65.5 million roubles in 2010, 76 million roubles (2011) and 94.1 million roubles (2012) of tax expenditure went on research in these years (scientific research and design and trial work). However, it is not possible to assess the completeness or accuracy of these figures, or to calculate the tax expenditure on innovation activity overall. Thus the question of the scale and effectiveness of indirect support for research and innovation remains open.

Uncertainty surrounding the volume and structural characteristics of indirect support for research and innovation in many ways explains the interest in such support for empirical studies and the interpretation of results.

Empirical studies on tax incentives for innovation in Russia

Empirical studies on tax incentives for innovation in Russia are relatively rare. Thus, very often such projects (studies, surveys) have quite general or complex aims and objectives. What interests us are the assessments that such studies contain, but only on a few specific issues, which in many ways predetermine the results obtained and seriously restrict the potential of their practical use.

According to experts who took part in a survey relating to the Russian Government's anti-crisis policy in 2008–2009, the positive effects of the government's tax instruments ultimately led to some improvement in tax administration and a lesser tax burden for one of the major industries in the Russian economy generating revenue for the budget: the oil industry [HSE, IAC, 2009]. Positive anti-crisis effects of reducing income tax (from 24% to 20%) and repealing value added tax (VAT) for imported technological equipment with no Russia-made equivalent were significantly diminished due to the high share of loss-making companies as well as the non-transparent practice of preparing a list of such equipment.

A study into innovation activity among Russian industries showed that tax benefits proved the most effective support instrument [*Gracheva et al.,* 2012; *Kuznetsova, Roud*, 2011]. 62% of the more than 2,000 respondents representing businesses from the 11 largest sectors of the manufacturing industry agreed with this, while only 40% of respondents recognized the effectiveness of direct support. These results can probably be explained by the fact that respondents had in mind the effectiveness of tax support for innovation, not for their own business or the country as a whole, but as an institution functioning under appropriate external conditions.

The majority of experts who took part in a 2011 survey on the innovation climate in Russia (the 'Innoprom' Barometer) [IRP Group, 2011] observed that the Tax Code and other elements of tax legislation did not incentivize innovation activity (75.5%), and that the support instruments in the legislation to encourage innovation supply and demand are ineffective (64% and 58.6% for innovation supply and demand, respectively). Similar assessments were made in a 2011–2012 study into the factors affecting innovation activity at Russian industrial businesses [*Ivanov et al.*, 2012]. Over one quarter of the participants

[5] The lack of an agreed method for calculating even public and official data on direct and indirect federal budget expenditure on innovation means that existing assessments are poorly developed from a methodological perspective, and are often fragmented and scattered. For instance, in 2010, the Russian Ministry for Economic Development valued direct federal budget expenditure on innovation in 2009–2012 at roughly 1 trillion roubles per year [Government Commission, 2010a], having included in this figure items which should not be categorized as such under accepted international standards and evoke doubts.

considered tax incentives to stimulate innovation the main barrier to innovation activity, although there was considerable variation in assessments of certain instruments' effectiveness. While 17–18% of respondents recognized the positive effects of the accelerated depreciation of fixed assets used solely for research activity and of VAT exemption on imported technological equipment with no Russia-made equivalent, only 13–14% of respondents thought that the application of the 1:5 ratio to R&D expenditure had positive results. Almost half of all respondents (47%) reported that they did not apply for tax benefits as a result of uncertainty surrounding their terms and conditions and the high likelihood of disputes with tax authorities. 37% reported that they did not want to attract the attention of the tax authorities or additional audits; almost one third (32%) stated that they did not want the burden of having to prove their entitlements to a certain benefit. In turn, 'consumers' of tax benefits have expressed dissatisfaction with the scale of benefits, their conditions and the quality of administration [*Ibid.*].

Moreover, we can turn to the surveys carried out by the Russian Union of Industrialists and Entrepreneurs (RUIE, henceforth referred to by its Russian abbreviation of RSPP) in 2011–2013 [RSPP, 2011, 2012, 2013] devoted specifically to government (primarily tax) support for companies' innovation activities. The advantages of these surveys include the efficiency with which they were carried out and the analysis and publication of the results, while the disadvantages include the considerable incomplete information on the programmes and methodology.

The 2011 survey [RSPP, 2011] concludes by indicating the respondents' affiliation with particular types of economic activity. The analysis of the survey groups the tax benefits which were in force between 2008 and 2010 according to the level of demand from business. This demand was assessed by the share of respondents claiming a particular form of benefit.

The 2012 survey [RSPP, 2012] only touched upon the 1:5 ratio for R&D expenditure, an updated list for which had been approved by the Russian Government in February 2012. This survey was carried out among 30 companies (mostly large companies) engaged in various types of economic activity: only three of the surveyed companies claimed this benefit. Other respondents either did not meet the eligibility criteria (as a rule, the list of R&D approved by the Russian Government) or did not attempt to claim to avoid any problems with the administration of standards (e.g. submission to the tax authority of R&D performance reports, expert assessments). Moreover, it became apparent that business considered this benefit not as a stimulus to increase R&D expenditure, but rather as a way to save money.

The 2013 survey [RSPP, 2013] looked at 24 tools of direct or indirect government support. More than half of all respondents (56.9%) represented the manufacturing industry, and roughly one in ten companies (10.8%) operated in transportation, communications, etc.

Assessments of the demand for and effectiveness of tax support for innovation (based on the results of the RSPP survey (Table 3) suggest low overall demand from businesses for state tax support and a correlation between demand and economic activity type.[6]

According to the assessment by RSPP experts, the key reason behind companies' low demand for tax stimuli for innovation is not meeting the eligibility criteria (Table 4). In particular, companies did not use VAT exemption on imported technological equipment or operations involving intellectual property because they did not actually import such equipment or did not carry out such opera-

[6] Thus, according to the 2011 survey, fuel and energy companies did not seek VAT exemption for imported technological equipment or the 1:5 ratio for R&D expenditure [RSPP, 2011].

Table 3. **Demand for tax incentives for innovation activity (based on the results of companies' surveys carried out by RSPP in 2011–2013)**

Benefits	Share of surveyed companies using the instrument
VAT exemption for R&D carried out using budget funds and funds from other sources, as well as by education institutions and scientific organizations under business contracts (sub-point 16, point 3, article 149 of the Russian Tax Code)	< 1% (2011) > 29.7% (2013)
VAT exemption for imported technological equipment on the Russian Government list (point 7, article 150 of the Russian Tax Code)	> 33% (2011) 15.6% (2013)
Use of the 1:5 ratio for R&D expenditure (point 11, article 262 of the Russian Tax Code)	< 25% (2011) 10% (2012) 6.2% (2013)
Accelerated depreciation of R&D fixed assets (with a coefficient of 3 or less; point 2, article 259.3 of the Russian Tax Code)	< 1% (2011) 4.7% (2013)
VAT exemption for patent and licensing operations (sub-point 26, point 2, article 149 of the Russian Tax Code)	4.3% (2013)

Sources: [RSPP, 2011, 2012, 2013].

Table 4. **Reasons for companies not claiming tax benefits for innovation activity (as a percentage of respondents who selected each option)**

Tax tools / Reasons for not claiming	Mismatch conditions of use	Closed list of conditions of use	Difficulty in proving right to use	Lack of information on tools	Small scale of benefits
VAT exemption for R&D carried out using budget funds and funds from other sources, as well as by education institutions and scientific organizations under business contracts (sub-point 16, point 3, article 149 of the Russian Tax Code)	58	—	2.4	17.1	7.3
VAT exemption for imported technological equipment on the Russian Government list (point 7, article 150 of the Russian Tax Code)	46	18	4	8	6.0
Use of the 1:5 ratio for R&D expenditure (point 11, article 262 of the Russian Tax Code)	40	9.1	12.7	5.5	10.9
Accelerated depreciation of R&D fixed assets with a coefficient of 3 or less (point 2, article 259.3 of the Russian Tax Code)	35.8	—	5.7	15.1	15.1
VAT exemption for patent and licensing operations (sub-point 26, point 2, article 149 of the Russian Tax Code)	55.6	5.6	5.6	5.6	8.3

Source: [RSPP, 2013].

tions. Other reasons worth noting, in our opinion, are companies' lack of information about certain stimuli and the small scale of the benefits.

These examples are, in essence, the only empirical analyses of tax incentives for innovation in Russia carried out to date. We took into account the approaches and conclusions above when designing our investigation into the demand for such tax instruments in 2012–2013, and present the key results of this study below.

Assessment of demand for R&D and innovation tax incentives in Russia

Aim and objectives of the study

In view of the lack of any objective information in Russia on demand for tax incentives for research and innovation activity, their target audiences and the effects of their use, the foremost aim of our research was to assess the level of demand for these stimuli and the factors governing this demand. The study focused on three groups of organizations (research organizations, universities performing R&D, and manufacturing enterprises) and on indirect forms of support for research and innovation.[7]

[7] The study was carried out in 2012-13 as part of a large-scale project to monitor the economics of science and research, implemented by HSE ISSEK at the request of the Russian Ministry of Education and Science (2011–2013).

To achieve the study's aims, several tasks were carried out to prepare and conduct the study, and analyze the results, including:

- Compiled a list of incentives related to each of the three, above-named groups of organizations[8], and analyzed practices in terms of claims (based on explanatory letters and other documents from tax bodies and materials from commercial courts);
- Developed a survey (questionnaires) for the three groups of organizations, the structure of each following the same logic (applied to a particular exemption i.e. if 'yes', what did it give the organization; if 'no', why).

Sample

The study covered 519 research organizations, 299 universities performing R&D and 851 manufacturing enterprises (a total of 1,669).[9]

The sample of the first group included research organizations with at least 51 R&D personnel spread across 25 Russian regions (federal subjects). The share of state academies of sciences,[10] state science centres (SSC) and Moscow in this group is in line with the overall number of research organizations in the country.

The sample of the universities (299 organizations) covered 25 Russian regions and the 29 national research universities (NRU) which are positioning themselves as hubs and drivers of development both within the R&D sector in Russia. It is important to bear in mind that a survey of all the NRUs could cause some bias of the results in favour of best practices (for example, over-estimating the share of universities using tax incentives for research and innovation activity).

The sample of manufacturing enterprises (851 organizations), spread across 26 regions, consisted of a group of organizations which fill out the federal statistical monitoring form for innovation activity.[11] Almost ¾ of these organizations carried out this type of activity i.e. incurred spending on technological, marketing or organizational innovation in 2011.

Toolkit

The survey was addressed to the directors of the organizations and was based around a questionnaire developed for each of the three groups mentioned above. The questionnaire contained questions on the characteristics of the organizations which were important in terms of achieving their research goals and their use of direct and indirect research and innovation support mechanisms (tax instruments were included as a separate block of questions in the questionnaires). The uncertainty over the initial list of tax benefits aimed at stimulating research and innovation activity complicated the planning of the study's questionnaire. This list was developed using expert assessments and contained the following income tax tools:

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[8] The lists were formed on the basis of expert assessments of the 'involvement' of certain tools specified in the Russian Tax Code that support/stimulate R&D and/or innovation, as defined in accordance with international standards on supporting and delimiting the corresponding types of activity [OECD, 2002a; OECD, *Eurostat*, 2005].

[9] The general population for these samples was formed based on corresponding impersonal data from a federal statistical survey of R&D and innovation, which harmonized its methodology with international standards in the field [OECD, 2002a; OECD, *Eurostat*, 2005]. Considering that in 2011, R&D was conducted by 581 universities, of which 299 participated in the survey [HSE, 2013b], it is obvious that this sample's size is excessive (and, admittedly, two others). However, the size of the universities sample and the other two samples was dictated by the requirements from the Russian Ministry of Education and Science, which contracted the project under which the survey was conducted.

[10] Since the study was carried out in 2013, i.e. prior to the restructuring of state academies of science (as per the Federal Law 'On Russian Academy of Sciences, the restructuring of state academies of sciences and amendments to certain legislative acts of the Russian Federation' no 253-FZ), the article looks at their former structure.

[11] The federal statistical monitoring of innovation activity is the only source of reliable and comparable data on domestic organizations carrying out innovation activity [*Gokhberg*, 2012]. It involves annual continuous surveys of legal entities which are not classified as small businesses but operate in the manufacturing industry and carry out other forms of economic activity. The survey is carried out using 'Form no 4 — Innovation' which comprises 12 sections, each of which reflect various characteristics of the surveyed organizations and their innovation activity.

- income tax exemption for funds to implement specific research, science and technology programmes and projects, as well as innovation projects. These refer to funds that have been received from budgets to support research, science and technology and innovation activity, created in accordance with Federal Law 'On science and government science and technology policy' no 127-FZ, dated 23.08.1996[12] (point 14, article 251 of the Russian Tax Code);
- accelerated depreciation of fixed assets used solely for scientific and technical activities and with a special coefficient of no more than 3 (sub-point 2, point 2, article 259.3 of the Russian Tax Code);
- the use of the 1:5 ratio for expenditure on R&D, the list of which was approved by the Russian Government (point 7, article 262 of the Russian Tax Code).

The questionnaires also included questions on organizations' claims for VAT exemption for patent and licensing operations[13] and for R&D carried out by education and research organizations using budget funds and resources from other Russian funds for fundamental research, humanitarian research and technological development, among others, based on business contracts etc. (sub-point 16, point 3, article 149 of the Russian Tax Code). Some other incentives were examined which were classified (for the purposes of this study) as instruments to stimulate research and innovation activity.

When drafting the questionnaire, we took into account general requirements in terms of the survey size — essential to guarantee the quality of the survey results.

Results: manufacturing enterprises

Amid low overall demand from manufacturing enterprises for tax support instruments for research and innovation activity (Table 5), variation between instruments and types of enterprises was extremely significant. Two exceptions to this — VAT exemption when exporting goods outside the Russian Federation (customs export procedures etc.) and accelerated depreciation of fixed assets — merely confirm the distinct legal nature of such provisions, as their relationship with research and innovation activity is small in practice. Accelerated depreciation of fixed assets is stipulated not only for 'innovation' reasons, such as, for instance, equipment being classified as energy efficient or used only for science and technology activities, but also for when it is used in aggressive environments, leasing, etc. (article 259.3 of the Russian Tax Code).

Three categories of enterprises were comparatively active: the largest (with more than 1,000 staff) organizations, those carrying out innovation activity, and organizations affiliated in some way with the state.[14] Accelerated depreciation of fixed assets was used by over one third of these three kinds of organizations (43%, 36% and 37.4% respectively) and less than a quarter (23.1%) of the overall sample; the 1:5 ratio for R&D expenditure was used by roughly 25% (compared with 7% on average).

While the leading performance of innovative organizations as noted above is logical, the two other categories raise some questions. In international practice, tax incentives for R&D and innovation are used to attract private investment in this sphere, increase innovation activity, national competitiveness, etc. In Russia on the other hand, major state and/or quasi-state companies (meaning the public sector of the economy as a whole) are the main beneficiaries.[15] The cur-

[12] Available at: http://www.consultant.ru/document/cons_doc_LAW_153964/, accessed 27.09.2013.

[13] As per sub-point 26, point 2, article 149 of the Russian Tax Code, exercising exclusive rights to inventions, useful models, industrial designs, software, databases, integrated circuit layouts, know-how, and the issuance of a license to use the mentioned results are exempt from VAT.

[14] In our survey, state affiliation was defined as when the surveyed enterprises belong to an integrated structure created by — or with the involvement of — the state (including state corporations).

Table 5. **Demand from manufacturing enterprises for tax incentives for R&D and innovation: 2011**

Examples of incentives	Share of organizations used tax incentive (percentage of total respondents)
For income tax	
Accelerated depreciation of fixed assets linked to research and innovation activity (including those used only for science and technology activities, energy-efficient equipment etc.; article 259.3 of the Russian Tax Code)	23.1
Expenditure on R&D on the Russian Government list (including R&D without positive results) with a ratio of 1:5*	7
Expenditure on innovation consisting of expenditure on production/product sales**	8
For value-added tax (exemption/zero rate)	
Patent and licensing operations (sub-point 26, point 2, article 149 of the Russian Tax Code)	0.3
R&D using government budget funds	3.8
R&D using Russian Foundation for Basic Research and extra-budgetary foundations funds (sub-point 16, section 3, article 149 of the Russian Tax Code)	0.6
R&D related to the creation of new products/technologies	0.8
R&D related to the improvement of products/technologies	0.5
Imported equipment with no equivalent manufactured in Russia (according to the Russian Government list)	2.8
For exports of goods from Russia (customs export procedures, etc.)	23.7
Incentives established by Russian regions	
Reduced income tax rate (specifically on profit that would be subject to transfer to regions' budget)	10.6
Property tax allowance (excluding allowance set out in the Russian Tax Code)	13.7

* Since 2012 this rate, in place since 2011 (article 262 of the Russian Tax Code), has been expanded to include a list of expenses which are classed as R&D expenditure for tax purposes, and other innovations.

** Other expenditure on production/product sales can be included in the following expenses linked to innovation activity: certification and standardization of a product/service; information, audit, consultancy and other similar services; training and re-training of staff; developing and setting up new plants and workshops; paying royalties, etc. (article 264 of the Russian Tax Code).

*** Since Russian regions are entitled to reduce income tax payable to their budget for certain categories of taxpayers from 18% (set by the Russian Tax Code) to 13.5% (article 284.1 of the Russian Tax Code), such decisions can also be taken to stimulate research and innovation activity in the region.

Source: authors' calculations based on data of Institute for Statistical Studies and Economics of Knowledge, National Research University – Higher School of Economics (henceforth HSE ISSEK).

rent situation in Russia is quite different from the recommendations of international organizations regarding priority support through tax instruments for innovative small, medium and start-up domestic companies [OECD, 2013d].

In line with the study's results, the weak demand for research and innovation tax support from manufacturing enterprises can be explained by two possible factors. Either these enterprises fail to meet the eligibility criteria (90% of respondents did not use the 1:5 ratio for R&D expenditure as they did not have any such expenditure in 2011), or the exorbitant transaction costs linked to proving entitlement to a particular benefit are an obstacle. As a result of the high transaction costs, almost one in nine respondents refused the opportunity of accelerated depreciation of fixed assets.

Statistical analysis of the typical combinations[16] of tax incentives used by companies allows us to delineate five basic models of their tax behaviour in research and innovation (Table 6).

The first model, predominantly based on VAT exemption for exports,[17] is implemented by roughly one in five of the surveyed enterprises (20.7%). The next three models of businesses' tax behaviour are linked to regional incentives (on

[15] In Russia, almost half of the Russian economy is concentrated in the public sector but plans to shrink this concentration are lagging and experiencing some difficulties [*Rodionov*, 2012; HSE, RANEPA, 2013; *Guriev*, 2013]. This fully explains the leadership of pro-state companies in terms of receiving the tax incentives provided in the Russian Federation for research and innovation activity.

[16] The grouping is derived using latent class analysis technique. The proportion or errors in the classification is 0.0581. The classification is statistically significant at the 1% significance level (based on bootstrapping).

[17] This refers to point 2, article 151 of the Russian Tax Code, which governs VAT levies when exporting goods from Russian territory. It is important to recognize that the classification exemption of exports from VAT among research and innovation incentives is highly relative.

Table 6. **Models of manufacturing enterprises' use of R&D and innovation tax incentives (%)**

	Tax incentives use model					Did not use tax incentives	Total
	1	2	3	4	5		
Share of enterprises having applied the corresponding model of R&D and innovation tax support	20.7	8.6	11.6	15.3	2.8	41.0	100
Share of enterprises that applied of some incentives (out of all enterprises that applied the corresponding model):							
Income tax stimuli							
accelerated depreciation of R&D fixed assets	3.2	1.5	29.2	7.4	1.7		
taking into account R&D expenditure	3.0	0.0	24.7	75.4	4.6		
taking into account innovation expenditure	0.4	0.3	11.3	0.0	1.3		
reduced tax rate, set by Russian regions	6.0	39.0	32.6	8.7	99.9		
VAT exemption or zero							
patent and licensing operations	0.1	0.0	0.2	4.4	0.0		
R&D using state budget funds	1.5	0.0	3.5	56.2	0.0		
R&D using Russian Foundation for Basic Research and extra-budgetary foundations funds	0.0	0.0	1.0	8.9	0.0		
R&D related to the creation of new products/technologies	0.0	0.0	4.9	7.9	0.0		
R&D related to the improvement of products/technologies	0.0	0.0	5.1	2.9	0.0		
imported equipment with no Russia-made analogue	0.6	3.9	3.9	4.7	71.6		
exports of goods from the Russian Federation (customs export procedures, etc.)	100.0	0.4	1.2	40.2	99.5		
Other allowance							
for property tax	10.7	99.6	4.7	21.2	99.9		
investment tax credit	3.1	0.2	29.2	0.0	0.0		

Source: authors' calculations based on HSE ISSEK data.

property and income tax; 8.6% of enterprises), income tax incentives (11.6% of enterprises), and a combination of stimuli for R&D and VAT on exports (15.3% of enterprises). The final model is used by less than 3% of enterprises which have taken advantage of VAT exemption for imported equipment, export and regional-level incentives.

An analysis of additional characteristics of those businesses which implement the tax models outlined above allows us to paint a portrait of such organizations and assess the effects of indirect incentives in the sphere of research and innovation (Table 7).

The first three tax strategies are for the most part intrinsic to medium-size private companies operating in low-tech and low level medium-tech sectors geared towards the Russian market and not engaging in expenditure on innovation activity. The fifth strategy, on the contrary, is largely used by large companies (with over 500 staff) in high level medium-tech forms of economic activity. Clearly, such a portrait of companies applying the different tax models can be used to assess the effectiveness of the tax system in research and innovation and to optimize the system by taking into account national priorities for social and economic development.

The choice of specific tax model is unequivocally linked to the resulting combined effects on the intensity and success of businesses' innovation activities (Table 8). Thus, the first of these variants is, as expected, neither linked to changes in businesses' spending on innovation nor variations in the amount of innovation output. The second model is associated with low intensities of incremental innovations and innovations geared towards regional markets. The most perceptible link with development of innovation activity is shown by the third strategy, which is linked to using a combination of R&D benefits relating to income tax. The resulting effects involve intensified spending on various forms

Table 7. **Characteristics of enterprises using various models of R&D and innovation tax support (percentage of total number of enterprises applying the corresponding model)**

		Tax incentives use model				
		1	2	3	4	5
Number of employees	51–100	3.9	7.4	14.3	7.9	0.5
	101–250	24.8	54.2	57.2	38.2	19.0
	251–500	41.0	12.2	14.5	9.4	2.5
	501–1000	13.7	14.8	6.1	11.0	51.9
	1001+	16.6	11.4	8.0	33.4	26.1
Ownership type	private	80.5	84.3	68.9	70.4	90.0
	public	4.0	7.1	14.7	9.2	2.5
	mixed public-private	7.4	3.2	11.2	13.4	0.5
	foreign involvement	8.1	5.4	5.2	6.9	7.0
Innovative activity in reporting year	no	78.5	71.7	62.3	39.9	70.6
	yes	21.5	28.3	37.7	60.1	29.4
Priority markets	local	9.1	26.4	21.8	2.1	15.8
	regional	15.6	18.2	42.5	3.6	0.0
	Russian Federation	71.9	54.6	31.8	88.8	75.3
	CIS	0.7	0.9	3.7	2.9	6.4
	other countries	2.7	0.0	0.2	2.7	2.5
Types of manufacturing	high-tech	9.5	3.3	10.2	22.7	0.0
	high level medium-tech	32.1	36.5	27.2	51.2	85.8
	low level medium-tech	23.3	37.0	6.7	12.8	13.7
	low-tech	35.1	23.3	56.0	13.3	0.5

Source: authors' calculations based on HSE ISSEK data.

Table 8. **Change in the intensity and performance of enterprises' innovative activity depending on the model of tax support in research and innovation (marginal effects of choosing the model on the likelihood of improving the corresponding measure)***

Effects on innovative activity		Marginal effects of the model					Regression characteristics		
		1	2	3	4	5	N	Stat. sig.	Pseudo-R2
Expenditure on innovation (by activity type)	R&D	-0.00124	-0.0121	**0.0167**	-0.00752	0.0114	366	0.1084	0.0177
	acquisition of machinery and equipment	-0.00825	0.00504	**0.0154**	-0.00497	0.00448	558	0.0225	0.016
	starting production	-0.0009	-0.00145	0.00424	0.00202	0.00559	579	0.1632	0.0113
	production designing	0.0047	-0.00217	**0.00772**	0.00326	0.0043	501	0.0705	0.0152
	purchase of intangible technologies	0.000594	-0.00571	**0.0202**	**0.00799**	**-0.0144**	363	0.000	0.048
	employees training	-0.00183	**-0.00534**	**0.00514**	0.00123	0.00357	502	0.0127	0.0223
Amount of output innovation (by level of newness)	improved	-0.006	0.013	0.029	-0.008	-0.005	467	0.022	0.0203
	new to firm	-0.013	-0.005	0.015	-0.015	**-0.041**	446	0.0008	0.0314
	new to region	-0.011	0.011	0.001	**-0.019**	-0.021	297	0.0609	0.0179
	new to Russia	0.0002	0.002	0.0004	-0.001	-0.015	220	0.5758	0.0201
	new to global market	0.007	-0.001	-0.0003	**-0.012**	**0.025**	91	0.0535	0.1017

* The marginal effects set out are calculated using logistic regression for the discrete ordered dependent variable (ordered logic). The dependence of the type of *Effect* = *F* (*profile, size, sales, ownership, innovation*) was assessed, where *Effect* is the scaled variable change in the corresponding parameter from 0 to 6, *size* and *sales* are the scaled variable number of employees and the amount of output, *innovation* is the existence of innovation activity in the reporting period, and *ownership* is the type of ownership. The figures in bold show statistically significant effects at the 5% level. The regression characteristics include the number of observations for which the corresponding dependent variable has been applied, the statistical significance of the regression overall, and pseudo-R2.

Source: authors' calculations based on HSE ISSEK data.

of innovation activity and an increase in performance, even in relation to the development of products which are new, at best, to the regional market.

Results: research organizations and universities performing R&D

Demand from research organizations and universities performing R&D for R&D and innovation tax incentives was higher than for manufacturing organizations (which fully reflects the distortions in the system of tax incentives in favour of research rather than innovation). An overwhelming number of research organizations (83%) used the opportunity of VAT exemption for R&D (sub-points 16 and 16.1, point 3, article 149 of the Russian Tax Code). Almost half (45.1%) took advantage of a tax benefit for grants supporting research, science, technology and innovation activity; roughly one quarter (24.3%) benefited from VAT exemption for patent and licensing operations. The remainder virtually did not carry out such operations, which indicates their performance.

Only 4% of all research organizations took advantage of accelerated depreciation of fixed assets used solely for scientific and technical activities. This could be explained by the prevalence amongst them of government-funded institutes (57.8%), whose property (excluding that acquired and used for entrepreneurial activity) is not subject to depreciation (point 2, article 256 of the Russian Tax Code). In several instances, respondents did not have any R&D equipment or instruments.

Universities performing R&D outstripped research organizations in terms of more frequent use of incentives for grants (over 60%) and accelerated depreciation of R&D fixed assets (7.4%). Similar to manufacturing enterprises, the main reasons research organizations and universities did not take advantage of research and innovation tax incentives were ineligibility (based on eligibility criteria) and the risk of disputes with tax authorities.

The approach we propose to identify models of organizations' tax behaviour in research and innovation, as tested above for manufacturing enterprises, can also be applied to research institutes and universities performing R&D. Doing this allows us to group them according to the structure of their demand for certain forms of tax incentives (Tables 9–12).

Table 9. **Models of research institutes' use of R&D and innovation tax incentives (%)**

	Tax incentives use model					Did not use tax incentives	Total
	1	2	3	4	5		
Share of research institutes that have applied the corresponding model of R&D and innovation tax support	36.4	26.2	14.1	7.5	6.4	15.8	100
Share of research institutes that applied some incentives (out of all institutes having applied the corresponding model):							
Income tax incentives							
accelerated depreciation of fixed assets	4.6	4.4	2.3	12.7	0.0		
taking into account R&D expenditure	38.1	26.6	45.3	33.4	52.1		
reduced tax rate, set by Russian regions	4.7	0.5	0.5	15.3	5.7		
VAT exemption or zero							
patent and licensing operations	24.4	29.1	17.3	43.5	37.7		
R&D using state budget funds	80.2	99.9	29.3	0.4	97.4		
R&D using Russian Foundation for Basic Research and extra-budgetary foundations funds	68.2	0.3	14.3	0.2	56.5		
R&D based on business contracts	62.3	0.6	85.8	0.2	81.3		
R&D related to the creation of new products/technologies	0.1	3.5	11.6	0.1	98.8		
R&D related to the improvement of products/technologies	0.0	0.0	8.3	0.0	93.2		
Property tax allowance							
tax exemption for State Science Centres	14.3	4.3	0.0	12.8	26.9		
reduced tax rate, set by Russian regions for organizations	4.5	15.8	2.2	17.9	2.9		
reduced tax rate, set by Russian regions for property	1.2	0.6	0.0	7.6	0.0		

Source: authors' calculations based on HSE ISSEK data.

Research institutes have exhibited five basic tax strategies (Table 9). Over one third of them (36.4%) primarily use income tax and value-added tax R&D incentives (not only for R&D carried out using budgetary funds but also under business contracts). Demand for tax instruments among the next group of institutes (26.2%) is restricted to allowance for R&D funded by the budget and VAT exemption for patent and licensing operations. Some organizations (roughly 14.1%) focus their attention on VAT benefits for R&D based on business agreements. There is also another small group of organizations which largely focus on incentives for patent and licensing operations (7.5%). The remaining organizations (6.4%) are characterized by high levels of demand for practically all VAT exemptions for R&D.

By analysing the characteristics of research organizations that implement each of the aforementioned tax models in R&D and innovation, we can confirm that these models contain a wealth of information and approximate reality sufficiently (Table 10).

Thus, research institutes implementing the **first model** are noted for their relatively high (compared with other research organizations) proportion of basic research (49.4%), focus on natural and engineering sciences (73.5%), and budgetary funding (almost 56%). The latter explains their usage rate of VAT exemption for R&D carried out using budgetary funds, grants and business contracts. The core of this group is made up of research institutes which until 2013 were part of the system of state academies of science, and now fall under the Federal Agency of Research Organizations. Those representing the **fifth model** differ from the first by their relatively uniform structure of R&D (like research organizations implementing the third model), and their large on average size (based on R&D personnel). This group includes the State Science Centres that were

Table 10. **Characteristics of research institutes using various models of R&D and innovation tax support**

		Tax incentives use model									
		1		2		3		4		5	
		As a percentage of total number of research institutes using the corresponding model									
Fields of science	Natural sciences	47.6		22.1		38.4		17.9		48.5	
	Engineering sciences	25.9		58.8		27.4		53.8		42.4	
	Medical sciences	8.5		8.8		12.3		17.9		3.0	
	Agricultural sciences	9.5		8.8		11.0		10.3		6.1	
	Social sciences	5.3		0.7		4.1		0.0		0.0	
	Humanitarian sciences	3.2		0.7		6.8		0.0		0.0	
R&D personnel	51–100	20.1		24.3		28.8		10.3		6.1	
	101–300	45.5		42.6		54.8		48.7		24.2	
	301–500	19.0		17.6		9.6		23.1		27.3	
	501–1000	9.5		11.0		5.5		12.8		15.2	
	1000+	5.8		4.4		1.4		5.1		27.3	
		Mean	S. E.	Mean	S. E.	Mean	S. E.	Mean	S. E.	Mean	S. E.
R&D Structure	Basic research	49.4	2.9	13.1	2.2	31.3	4.2	10.1	3.0	31.2	6.1
	Applied research	30.3	2.1	40.6	2.8	37.5	3.8	43.5	5.5	38.2	5.1
	Development	20.3	2.1	46.3	3.0	31.2	4.2	46.3	6.1	30.6	5.2
	Total	100.0		100.0		100.0		100.0		100.0	
Funding source structure	Budgetary estimate or subsidy	51.9	2.5	27.3	3.1	40.8	4.2	34.3	6.3	40.9	6.3
	Budgetary subsidy for other purposes	4.0	0.9	1.7	0.6	2.5	1.0	6.7	2.8	2.1	1.7
	Own funds	5.8	1.0	12.2	1.9	11.5	2.9	24.4	6.0	5.9	3.1
	Government R&D contracts	18.5	1.8	34.2	3.0	12.2	2.7	5.9	1.9	26.0	5.0
	Government foundations for R&D support	5.1	0.6	0.4	0.2	6.7	2.1	2.7	1.5	2.2	0.6
	Business funds	12.7	1.4	22.2	2.5	21.2	3.8	25.4	5.9	18.9	3.6
	Funds from abroad	1.0	0.2	1.5	0.5	3.0	1.5	0.1	0.0	2.5	1.2
	Other	0.9	0.3	0.5	0.2	2.2	1.3	0.6	0.6	1.4	0.8
	Total	100.0		100.0		100.0		100.0		100.0	

Source: authors' calculations based on HSE ISSEK data.

Table 11. **Models of universities' use of R&D and innovation tax support (%)**

	Tax incentives use model				Did not use tax incentives	Total
	1	2	3	4		
Share of universities that have applied the corresponding model of using R&D and innovation tax incentives	44.5	32.1	11.0	2.7	9.7	100
Share of universities which have used some incentives (out of all universities having applied the corresponding model):						
Income tax allowance						
zero rate	12.2	32.4	46.8	30.3		
accelerated depreciation of R&D fixed assets	8.4	0.0	2.9	68.8		
taking into account R&D expenditure	99.2	4.4	21.0	45.9		
reduced tax rate, set by Russian regions	3.1	0.2	17.6	33.6		
VAT exemption or zero						
patent and licensing operations	27.4	26.3	11.4	53.9		
R&D	77.4	99.7	32.9	98.9		
Other incentives						
for property tax	25.2	22.3	50.2	16.6		

Source: authors' calculations based on HSE ISSEK data.

surveyed, which actively seek the benefits established for them offering exemption from property tax.

As for universities performing R&D, we have identified four tax strategies in this field (Table 11). Their R&D and innovation tax behaviour is more heterogeneous than research institutes and manufacturing enterprises: universities have shown demand for virtually all the instruments set out in Table 11.

In the **first variant**, slightly less than half (44%) focus their demand on income tax and VAT incentives for R&D. The **second tax model**, which covers roughly one third of universities (32%), is notable for 100% implementation of incentives for R&D through VAT and income tax exemption.[18] The parameters of the **fifth model** (demand for all instruments as set out in Table 11) are largely down to the relatively high representation in this group of national research universities (NRU), which are the core of higher education research in Russia; their activity in absorbing state support measures is easily understandable (Table 12).

The statistical analysis has not revealed any significant effects of the impact of R&D and innovation tax incentives on research and innovation activity indicators among research institutes and universities (R&D personnel, intensity of internal R&D expenditure, income from commercializing R&D results). This means that we cannot posit any direct link between the tax strategies of research institutes and universities in the research and innovation sphere and real indicators of the intensity and effectiveness of R&D and innovation, at least in the short term. The existing tax incentives in this field are not immediately reflected in the changing everyday practices of research groups and, in particular, in the principles governing how resources are prioritised and distributed.

Conclusions

This article has presented the initial results of our empirical study into the demand for tax incentives for R&D and innovation from manufacturing enterprises, research institutes and universities performing R&D. Some comments must be made before we analyse the results.

First, it is important to recognize a certain bias towards R&D in the list of tax incentives included in the study. This was due to the previously noted lack of any

[18] In accordance with Article 284.1 of the Russian Tax Code, higher education institutions can use a zero income tax rate if their income from education and science/technology activities accounts for no less than 90% of their income.

Table 12. **Characteristics of universities performing R&D and using various models of R&D and innovation tax support**

		Tax incentives use model							
		1		2		3		4	
		Percentage of total number of universities implementing the corresponding model							
Type/category of university	Federal university	6.8		6.3		6.1		0.0	
	University	53.4		55.2		45.5		25.0	
	Academy	18.0		18.8		27.3		0.0	
	Institute	11.3		9.4		18.2		25.0	
	NRU	10.5		10.4		3.0		50.0	
		Mean	S. E.	Mean	S. E.	Mean	S. E.	Mean	S. E.
Average number of:	Employees	1746	193	1708	140	770	145	1817	378
	Students	9404	852	10004	935	5445	1011	10602	3107
	Post-graduates	282	37	310	28	138	26	340	101
R&D	Share of R&D personnel (%)	23.58	23.10	21.44	2.08	24.45	3.88	15.55	4.81
	Share of R&D in total expenditure (%)	13.95	13.88	13.92	1.26	10.43	1.95	14.83	5.14

Source: authors' calculations based on HSE ISSEK data.

recognized formal lists of such stimuli for R&D and innovation or criteria for 'affiliation' with this list. It was also useful to examine more or less universal incentives which are geared towards each of the three groups of organizations and which are actually used by them in practice. A study of manufacturing enterprises, research institutes, and universities required an analysis above all of the instruments supporting R&D specifically. It is possible that such an imbalance in the coverage of the various indirect tools for R&D and innovation partially influenced the finding that research institutes and universities performed best in terms of the use of such incentives (especially when compared with the low average demand for these tax instruments from the manufacturing companies surveyed).

The variation in demand among respondents for R&D and innovation tax incentives according to their type and characteristics (size, type of economic activity, state affiliation, etc.) was, in our opinion, meaningfully significant and must be taken into account when considering the effectiveness and design of tax instruments, particularly their aims, target audience, and content, among others.

The dominance of the state sector (and affiliated organizations) among the beneficiaries of tax support measures for R&D and innovation contradicts the best global trends in terms of rates for private business, especially for start-ups, and small and medium-sized companies. Such a situation means significant economic effects from these policy measures are unlikely and implies that there is significant potential to improve the mesures.

Table 13 shows some summary indicators of the demand for R&D and innovation tax incentives from research institutes, universities performing R&D, and manufacturing companies. These indicators allow us to highlight certain key features of the existing indirect support mechanisms.

First, considering the survey's focus on tax incentives for R&D, as noted above, we can explain the relatively low demand for incentives from manufacturing enterprises by the fact that in the reference period (2011) only about 5% of such organizations carried out R&D, and 13.3% engaged in innovation activity [HSE, 2013a]. Demand for tax incentives for R&D and innovation from this group of respondents can be characterized as follows:

- 'Ignorance' of the potential to gain VAT exemption for patent and licensing operations (article 149 of the Russian Tax Code) predominantly due to the lack of such operations, which, in our opinion, is an indirect indicator of

Table. 13. **Indicators of demand for R&D and innovation tax incentives: 2011**

Indicators of demand	Research institutes	Universities	Manufacturing enterprise
Organizations that received Russian Foundation for Basic Research or Humanitarian Foundation grants (percentage of surveyed organizations)	45.1	63.9	0.6
Organizations without any problems concerning tax allowance use of Russian Foundation for Basic Research or Humanitarian Foundation grants (percentage of organizations received the grants)	96.6	95.8	—
Organizations claiming accelerated depreciation of R&D fixed assets (percentage of total surveyed organizations)	4.0	7.4	3.4
Organizations not using accelerated depreciation of R&D fixed assets due to the lack of such assets or allocation difficulties (percentage of organizations not using the incentive)	48.4	78.3	—
Organizations that used income tax relief for R&D expenditure (percentage of total surveyed organizations)	33.7	45.8	9.9
Organizations that used a reduced income tax rate established by Russian regions for that part of their profit that would be subject to transfer to its budget (percentage of total surveyed organizations)	3.5	6.0	9.6
Organizations that used VAT exemptions for patent and licensing operations (percentage of total surveyed organizations)	24.3	23.1	0.3
Organizations that did not carry out patent and licensing operations (percentage of total surveyed organizations)	92.4	93.5	—
Organizations that used VAT exemptions for R&D carried out on the basis of business contracts (percentage of total surveyed organizations)	52.0	70.6	—
Organizations that used property tax incentives (percentage of total surveyed organizations)	19.3 (including state science centres)	25.0	13.7

Source: authors' calculations based on HSE ISSEK data.

the low technological level and innovation activity of these organizations.[19] Despite the fact that roughly a quarter of research institutes and universities carrying out R&D made use of this benefit and the tax expenditure on this benefit almost doubled between 2010 and 2012 to reach 16.4 million roubles [Ministry of Finance, 2015], the question of who the beneficiaries are and what the effects of the tax benefit are remains open to debate;

- Relatively high (compared with research institutes and universities carrying out R&D) demand for regional income and property tax incentives, which suggests not only their importance for manufacturing enterprises, but also the efforts of regions to attract investment;
- Leadership of large (more than 1,000 employees) and state-affiliated companies in the use of R&D and innovation tax incentives; this is different from the declared aims of supporting R&D and innovation and actually restricts the impact and positive effects of such measures.

Second, the finding that universities performing R&D were leading in terms of using the tax incentives (those included in the survey) should be understood bearing in mind the modest size of higher education sector in R&D (9% of R&D expenditure and 7.3% of R&D personnel in 2011 [HSE, 2013b]). Nonetheless, together with the perceptible recent growth in state funding for R&D in higher education, the comparatively high demand from universities for indirect support measures reflects the key role of science and technology policy in developing the research and innovation potential of higher education institutions.

Third, the 'popularity' of tax incentives for grants from foundations supporting R&D and innovation (article 251 of the Russian Tax Code) is somewhat undervalued by the small size of these grants (for instance, the average size of Russian Foundation for Basic Research and Humanitarian Foundation grants is 400,000–500,000 roubles). It is true that the forthcoming increase in financing

[19] In the RSPP survey mentioned above, 4.3% of businesses surveyed used this instrument, which does not contradict our results.

these foundations and the creation of the Russian Science Foundation in 2013 could lead to growth both in the average size of the grants and in the corresponding tax expenditure.

Fourth, despite the weak overall demand for R&D and innovation tax support measures, Russian research institutes, universities performing R&D, and manufacturing enterprises use certain combinations of these measures which tend to be standard across these groups. Only a small number of organizations use integrated strategies for R&D tax support due to the low levels of innovative activity in Russia. The statistical analysis of manufacturing businesses showed a link between actively applying income-related R&D and innovation tax incentives and intensified innovation activity. In the case of research institutes and universities, we were unable to reveal any significant impact on the distribution of R&D-related resources and the effectiveness of R&D, at least in the short term.

The results presented in this paper are only a first step of a more in-depth analysis. Further research is necessary on the demand for tax incentive instruments to assist in the development of research and innovation, the assessment of the impact of tax incentives on performance in this sphere, and on rationales to underpin policy recommendations that will improve the effectiveness of science, technology and innovation policy. F

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Innovation in Russian District Heating: Opportunities, Barriers, Mechanisms*

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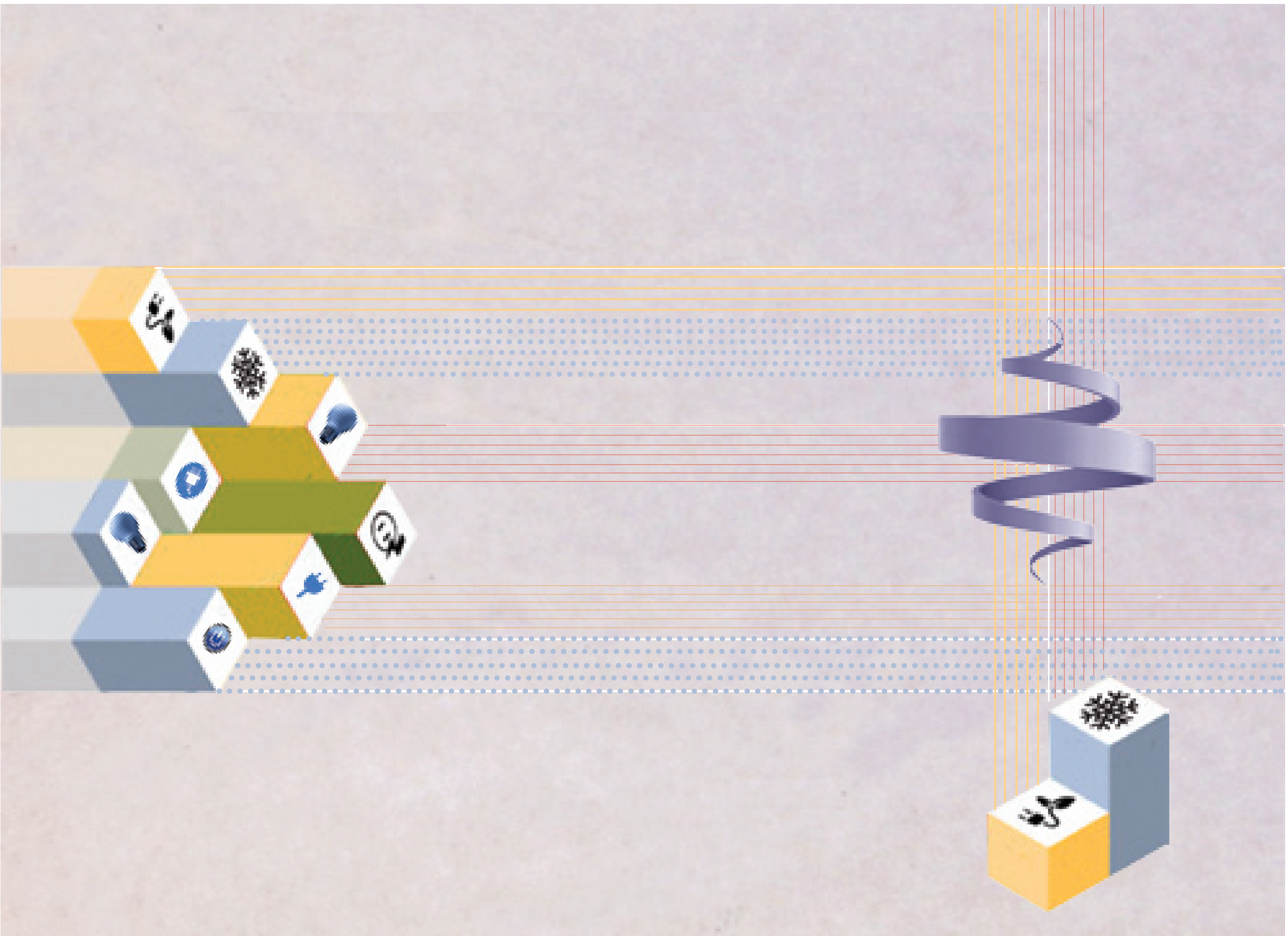

Contrary to the advanced countries, heat energy sector in Russia hardly embraces radical innovations. Moscow heat supply system, the most innovative comparing to that of other Russian cities, is no exception. It focuses on incremental innovations while lagging in radical innovations in cogeneration, trigeneration etc.

The paper considers the reasons for such a situation, compares Russian and European heating markets and corporate strategies, provides recommendations for supporting the innovative development of Russian heating companies.

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District heating in Russia accounts[1] for roughly 44% of the world's total heat production capacity, and if small boilers are included, its share is even greater [*Kozhukhovskii*, 2013]. Local monopolies prevail in Russian district heating, while in other countries distributed heat generation exists in more balanced proportions. Erroneous managerial strategies (including strategies for innovative development) can potentially lead to greater costs in such systems than in a competitive market environment. In recent decades, this field has accumulated problems such as wear and tear on equipment, heat losses, and low efficiency of heat sources [Ministry of Energy, 2013; *Begalov*, 2013]. The situation is compounded by a number of systemic factors [IFC, World Bank, 2008], including the lack of innovative development at most district heating companies. Their activities mainly target maintaining the technological process under conditions of highly depreciated equipment and delayed payments from customers. An exception is the metropolitan district heating system where a key organization — Moskovskaya Ob'edinennaya Energenticheskaya Kompaniya (Moscow Integrated Power Company, MIPC) — is focused on implementing innovations [MIPC, 2011b, 2013a]. For this reason, an analysis of the features of the metropolitan heating industry's innovative development makes it possible to formulate recommendations that may be sought after by other heating companies.

This paper examines the innovative development of Moscow's district heating system enterprises. Equipment availability, financial support, and strict compliance with technical regulations in municipal heating supply make it possible to eliminate subjective factors that are typical for many regional companies and have caused them to lag behind technologically. This has allowed us to focus our research on the strategic aspects of innovative activities instead of the traditional discussion of current problems. We present the sector's development strategy in recent decades and the results of innovative activities conducted by companies in the field.

During our research we discovered barriers that prevent the introduction of new developments at the national and corporate levels. A comparison of approaches employed by domestic and Finnish heating utility companies makes it possible to make recommendations regarding the development of corporate strategies for innovative development. Special attention is given to breakthrough innovations in cogeneration and trigeneration.

Moscow district heating in brief

The heat supply system of Russia's capital differs from its counterparts in European cities. It is unique in terms of its scale and is generally comparable to individual EU nations in terms of major characteristics. For example, in 2012 the total length of pipelines in Moscow was 16,323 km and the associated contractual thermal load was 19 GW[2], which exceeds the corresponding aggregate figures for Finland (roughly 13,600 km and 18.5 GW, respectively). MIPC receives gas from a local supplier with a stable distribution system, which reduces the risks of an interruption in supplies and eliminates the need to diversify the types of fuels consumed. The capital's heating companies do not have access to large thermal reservoirs (such as the Baltic Sea for coastal Scandinavian cities or the Pacific Ocean for certain US states) which complicates the creation of certain systems, e.g. *free cooling* [Euroheat & Power, 2006; State of Hawaii, 2002] based on seawater.[3] Finally, the basic source of energy in Moscow is natural gas, which is relatively clean from an environmental point of view.

[1] Note that the magnitude of this indicator is determined by more than heat suppliers' activities. Considerable energy losses in Russia are due to the inefficient thermal insulation of buildings.

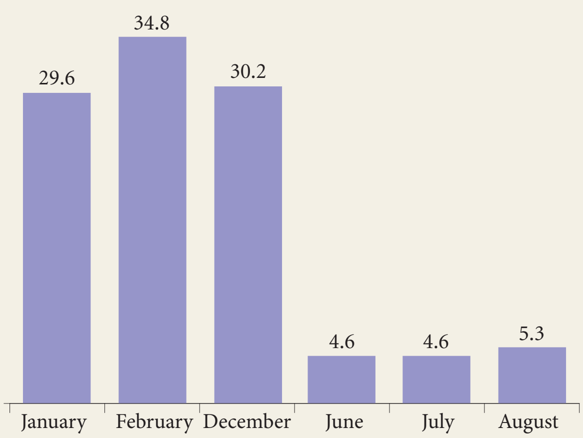
[2] Hereinafter, information about MIPC is presented based on annual reports [MIPC, 2005, 2006, 2007, 2008, 2009, 2010, 2011a, 2012].

[3] However, there are also other *free cooling* technologies. For example, see [*Baggini, Sumper*, 2012; *Wu*, 2010].

These circumstances sideline potential innovative projects related to diversifying the fuel mix, that are of immediate interest to European heat utilities: the use of boilers fueled by waste from the timber industry, technologies to reduce carbon emissions from thermal power plants, the construction of automatic coal storage facilities, reduction (or the complete elimination) of ash dumping areas, etc. These trends are not high-priority for Moscow's heating industry. Top priority is given to improving reliability and energy efficiency, and developing the information technology (IT) infrastructure. These innovation initiatives are chiefly aimed at testing new pipelines and types of thermal insulation and surfactants [MIPC, 2013a; RosTeplo.Ru, 2010; Startbase, 2014], and introducing variable-frequency drives (VFD) and their analogues [RosTeplo.Ru, 2010]. However, implementation of these technological solutions lags behind other countries. In particular, surfactants have already been used in foreign pipelines systems for nearly 20 years [*Pollert et al.*, 1994], while plastic pipelines have been used since the mid-1980s [KWH Pipe, 2006]. State-of-the-art VFDs are an energy-efficient, but very common, flow control technology [*Herman*, 2009; *Petchers*, 2003; *Bloetscher*, 2011]. Such solutions provide gradual quantitative changes that may be viewed as evolutionary innovations at the enterprise level.

There are, however, potential breakthrough innovations related to the combined production of different types of energy which may transform Moscow's energy market radically and offset its considerable disadvantage — a low capacity factor. This is a typical problem for boiler plants (Figure 1). The summer-time capacity factors are extremely low because a typical boiler plant produces only one type of energy — heat. Hot water supply, which keeps the capacity factor from dropping to zero, does not provide a significant load for the equipment. Evidence confirms[4] that increasing a capacity factor is a significant resource in energy sector. It is known that mono-generation, be it electricity or heat generation, is less productive than combined generation of several types of energy [*Andrews et al.*, 2012; Inter RAO UES, 2013; European Commission, 2002; DHC+ Technology Platform, 2009]. Moreover, the transition to combined energy production may contribute to an increased capacity factor. MIPC has two opportunities in this area: expansion of electricity production and production of cooling. The latter would be a breakthrough innovation for the capital's energy industry.

Figure 1. **MIPC's capacity factor in winter and summer months** *(%)*



Source: [MIPC, 2005].

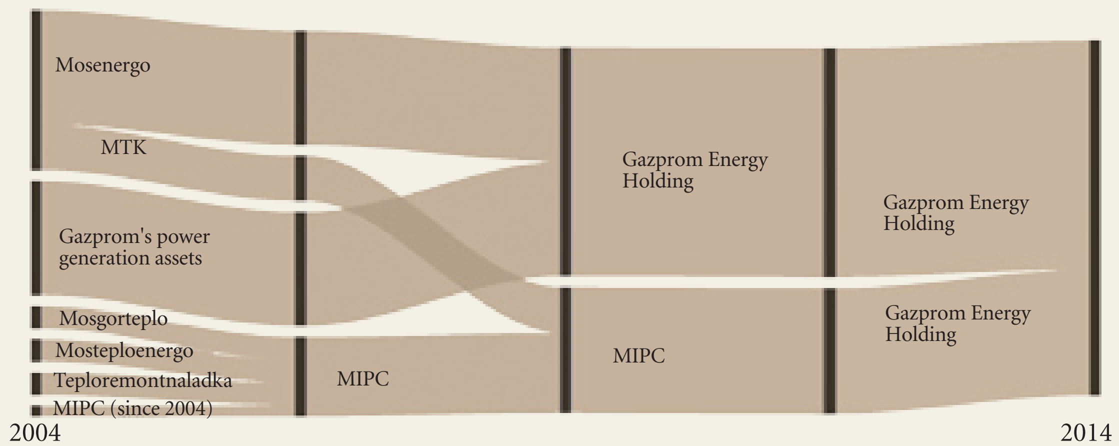
[4] For example, the average capacity factor of US nuclear power plants has grown from 50 to 90% [World Nuclear Association, 2014; Nuclear Energy Institute, 2014].

To a certain extent the technological lag is caused by the preceding managerial practices and strategies adopted in Moscow's district heating system. In recent years it has been reorganized repeatedly: multiple changes have been made to the structure and number of enterprises, their functions, internal business processes, and the forms of interaction between them (Figure 2). Before 2004, state unitary enterprises were directly responsible for supplying heat to customers through the operation of heating stations and the separate heat distribution systems of Mosgorteplo, Mosteploenergo (including district heating stations, and accompanying water networks and heating substations), and Teploremontnaladka (service to over 500 heating substations in northeast Moscow). They did not compete with each other, because customers were divided between the companies depending on their location. Innovative development was hampered by the irregular territorial division of heat districts, inefficient business processes, and delayed payments both from customers and to heat suppliers.

In 2004, to consolidate these assets and improve their efficiency, the Moscow government created MIPC, which assumed the role of municipal heat supplier.[5] The new entity included unitary enterprises which had been reformed into joint stock companies and become its subsidiaries and business units afterwards. Later, MIPC underwent several more reorganizations during which the number and function of the units changed.

Moscow's main sources of heat are Open Joint Stock Company (OAO) Mosenergo's power plants (in 2004, its principal shareholder was OAO Unified Energy System of Russia, or 'RAO UES Russia'[6]), which was reorganized in 2005. During the reorganization, more than ten business units were separated

Figure 2. **Reorganization of the Moscow district heating companies in 2004–2014**



Note: This diagram shows a simplified representation of mergers and acquisitions. It does not depict information about the structure of ownership or organizations' legal status.

Mosenergo is the largest of Russian regional generating companies and the basis of the Moscow energy system. The company comprises 15 power plants for Moscow with an installed electric capacity of 12.3 GW and heat capacity of 35 000 Gcal/h, which makes the company the world's largest heat generator. Currently, Mosenergo is a Gazprom Energy Holding subsidiary.

MTK was a Moscow infrastructure company controlling major large-diameter district heating water pipelines used for transporting heat from Mosenergo's power plants to local distribution heating water networks.

Mosgorteplo, Teploremontnalandka, Mosteploenergo were Moscow state unitary enterprises that operated local district heating substations and distribution heating water networks.

(Open Joint Stock Company) Gazprom's power generation assets refer to Gazprom's shares in Russian heat and power generation companies which have been steadily growing over the decade.

Gazprom Energy Holding — operates as a subsidiary of Gazprom (since 2009) and controls its heat and power generating assets such as MOEK, Mosenergo, etc.

Source: Prepared by the authors.

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[5] Order of the Government of Moscow 'On the Creation of Open Joint Stock Company Moskovskaya Obedinennaya Energenticheskaya Kompaniya' (including subsequent changes) no 2261-RP, dated November 11, 2004.

[6] RAO UES of Russia was a national energy monopoly controlling more than two thirds of Russia's electric power capacity and most of electric transmission grids in Russia. The company was reorganized in 2006 – 2008 when its subsidiaries were spun off into separate generating companies.

from Mosenergo, becoming independent companies. One of them was OAO Moskovskaya Teplosetevaya Kompaniya (Open Joint Stock Company Moscow District Heating Network Company, MTK), which controlled the city's main heating water pipelines. The separation of assets made it possible to split competitive businesses from the monopolistic and divide profitable and loss-making assets.In 2007, the capital's government acquired a controlling stake in MTK. Then the government initiated a merger between MTK and MIPC, which was completed in October 2012. The merger did not eliminate the challenges that had existed in heat supply: the imbalances between seasonal fluctuations of the heat load (and the wholesale heat purchased from Mosenergo), the fixed size of the payment received from customers, and the resulting regular cash deficiency for a long time. Correcting the accumulated problems took nearly a decade.

Barriers for innovative activities

Low labour productivity

Insufficient productivity impedes innovative activities because introducing new services based on costly and outdated business processes and service technologies decreases innovations' potential profitability. Given the high discount rates and the inability to introduce inexpensive technologies (for example, *free cooling*), innovation projects that succeeded abroad in terms of *net present value* (NPV) could prove to be loss-making in the Russian energy industry. Discount rates associated with the cost of capital for companies depend on the state of the financial markets. Like the lack of access to free thermal reservoirs, this is an external factor that an enterprise is unable to influence. However, an enterprise can improve the efficiency of its operations through technological and managerial innovations.

Many researchers have noted the connection between labour productivity and innovative activities. For example, Philip Cooke asserts that the latter is the primary factor in increasing productivity [*Cooke,* 2012], while Peter Brödner points out the correlation between a deceleration of growth in productivity and a reduction in innovative activities in Germany [*Brödner*, 2011]. Studying investments in employees' key skills during a period of crisis, Lidia Garcia Zambrano and her colleagues have also demonstrated a connection between pioneering activities and productivity [*García-Zambrano et al.*, 2014]. In their research on the management of a high-tech company, Roman Boutellier and Mareike Heinzen use labour productivity as one of the characteristics of innovative activities [*Boutellier, Heinzen,* 2014]. Sorin Krammer evaluates innovative policy by looking at employees' skills and productivity [*Krammer,* 2009]. Francesco Bogliacino and Mario Pianta, relying on the results of company innovation surveys in EU countries (Community Innovation Surveys, CIS), identified the relationship between the quality of innovative activities and labour productivity [*Bogliacino, Pianta,* 2009]. However, increasing productivity based on innovations requires a modern overall technological foundation, because low-tech enterprises usually lag behind high-tech enterprises [*Kirner et al.*, 2009] in terms of the effectiveness of their innovative activities.

We compare the labour productivity of several Russian and Finnish energy companies, taking output-labour indicators — the ratio of annual energy sales (GW·h) to the number of employees — as our criteria. To do this, we formed several groups of companies with comparable generation, transmission/distribution and sales indicators. We created three groups of companies:

A. Heat and electric power transmission/distribution systems including heat and electricity sales — the Finnish company Turku Energia and the Russian MIPC / MOESK total staff and sales (green).

B. Combined generation of heat and power (*combined heat and power*, CHP), heat and electric power transmission/distribution systems, including heat and electricity sales — Finnish companies Turku District Energy Ltd.[7] and Turku Energia, and Russian companies Mosenergo, MIPC, and MOESK (blue); Helsingin Energia's data are also provided for comparison.

C. Combined generation of heat and electric power — Mosenergo and Turku District Energy Ltd. (yellow).

It is not possible to achieve a complete match for these groups because of the scale effect and differing distribution of assets. MIPC is a wholesale reseller of heat for Mosenergo (67.7% of the annual heat production by the latter in 2012); and the remaining 32.3% is supplied to retail customers. In 2012, Mosenergo's heat sales amounted to $6.8663 \cdot 10^7$ Gcal, while MIPC's own heat production was $2.4699 \cdot 10^7$ Gcal. However, the approximate match makes a qualitative comparison possible.

The data in Table 1 indicates that average labour productivity in the Moscow energy industry is noticeably lower than it is at Turku: by roughly a factor of 2.5-3 for groups A and B. MIPC's employee headcount does not fit the volumes of heat sales, considering that most (about 75%) of the heat is purchased from Mosenergo. MOESK looks somewhat better. But in this case Turku Energia, which serves two types of transmission and distribution systems (electric power and heat) has demonstrated approximately the same productivity (E/P) as MOESK, which only operates electric power transmission and distribution systems. Moreover, total productivity at Turku Energia ((Q+E)/P) is more than twice that of MOESK (E/P). Only Mosenergo is approximately equal to Turku District Energy Ltd (group B).

A cause of the Russian enterprises' considerable lag in labour productivity is technological inefficiency: a low level of automation, mostly manual labour when repairing and maintaining sources and distribution systems, excessive capacity redundancy, and an insufficiently developed IT infrastructure. Eliminating these shortcomings requires a basic set of methodological tools that can be taken from the *lean production model*.[8] Despite requiring significant labour and

Table 1. **Labour productivity in the production, transmission, and distribution of heat (Q) and electricity (E)** (*GW•h/person*)

	Q/P (*GW•h/person*)	E/P, (*GW•h/person*)	(Q+E)/P, (*GW•h/person*)
Turku Energia (2013)	6.52	5.50	12.02
Turku District Energy Ltd	12.26	6.25	18.51
Turku Energia — Turku District Energy Ltd	5.55	3.59	9.15
Helsigin Energia (2012)	5.39	5.25	10.64
MIPC (2012)	3.25	-	-
Mosenergo (2012)	9.80	8.07	17.87
MOESK (2012)	-	5.16	-
MIPC – MOESK	-	-	4.01
MIPC – MOESK – Mosenergo	-	-	4.02

Note: P — employee headcount, Q — annual heat sales *(GW•h)*, E — annual electricity sales *(GW•h)*. The closest analogue to MIPC is Turku Energia (highlighted by orange).

Source: The authors' calculations based on the publicly available materials of the companies mentioned in the table.

[7] For Turku District Energy Ltd., the heat capacity supplied to industrial customers in Naantali and cooling production of roughly 25 GW·h are also considered.

[8] Methods to model and optimize the operations of technology, industrial, and power companies are described extensively in the literature [*Henriques et al.*, 2014; *Curry, Feldman*, 2011; *Bangert*, 2012; *de Souza*, 2012; *O'Kelly*, 2013; *Blank*, 2012].

time, optimization may result in improved efficiency and innovative potential. This process has begun at MIPC [Production Management, 2013, 2014; M24.ru, 2013] but so far only concerns some particular operations. It can be considered innovative to an extent because it implies the adoption of the world's best practices used to define optimal operating procedures.

Barriers for long-term planning

An effective strategy for fostering innovations cannot be separated from the company's overall development strategy [*DeSai*, 2013]. Setting goals for innovation policy should rely on the corporate strategy and the long-term financial policy.

The Moscow heating industry's development strategy was created over an extended period of time under the influence of several executive bodies — the Government of Moscow, RAO UES, and most recently, under the state-owned energy giant Gazprom.[9] Each of them implemented their own action plans. The interplay between them entailed adjustments to MIPC's corporate strategy. Thus, it is promising for the company to enter the electricity market, which creates an opportunity to start combined heat and power production using new equipment such as combined-cycle units. To develop power generation, MIPC Generatsiya (MIPC Generation) was created in 2008 as a subsidiary of MIPC. Its assigned task was to achieve a 9% share of Moscow's power generation market, which required building 1.5 GW of generating capacity [*Krivoshapka*, 2008]. In the same year, OAO Mosgorenergo passed into the control of MIPC [Mosgorenergo, 2014]. However, in 2012 MIPC's power generation remained at approximately 193 MW [MIPC, 2012], which makes it possible to assume that the expansion strategy was cancelled.

The deployment of 1.5 GW capacity at 14 of MIPC's stations would be the basis for small-scale distributed generation in comparison with Mosenergo's major thermal power plants, which have a larger capacity. On the other hand, the construction and modernization of district and area heat stations in the 1990s and 2000s included the installation and repair of water boilers. Obviously, gas turbines can be purchased and installed independently, but this would be a separate production of heat and power, which does not possess the advantages of combined generation. The possibility of simultaneously modernizing boilers to recover heat from the turbines' exhaust, which would increase the project's cost, could be explored. In this regard, the attempt to change the strategy proved difficult due to the decisions that had been previously adopted as part of a different strategy. Such inconsistency *(short-termism)* is a common corporate management problem [*Barton, Wiseman*, 2013; *Kappel*, 1960] that affects both innovative development [*Tidd et al.*, 2005; *Johnson et al.*, 2008] and the general long-term perspective [*McLaney*, 2009].

The difficulties of planning for the distant future are illustrated in the chart (Figure 3), which demonstrates that in 2011 MIPC lost 14% of its associated contractual thermal load. The twofold increase in MIPC's heating capacity reserve in 2011 roughly corresponds to the decrease in the load. This drop could presumably be the result of the reassessment of customer characteristics based on new power consumption standards.[10] In this case, the 'virtual' changes are rather an indication of the degree of uncertainty concerning the city's energy balance than evidence of improved energy efficiency in Moscow.

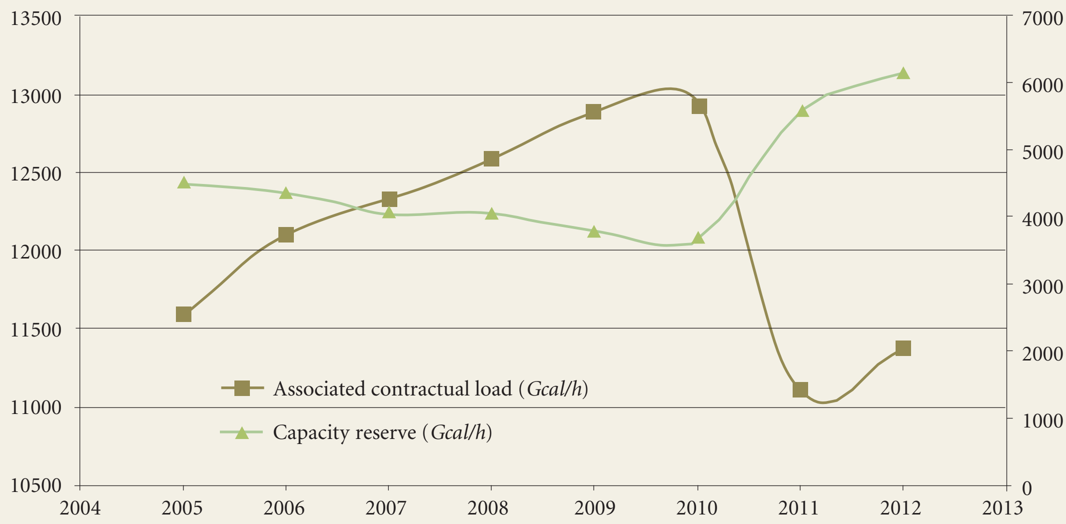
Lack of Intrapreneurs

Research has shown that district cooling is economically justified [*Shimoda et al.*, 2006; *Chow et al.*, 2004; *Lozano et al.*, 2010; *Deng et al.*, 2011]. It enables

[9] Gazprom's core business is associated with the extraction and sale of gas, which potentially conflicts with the need to improve the energy efficiency of heat supply.

[10] Order of the Ministry of Regional Development 'On Confirmation of the Rules to Establish and Change (Review) Thermal Loads' no 610, dated 28.12.2009.

Figure. 3. **Associated contractual load (left vertical axis, *Gcal/h*), reserve capacity (right vertical axis, *Gcal/h*)**



Source: MIPC's annual reports for 2005–2012.

heat which would be otherwise lost to be used for cooling. District cooling can potentially be a breakthrough innovation for the domestic heating industry for several reasons:

- Such systems, including sources of cooling, cold water network (there are water supply systems, but in this case water is not a cooling medium and the conditions are different), and residential equipment have not yet been developed in Russia; there are no long-standing practices for selecting and maintaining equipment, no guidelines for feasibility studies, etc.
- Designing district cooling systems represents a complex engineering challenge, involving a switch from the heat delivery control by water temperature variation (which is widely used at present in Russian heating water networks) to the heat delivery control by flow rate variation, the construction of cold water storages integrated into the cooling water network, operating water networks in a different temperature range, different water treatment conditions, etc.
- There may be an opportunity to combine production of electric power, heat, and cooling (trigeneration) and use new methods for unit commitment optimization.

As early as 2010, the Moscow government considered ways to introduce trigeneration [*Ivanov*, 2010]. Priority was given to centralized generation. Despite the fact that MIPC has indicated its interest in cold supply [MIPC, 2013b; The Presidential Council for Economic Modernization and the Innovative Development of Russia, 2012], construction dates have still not been set.

It is well known that adopting breakthrough innovations is hampered by certain barriers [*Ford et al.*, 2014]. For Russian companies, these barriers are accompanied by problems associated with the specifics of the national and regional economy, and the business environment in particular. For MIPC, unlike other European players, building a centralized cooling supply system is a more difficult organizational and engineering challenge. Unlike the Finnish Helsingin Energia, MIPC does not have sufficient CHP electricity-generating capacity to power vapour-compression chillers for a district cooling system. *Free cooling* can hardly be used in Moscow. For this reason the company will likely be forced to focus on relatively low-efficiency absorption refrigerators or buy electric power for vapour-compression refrigerators, which may be quite expensive.

Such difficulties are frequently resolved through the organization of a new 'start-up' business entity or division (*intrapreneurship*, *corporate new ventures*) [*Byers et al.*, 2011]. In this case, the core business is isolated from the risks and there are greater opportunities for innovative pilot projects to be flexibly managed. However, major Russian companies have little experience in organizing such start-ups.

MIPC managers are wary of launching a large-scale district cooling programme. It is telling that Gazprom Promgaz, which developed a detailed plan (approved by MIPC) for supplying heat and gas to the 'New Moscow'[11] area, makes only one reference to the district cooling system based on trigeneration. The plan states: 'It is planned to unite the generating facilities in new areas with power substations to create a unified consumer power supply system, Energokompleks, with the additional ability to produce cooling (trigeneration), if needed.' [Government of Moscow, 2014].

Subsidies and the lack of competition

When a company enters a new market with an innovative product or service, the first customers share the risks associated with the early adoption of this product. This is especially true in the energy industry, which requires large-scale investments and thus, switching from one cooling technology to another may be very costly. District cooling is no exception.

The conquest by district heating companies of untapped markets is inhibited by their weak connection with customers and insufficient flexibility in their interactions with them. For example, customers must contact the companies and submit a request for a 'technological conjunction' with the heating water network which may be a time-consuming and laborious process. District cooling is a new field for Russia — no single player in this market is close to even having a local monopoly. Players must prove their competitiveness and fight for customers, but the Moscow district heating companies have not demonstrated their intention of doing so. Yet interaction with customers itself could benefit from innovations already tested in other industries or abroad [*Mattsson*, 2008] in areas such as organizational flexibility, customer relations strategy, remote services, etc. [*Nandakumar et al.*, 2014; *Edward, Sushil*, 2013; *Eapen*, 2009; *Peppers, Rogers*, 2011; *Eid*, 2013]. However, development in these areas is slowed by several circumstances.

Customer relationship management is naturally driven by the competitive pressure and a customer's decision to buy from the company which finally generates its revenue. In Russian district heating this connection is distorted. Unlike European practice, Russian district heating companies are systematically subsidized.[12] This condition is determined by Federal Law 'On the Heat Supply' no 190-FZ, dated 27.07.2010, which spells out the principles for regulating tariffs. Article 7 of that law states that the tariffs should be affordable. Article 7 also requires local governments to ensure sufficient financing for heating systems. Article 3 stipulates the foundations of the state policy, including the develop-

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[11] The 'New Moscow' is a colloquial name of a group of newly established Moscow districts.

[12] To cite just a few examples, we will mention the Decree of Kursk Regional Administration 'On the Process for Providing Subsidies to Organizations Providing Heat, Cold and Hot Water, Water Disposal, and Solid Household Waste Recycling (Disposal) Services, to Compensate for a Portion of Income Not Received Due to the Application of State Regulated Prices (Tariffs) when Rendering Services to the Public' no 1140-pa, dated 26.12.2012; Decrees of the Government of Moscow 'On Confirmation of Prices, Rates, and Tariffs for Housing and Public Utility Services for the Public' no 1038-PP, dated 30.11.2010 (revised 14.12.2010) and 'On Confirmation of Prices, Rates, and Tariffs for Housing and Public Utility Services for the Public for 2014' no 748-PP, 26.12.2013.

ment of centralized heating supply, balancing the economic interests of heat suppliers and customers, and providing consistent and non-discriminatory conditions for entrepreneurial activities.

Subsidization and monopolization distort the incentives, which are supposed to reflect the actual costs of heat production and distribution. Competitors who do not receive this support face increased price pressure. As a result, the state is accumulating inefficiency, hampering partnership between service providers and customers, and thereby incurring systemic risks. Indeed, regulation in the energy industry is itself a potential risk [*Peterson, Augustine*, 2003; *Sweeney*, 2002].

In Finland, priority is given to promoting competition: a centralized district heating operator is one of the market players, with whom local heat producers may compete [Finnish Energy Industries, 2013]. Thus, in Finland there is no counterpart to the aforementioned Russian law 'On the Heat Supply'. In Russian practice, the centralized model is emphasized, which complicates the district heating's transition to market principles. Certain restrictions and regulatory documents have been imposed. For example, the 'Rules for the Organization of the Heat Supply System in the Russian Federation' (Approved by Order of the Government of the Russian Federation no 808, dated 08.08.2012) stipulate the procedure by which the status of sole heat supplier is conferred. A sole heat supplier may revoke the contract cancellation option for a customer if the supplier unilaterally considers that the corresponding disconnection in the water network may have a negative impact on other customers (paragraph 32 of the Rules).

In 'New' Moscow, as well as in other regions, given the amount of heat losses in water networks and the depreciated equipment, versatile solutions based on modern condensing boilers may prove efficient, at least when competing with boiler plants. However, paragraph 2.3 of the Government of Moscow Decree no 1508-PP 'On the City of Moscow's Heat Supply Plan for the Period up until 2020 with Identification of Two Stages in 2010 and 2015' states that 'decentralized heat supply sources shall be used in exceptional cases approved by the City of Moscow's Fuel and Energy Department, or as emergency or backup sources.'[13]

Russian district heating systems are less efficient technologically and economically than their best foreign counterparts. For this reason, local small-capacity heating sources based on highly efficient cogeneration plants seem entirely commercially viable as innovative solutions [*Pehnt et al.*, 2006; *Parker*, 2009; *Pilatowsky et al.*, 2011; *Praetorius et al.*, 2012]. However, artificial administrative prohibitions must be revoked for them to spread. Liberalization of the Russian gas market and incentives for utility companies engaged in small-scale distributed generation of heat and power are capable of making a positive contribution.

Innovation in district heating companies' strategies

Knowledge management

The key underlying element of technological innovations is knowledge management. To this day, a significant portion of Russian infrastructure companies' documents — from thermal and hydraulic diagrams to information about equipment's operating modes — remains undigitized and stored on paper. Even if some information has been digitized, there may be no standard procedure for accessing it. Information exchange is not only problematic in IT but also in organizational dynamics: collaboration between specialists and managers of different levels, especially if they are not direct subordinates, has not been developed or formalized. Similar problems persist in many large Russian en-

[13] Available at: https://www.mos.ru/documents/index.php?id_4=118398, accessed 17.06.2014.

terprises — tech companies, industrial and infrastructure companies, utility enterprises, and others.

The development of knowledge management systems at companies focused on innovations must incorporate procedures widely accepted in the scientific community: peer review, collective decision-making and appraisal, etc. There are definitely not enough seminars, conferences, and workshops. Of course, there must be a reasonable balance between transparency and business interests (including protecting intellectual property). However, at present a closed mindset and non-transparency dominate in this field in Russia.

Finally, the transition to market principles in an area as complex as the energy industry requires consistent optimization of production facilities and distribution systems using appropriate analytical methods, which is impossible without consistent knowledge management programmes. An example of such an optimization is the calculation of the optimal load allocation *(unit commitment problem)* [*Wood et al.*, 2013; *Tagare*, 2011; *Catalao*, 2012; *Soliman, Mantawy*, 2012]. Such a calculation is also relevant to thermal loads [*Sakawa et al.*, 2002]. Load allocation in Russia's district heating has not been analyzed at this level, even though it has significant innovative potential.

Collaborative networks as the basis for technological innovations

The way innovations are developed and adopted in enterprises is changing fundamentally. They are starting to engage customers in the search for innovations. The R&D process is becoming more diversified and more specialized [*Chesbrough*, 2003]. At present, it is impossible to gather all the required specialists in one organization because they are affiliated with many organizations and there is often no need for their full-time labour. Many innovative companies are becoming open: consequently, they have a growing number of ties to external partners and contractors and pioneering activities are becoming interconnected.

General Electric (GE) is an example of this trend. For a decade it has allocated an average of approximately 4.3 billion USD to research and development (R&D) per year, which exceeds the average annual budget for the Russian Academy of Sciences for the same period. GE initiated an open innovation program [*Bingham, Spradlin*, 2011; *Möslein*, 2014]. It is aimed at technological crowdsourcing and mobilizing external contractors who specialize in key technologies such as 3D-printing.

The term 'network' is not coincidental. The interactions of R&D participants are similar in structure to traditional information networks [*Scherngell*, 2013; *Prahalad, Krishnan*, 2008; *Tidd et al.*, 2005]. Scholars today are vigorously studying innovative network processes [*Grosfeld, Roelandt*, 2008; *Prause, Thurner*, 2014]. According to Nabil Sakkab, a senior vice president at Procter & Gamble (P&G), the future of corporate R&D is network structures for collaborative work, uniting 99% of researchers [*Tidd et al.*, 2005]. P&G has a research budget comparable to GE's, and one of its most important principles is to 'Connect and Develop.' Similarly, Bosch leader Franz Fehrerback is confident that his company 'will expand its work in research networks with other firms' [*Dutta et al.*, 2009].

A 'closed innovation' model was practiced 30–40 years ago by many companies famous for innovative success but nowadays seems obsolete.[14] Under these conditions, small firms that lack GE's massive R&D budgets but are trying to implement innovative solutions are essentially left no choice other than to develop their own 'innovation network.' Georg Weiers notes that more and more new

[14] PARC Research Facility (Xerox) is a good example of the 'closed' approach at that time.

solutions are coming into a company from outside and engineering research is increasingly distributed across collaborative networks. This trend accelerates development speed and reduces risks and expenses which are redistributed across the entire network [*Weiers*, 2014]. By contrast, by closing the innovation process, a company assumes the corresponding risks. Furthermore, 'external' innovative activities should not preclude internal developments. It has been demonstrated that conducting internal corporate R&D simplifies the implementation of external innovations [*Hervas-Oliver et al.*, 2011].

In this context, managing distributed developments acquires special importance. People are actively studying these practices abroad [*M hring et al.*, 2014] but not yet in Russia, especially regarding interactions with foreign partners; that affects the implementation of R&D.

Another significant factor impacting the efficiency of distributed innovative developments is the ability to engage a large number of experts and consultants — companies and individuals — especially for a feasibility study of industrial and technological projects. Developing collaboration with multiple partners at a proper level is a managerial challenge which includes knowledge management and the development of an IT infrastructure. DuPont asserted its global leadership in R&D due to a distributed network for collaborative scientific and engineering work [*Boutellier et al.*, 2008] while keeping the focus on the distributed IT infrastructure which provides tools for distributed collaborative R&D teams. It saves financial and time resources because there is no need to reorganize R&D divisions under new programmes. Otherwise, significant expenses would be required to support employees' international mobility.

In Russia, the usual practice is based on the principle of 'doing everything ourselves', which leads to an extreme concentration of research and development activity within a single organization and weak specialization, and few R&D centres, thereby further weakening competition. The current level of competition does not correspond to the amount of financing allocated by companies for innovative development. As a result, market power is shifting from the company to its R&D contractor. Several major corporations are often forced to invest in the same limited pool of R&D projects, i.e. in effect they have to compete for a contractor.

The Russian market for innovations is in acute need of competition. In the long run, this problem may be solved through systematic development of scientific organizations and their collaboration with technology companies. Involving foreign innovative firms and applied research centres in Russian innovative projects would bring a quick positive effect.

Conclusions

Innovations in Russian district heating are chiefly evolutionary or incremental. The innovations are often based on introducing technologies whose effectiveness has been proven through many years of operation abroad. Moving forward with breakthrough solutions, even if they have proven their effectiveness at leading global companies and are supported by federal and regional authorities, encounters significant obstacles in Russia. These obstacles include inflexible corporate management, including when interacting with customers, and inexperience in creating internal corporate startups and managing risks in the early stages of R&D.

The technological gap results in increased costs when assessing innovative projects' investment attractiveness. Excessive costs are critical for the development of new infrastructure that has significant initial fixed costs, as in the case of district cooling.

Recommended measures to support the innovative development of district heating can be split into institutional and corporate recommendations. The first group concerns stimulating competition in the heat supply market and creating a stable legal and investment environment. The second group calls for technological modernization, development of long-term corporate strategies that include investment programmes, systematic analysis of the best international practices for innovative development, and the formation of partner networks involving foreign innovative, consulting, and research centres.

The example of Moscow demonstrates that energy companies' strategic development in the past decade was focused primarily on mergers, not innovation. The capital's horizontal mergers of the 2000s and subsequent vertical mergers were performed based on administrative considerations. As a result, business processes and cash flows were largely streamlined but the European level of productivity was not achieved. The creation of a single vertically integrated entity in Moscow's energy industry has limited the ability to develop alternative heating systems. The tariff policy and subsidies in combination with regulatory restrictions on alternative heat supply technologies essentially neutralize the incentives for companies to implement innovation policies. Multiple reorganizations in Moscow's energy sector resulted in the domination of short-term planning, while long-term strategic planning is virtually non-existent.

Experience has shown that centralization does not guarantee simplicity in the interactions between the main entities of Moscow's energy industry. As an example, consider the cash deficiency caused by the seasonal variation in MIPC's thermal load and the particulars of purchasing heating capacity from Mosenergo.

Many large Russian companies tend to follow the 'closed innovation' model where R&D activities are concentrated within an organization. In contrast, the predominant trend demonstrated by the major technological leaders abroad is clearly the opposite. Innovative engineering solutions are developed in broad, often international, collaborations which make the development more efficient and less risky .

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Science

Performance-related Pay in the Russian R&D Sector*

Mikhail Gershman, Tatiana Kuznetsova

Strengthening the motivation, quality and efficiency of researchers' work is a pressing issue in all countries pursuing active science, technology and innovation policies. One way to address this challenge is by introducing flexible remuneration mechanisms which are country-specific yet still share certain basic principles such as a relationship between compensation and research productivity. Improving R&D workers' remuneration is particularly urgent now in Russia given researchers' low salaries in many areas of science (particularly considering the complexity of their work). To address the problem of compensation for researchers, new policy measures have been adopted since 2012.

This paper presents new evidence from Russia's scientific community — researchers, managers of R&D organisations, and government representatives — collected via a survey and focus group discussions on the desirability and efficiency of the current remuneration policy. Although most members of Russia's scientific community do not question the necessity and relevance of the government's 'efficient contract' initiative in the R&D sector, its implementation has had a more mixed response. The authors analyse the reasons and effects of this controversy.

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performance-related pay; research evaluation; efficient contract; remuneration; R&D sector; S&T policy; research productivity; Russia

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Raising the productivity of the R&D sector and improving the mechanisms of state support are important goals of many countries' state science and technology (S&T) strategies [OECD, 2012a, 2013]. Designing effective and flexible remuneration systems that recognise the complex, creative and intellectual nature of scientific work is a challenging issue. Policy-makers are addressing the problem with performance-related pay (PRP) schemes[1] [OECD, 2005]. The objectives of PRP schemes are to increase scientists' motivation, research quality and productivity. There is evidence that introducing PRP systems on a large scale has positive effects for remuneration and for science overall [*Hasnain et al.*, 2012]. However, there is also much evidence pointing to the ambiguous, and sometimes negative, effects of introducing PRP schemes in various areas of social policy. The PRP concept adopted by many countries in the 1980s and 1990s (for example, in education and healthcare) was later heavily criticised. Only a small proportion of civil servants were motivated by such schemes [*Marsden*, 2004, 2010; OECD, 2005, 2012b]. Of course employees worked hard to get a higher salary; however, the nature of the work (how interesting it is to them) and career prospects were stronger incentives [*Eckartz et al.*, 2012; *Ederer, Manso*, 2013]. Other studies have reached similar conclusions regarding the role of intangible incentives for researchers in Russia [*Gokhberg et al.*, 2010].

Mechanisms and criteria to remunerate researchers usually have a distinct national flavour. For example, Germany and Colombia measure researchers' performance using specific (occasionally quantitative) criteria [*Huisman, Bartelse,* 2001; *Altbach et al.*, 2008]. Other countries, such as the USA and Canada, take advantage of different levers to strengthen motivation and increase productivity. In particular, the institution of tenure track largely eliminates the need to apply specific productivity measurements: a chance to get a permanent professorial position becomes a better motivation than monetary incentives. However, to get this a researcher must demonstrate first-rate scientific results [*Chait*, 2002, 2005].

There are other mechanisms as well. For instance, Switzerland adopted a three-tier system in 2006 which provides a small basic salary, an annual increase based on experience, and bonuses which vary depending on researchers' performance. In reality, each tier consists of many grades with specific rules for upwards promotion. Sometimes, the regular package of employment benefits includes certain performance bonuses. In the USA, the introduction of PRP systems started at the management level, while in France and Canada PRP schemes are extended to lower-level rank-and-file positions as well [OECD, 2005].

Various remuneration mechanisms used in different countries can be classified into five groups: European, North American, South American, Russian (or Chinese), and Mixed [*Altbach et al.*, 2012, 2013; *Huisman, Bartelse*, 2001].[2]

The mechanisms predominant in European countries have complex hierarchic relations, a focus on long-term contracts[3], and guaranteed salaries provided by the state which strictly regulates the whole process. For this group, it is typical (but not compulsory) to categorise researchers as civil servants, who have an effectively pre-determined career development remuneration scheme. The second model (North American) involves relatively less state influence, with the academic community playing an active role in determining the criteria and indicators to allocate remuneration funds. The South American model is still emerging: its key features are hard to distinguish because of the variation in economic and technological development across countries in the region, but in

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[1] The 'efficient contract' term initiative, which has been widely implemented in Russia in recent years, is similar to PRP [*Kouzminov*, 2011].

[2] This rough, much aggregated categorisation may be of more value to highlight some basic principles of remuneration and evaluation of researchers' work cross-nationally than as a classifying tool.

[3] Although recently there have been tendencies to employ more researchers on short-term contracts, especially at the junior level in the UK [Science is Vital, 2011].

most countries specific remuneration requirements are included in national and foreign research grants, which account for a substantial share of research funding.

The Russian (or Chinese) model is determined by i) rigid remuneration schemes with low basic salary (basic rates); ii) numerous formal productivity criteria that are often implemented voluntarily and opaquely; iii) low academic mobility with a persistent disjuncture between science and education; and iv) social networks and contacts playing a significant role in career development and appointment to highly paid positions. Finally, the mixed model combines different features of the models described above and is relevant, for instance, for some Eastern European countries.

Russian science today is noted for tensions between the state and society in terms of desired outcomes in the quality of R&D output and the contribution of S&T to economic growth and improving the well-being of citizens. At the same time, the R&D sector itself has numerous problems such as low prestige of the scientific profession, the relatively low level of researchers' salaries compared to other economic sectors and other countries, outdated infrastructure and facilities, the rising average age of R&D workers, and outflow of talented scientists [*Gokhberg et al.*, 2010, 2011].

Three quarters of Russian R&D organisations are currently state-owned, with nearly half (47%) of them fully government funded and controlled [HSE, 2014, pp. 29–33]. The majority of such organisations consume a large share of public resources show poor results, and are not competitive enough to operate under market laws. As in other countries, Russian public research organisations (PROs)[4] are under pressure to adapt to changing innovation dynamics including increased competition for key resources (especially highly skilled personnel) and changing priorities of public research and innovation procurement. Unsurprisingly, PROs are the key target for many reforms in the Russian R&D sector although the sector's size means implementing such reforms is not a quick or painless process.

The government could use a variety of tools to manage PROs' research focus and performance in terms of both quality and relevance.[5] In 2012, the Russian government adopted several national policy documents to improve the development of S&T in terms of productivity and scientific output, including measures to improve the remuneration of researchers employed by public research institutions (PRIs) and universities. The new system aims to i) increase researchers' salaries to at least 200% of the mean wage in the regional economy by 2018[6]; and ii) introduce PRP mechanisms that regularly evaluate researchers' productivity.[7] Although this remuneration reform is already under way, the scientific community lacks awareness about the reform's main components and mechanisms. In particular, the optimum ratio between basic salary and incentive bonuses, the criteria to evaluate researchers' performance and the extent to which an increase in researchers' remuneration could affect their productivity remain unclear.

Reflecting on the ongoing debates in Russia, this paper discusses the potential merits and drawbacks of implementing a PRP system in the R&D sector. We argue that a large-scale transition to the new remuneration scheme could be inefficient without completing institutional reforms in the R&D sector. Several important issues should also be considered when designing a PRP scheme, such

[4] Here we refer to public research organisations (PROs) which include public research institutions (PRIs) and universities.

[5] Practically, performance-based contracts and competitive funding mechanisms for PROs have been more widely used than measures to improve incentive structures and remuneration schemes at the level of research teams and individuals [*Arnold et al.,* 2007; *Guinet,* 2012; OECD, 2013].

[6] Presidential Decree 'On measures to implement state social policy' no 597, dated 07.05.2012.

[7] Government Order 'Program to gradually improve the remuneration system in public budgetary institutions for 2012-2018' no 2190-r, dated 26.11.2012.

as providing a decent basic salary; interpreting research productivity more widely to include researchers' scientific, educational, and administrative responsibilities; and allocating R&D funding directly to research teams.

Methodology and Data

The basis of our study is comprised of empirical data collected by the authors through a survey and focus group discussions in 2013.

The survey covered homogenous groups of public R&D organisations. They included institutes of the State Academies of Sciences (SAS)[8], universities (including national research universities[9]); and PROs belonging to ministries and other government agencies, including public research centres (PRCs).[10]

The sample was designed to have an approximately equal number of managers and scientists representing the major groups of the above listed organisations. In total, the survey got responses from nearly 1500 managers (heads of organisations and research divisions) and researchers. The two questionnaires (for managers and researchers) each contained approximately 40 questions divided into two main blocks:

i) Factors influencing researchers' motivations;

ii) Organisational practices of researchers' evaluation and remuneration; respondents' opinions on the current government policies.

In addition, the authors conducted 5 focus groups to analyse a wider range of issues.[11] Focus groups are considered an efficient technique for collecting and classifying diverse kinds of expert information.[12] The expert-participants not only discussed recent government initiatives and more general problems associated with the development of national S&T potential, but also suggested ways to boost research productivity. Three separate focus groups were held with representatives from i) government agencies; ii) managers of PROs and universities; and iii) leading researchers. We ran separate focus groups to allow the participants to express their opinions freely. 8–12 experts participated in each discussion group, which ensured sufficient diversity of opinions and still enabled the participants to have interactive discussions.

Discussions focused on the following issues:

- Factors affecting researchers' loyalties (hierarchy of values, financial and non-financial incentives, prestige of the profession);
- Work organisation and remuneration (job description, workload, work planning, control by management, etc.);
- Research productivity;
- Institutional factors affecting research productivity;
- Government policies and instruments to evaluate research productivity.

In the next section, we discuss the most important and interesting findings from the survey and focus group discussions.

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8 The study was carried out before a recent law enacted on September 2013 which merged the three previously separate academies (focusing on medicine, agriculture, and the sciences in general) into one body (Federal Law 'On the Russian Academy of Sciences and the reorganisation of the state academies' no 253, dated 27.09.2013).

9 The status of 'National Research University' is enjoyed by 29 Russian universities with strong research capabilities. This group of universities receives vast public support in the form of additional funding from the federal budget.

10 Public research centre (PRC) is the official public status that has been assigned since 1993 to PRIs and universities which possess a unique research and experimental base, talented research staff, and internationally-recognised scientific results. As of 2014, there are 48 PRCs.

11 For more information on the focus group discussions, see [*Gershman, Kuznetsova*, 2013].

12 On the methodology and practice of focus groups, see [*Bloor et al.*, 2001; *Johnson*, 1996; *Krueger, Casey*, 2009; *Belanovsky*, 1996].

Main results

Remuneration mechanisms

As already noted, many countries emphasise providing decent compensation to researchers with strict performance-related requirements for hiring and promotion [*Altbach et al.*, 2012]. In Russia, however, low basic salaries and insignificant differences between pay grades remain. This situation does not help attract talented younger researchers and retain experienced professionals, which hinders the renewal of the R&D sector. Most Russian experts who took part in the focus groups believed, therefore, that the government should primarily focus on raising basic salaries, which means increasing core funding for PRIs and universities [*Gershman, Kuznetsova*, 2013].

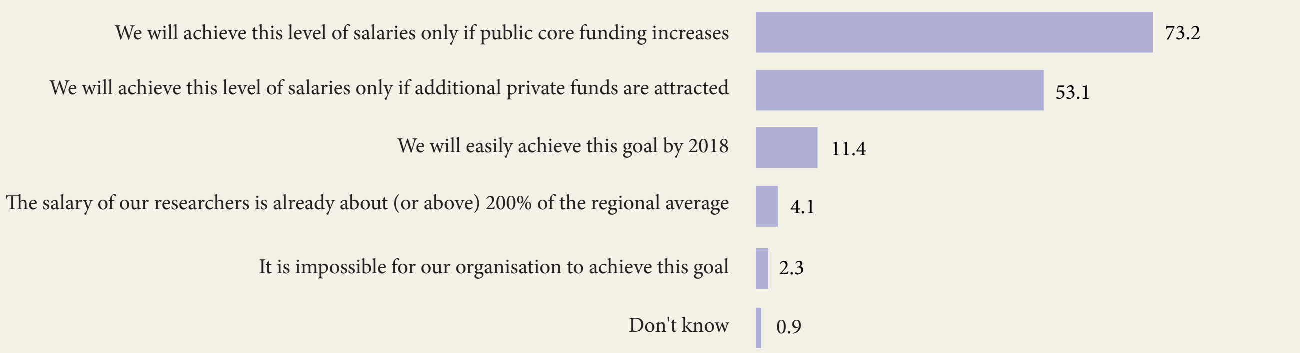
Figure 1 shows the distribution of PROs' managers' opinions concerning the actual potential to increase researchers' salaries. At the time of the survey, only 4% of the surveyed organisations were close to achieving, or had attained, the target increase in researchers' salaries, set by Presidential Decree no 597, dated 07.05.2012 (see footnote 6 above). Only about 11% of respondents are positive they will be able to reach this goal. The majority of managers (73%) think that this target is unachievable given the available resources; 53% of surveyed managers, meanwhile, believe that attracting extra non-government funds seems to be the more urgent matter. PROs' managers think state (institutional) funding to their organisations should be raised by about 160% and non-government investments by 140% to increase researchers' remuneration. These estimates suggest that without structural reforms, remuneration targets put too much pressure on the federal budget.

During the focus group discussions, the participants suggested the following funding scheme: research teams or organisations which receive public funding (in any form) should first provide a decent level of basic salary to retain personnel. The remaining funds (if any) should be used to reward good performance and for other purposes. To support the highest qualified staff, the experts in the focus groups recommended creating a few high-paid permanent positions as well as 'guest' positions for talented researchers from other regions or countries.

An important issue which requires serious consideration is who should receive the funds. Research teams could receive the funds directly or the host R&D organisations could receive the resources and subsequently allocate the funds between teams of researchers. At present, the second approach for public fund-

Figure 1. **Prospects for raising average salaries of researchers by 2018, according to PROs' managers(as a percentage of respondents picking each option out of total number of respondents)**

Question to PROs' managers: Please estimate the real prospects of raising the level of salaries of your researchers up to 200% of the regional average by 2018 (sum of answers is more than 100% as more than one option possible)



Source: authors' calculations based on data of Institute for Statistical Studies and Economics of Knowledge, National Research University — Higher School of Economics (henceforth HSE ISSEK).

ing of R&D predominates in Russia.[13] While international experience suggests that both these models are viable, almost all participants of our focus groups agreed that remuneration funds should be allocated and managed at the level of research teams.

Prerequisites for increasing salaries

On the whole, introducing efficient contracts in PROs would mean researchers could earn salaries comparable with the private sector. This would help markedly improve their living standards. As a result, many scientists — including younger researchers — would for example then be able to get on the property ladder by taking out a mortgage.[14] At the same time, raising researchers' salaries would be risky without also tackling other critical issues (increasing individual productivity, completing institutional reforms, etc.) Specifically, increasing researchers' salaries relative to other sectors of the economy could lead to an additional inflow of university graduates and workers from other industries into the R&D sector (as happened incidentally in the USSR in the middle of the 20th century). However, such an inflow of personnel in itself does not automatically improve the situation; on the contrary, the quality of R&D might deteriorate [*Gokhberg et al.*, 2011]. Thus, the new remuneration mechanisms should not only guarantee a reasonable salary but also be a method of selecting the best researchers through assessing their performance. This selection could be made through researchers' performance assessment. In addition, workers who do not meet the evaluation criteria should be transferred to alternative positions or subject to dismissal.

Linkages between remuneration and productivity

The experts confirmed the importance of linking remuneration to productivity. However, they felt that appropriate incentives could be effective only if other measures were introduced in parallel, namely provision of modern equipment, improvement of working conditions, and designing adequate performance criteria.

In particular, a widespread worry among the focus group participants was that as researchers' productivity is hard to measure, any evaluation system would turn into a profanity or just a formality, while the emphasis on quantity of academic publications might negatively affect their quality. Researchers might end up being concerned with only meeting formal targets. Other risks voiced by the experts include more (occasionally unreasonable) demands for salary increases, an outflow of highly skilled workers, and an influx of under-qualified people who are mainly motivated by money.

Nevertheless, the vast majority of the survey respondents agreed that to increase individual and group productivity, the current remuneration system should be changed in combination with other factors (Figure 2).

Rank-and-file researchers stressed the importance of purchasing new scientific equipment and materials (62%) and raising basic salaries (57%). Over half of respondents (51%) emphasised the need to work harder which suggests that the R&D sector could be more productive — including by introducing PRP systems (44%). The distribution of respondents' answers confirms that current funding is not enough to make these mechanisms efficient: the need to receive more research grants and expand both public and private financing was mentioned by 50% and 44% of researchers, respectively. This corresponds to what managers of PROs felt about the real possibilities of raising staff salaries (Figure 1).

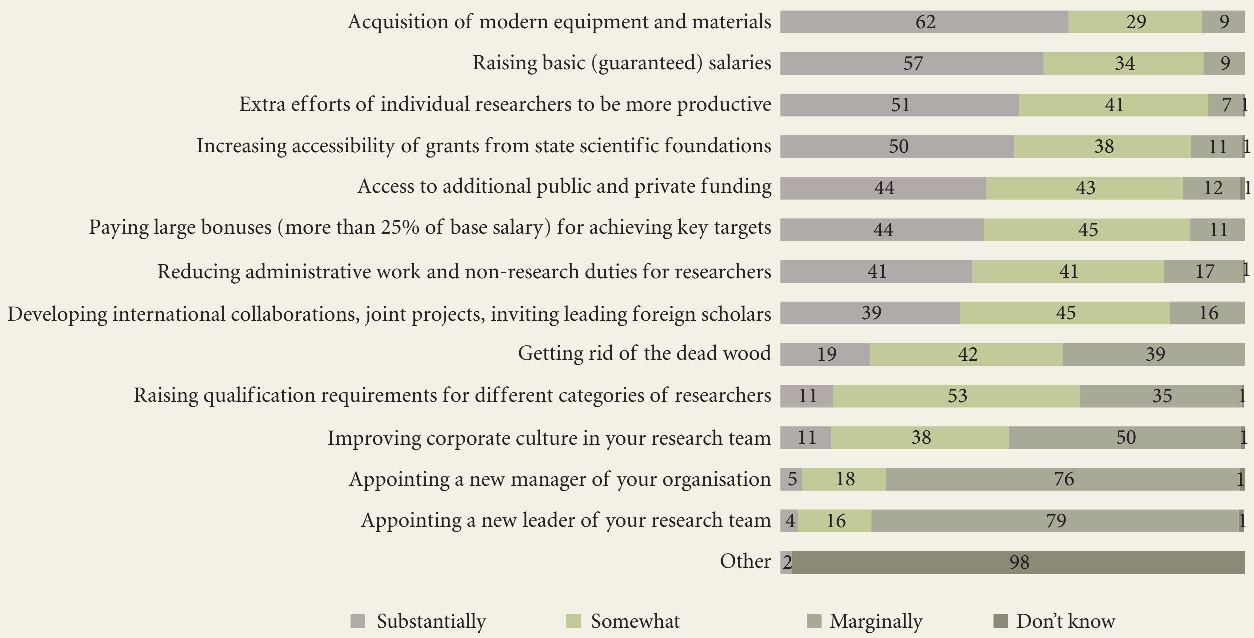
Another way to make researchers work more productively is by reducing their administrative responsibilities and allowing them to focus on science (41%).

[13] The newly established Russian Science Foundation (RSF) is an exception to this trend, as it allocates grants directly to research teams (see http://www.rscf.ru/).

[14] Low geographic mobility of researchers is an important factor hindering the development of science [*Gokhberg, Meissner*, 2013]

Figure 2. **Measures to increase research productivity, according to researchers (as a percentage of respondents picking each option out of total number of respondents)**

Question to researchers: To what extent may the measures listed below increase research productivity in your organisation?



Source: authors' calculations based on HSE ISSEK data.

Finally, taking part in international research networks and bringing leading foreign scientists to Russia was considered significant by almost 40% of respondents. Interestingly, getting rid of the 'dead wood' (inefficient researchers) was only seen as an important way to boost productivity by about one fifth of respondents (19%). It is probably because in Russia (and in the USSR) PROs' institutional funding is allocated on the basis of the previous year's payroll.

These findings provide more clear evidence that switching to a new remuneration system cannot be limited to an automatic pay raise (including guaranteed salary) and would be largely pointless without taking into account other important factors.

Criteria and measurements

Overall, experts think that it is impossible to design universal evaluation criteria due to the large variety and specific nature of branches of science and the peculiarities of PROs. For example, researchers' work is organised differently in the State Academies of Sciences, PRCs, industry-specific institutes, and universities. Therefore, the specific parameters of remuneration and evaluation criteria should undoubtedly differ by organisation.

In addition, there are more fundamental challenges. PRIs and universities typically produce goods (such as research papers) whose quality can only be reliably assessed by professionals [*Altbach et al.*, 2008; *Gassler, Schibany*, 2011].

The survey shows that 40% of managers would welcome more stringent hiring and promotion requirements (meaning more tough evaluation criteria) to improve researchers' skills and productivity. However, the exact indicators and the values which should be applied for the criteria remain a subject of fierce debate.

The participants of the focus groups agreed that the number and quality of publications remains the best measure of research productivity (with certain disciplinary-specific exceptions). Although the number of publications in highly ranked journals is an exceptionally important criterion, it should be supplemented with other indicators especially when making administrative decisions (Figure 3). For each knowledge area, specific publication and citation indicators should be used alongside additional academic productivity indicators [*Kahn et al.*, 2009].

The experts believed that using only international databases to evaluate Russian researchers is unacceptable in principle given that these databases may be inaccurate (as shown in Figure 3, 23% of survey respondents shared this idea). Several emerging systemic problems cause some concern, despite the growing popularity of such bibliometric indicators.

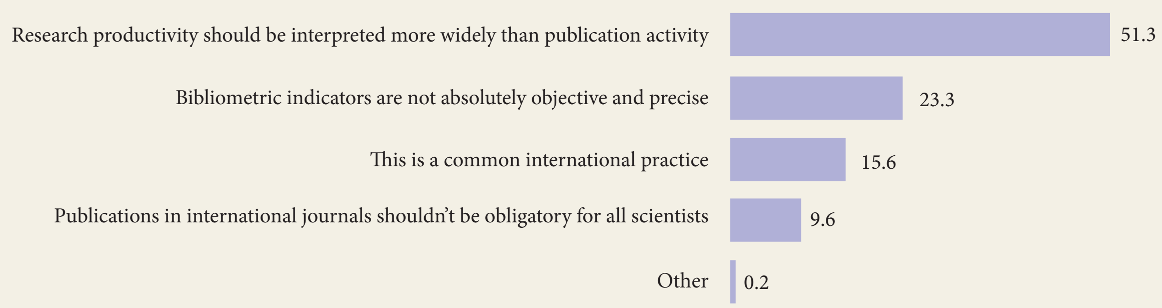
In the first place, we observe a recent tendency to overestimate the significance of bibliometric (and other scientometric) indicators in measuring scientific productivity without integrating these indicators into a more comprehensive framework that would account for the specificities of various areas of science. A consequence of the growing demand for bibliometric indicators is the relatively new but widespread global practice of paying for publications in some international, indexed academic journals without proper peer review. In addition, powerful lobbying groups exist around high impact scientific journals. As stated above, the blind use of journal ratings for evaluating researchers' work can negatively affect the quality of research [*Rafols et al.*, 2012].

In 2012–2013, many national debates took place in Russia about making changes to the regulatory and legal framework for PRIs' evaluation procedures. During these debates, certain attempts were made to exclude the indicator for the 'number of publications in Russian scientific journals' from the list of productivity indicators given the low quality of many of such journals.

However, according to many experts, publications in Russian journals (and their weighting when evaluating research productivity) are important to scientists who investigate particular domestic issues such as language, culture, and history. Issues dealing with internal Russian problems may be of little tangible interest to foreign readers but it is important to develop those branches of science, to train staff and future researchers, and to preserve cultural traditions. It is worth noting that Russian researchers also face certain objective barriers hindering their international publication activity. These include specific features of certain research fields, a shortage of relevant materials and data, and insufficient financial incentives. Other significant barriers that are more of an individual nature include: lack of experience and skills in academic writing, lack of international contacts and insufficient knowledge of foreign languages. These problems set the agenda for future reforms in Russian science.

Figure 3. **Researchers' opinions on the practice of evaluating research productivity by the number of highly ranked publications (as a percentage of respondents picking each option out of total number of respondents)**

Question to researchers: Which of the following statements do you think most precisely characterizes the practice of evaluating researchers by the number of highly ranked publications?



Source: authors' calculations based on HSE ISSEK data.

Given the above, it is strategically important to raise the quality of domestic scientific journals and help them to be included in international citation databases. This would undoubtedly contribute to the overall growth of Russian science, increased collaboration, the application of new knowledge to industry, and more distribution of knowledge to wider and younger audiences. Russian-language publications may be considered less important compared to international ones, but ignoring them would not only be unwise, it would be harmful.

However, some participants in the focus groups were inclined towards introducing 'strict' criteria of R&D productivity based mainly on international publications in high impact factor journals. This reflects the significant diversity of the Russian scientific community and the convention of occasionally adopting international experience uncritically. Scientific productivity can also sometimes be better measured with the whole team working on a particular problem, rather than by using individual contributions by specific team members.

Types of activities and working time structure

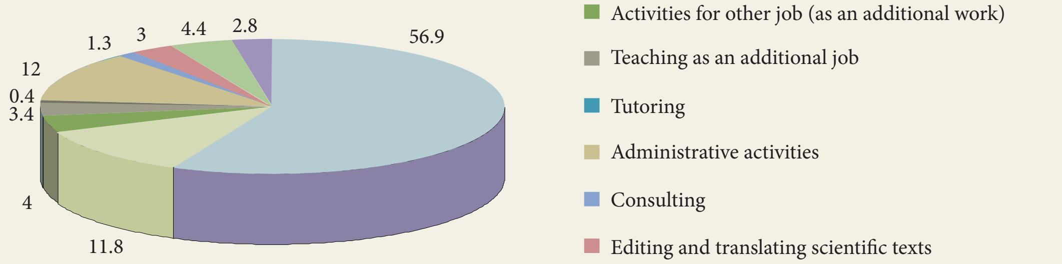
One of the important factors lowering the efficiency of standardised R&D productivity measuring systems (based on bibliometric indicators) is the variety of activities that researchers have to undertake (Figure 4).

It is not uncommon in Russia that certain responsibilities (planning and coordination of work, dealing with suppliers, etc.) are delegated to particular staff members during a project, which distracts them from their main work. Managers must be able to evaluate and reward such administrative activities performed by employees in addition to their research. According to the survey results, these extra administrative responsibilities account on average for at least 12% of researchers' working week. Another example is teaching. For staff of Russian universities' research departments, these responsibilities are by definition not a priority. On the other hand, educational activities have a higher priority for teaching staff which encourages them to reduce their research-related responsibilities.

Yet another important issue is the evaluation (and remuneration) of peripheral research that often take up a large proportion of working time. These consist of writing long reports with many formal requirements for government agencies and other customers or preparing finance statements required by funding agencies. Very often, such activities dominate the researcher's timetable (although researchers usually consider this work as an integral part of their main job, see Figure 4). It is simply impossible to avoid doing such work because researchers have to take on many projects to earn an adequate salary.

Figure 4. **Time structure of researchers' average working week (%)**

Question to researchers: Please say what proportion of your working time in a typical working week is spent on the following activities



Source: authors' calculations based on HSE ISSEK data.

Researchers' low basic salaries in Russia, as well as a lack of equipment and reliable data, affect the allocation of the time they spend working. Small salaries are offset by consulting activities, private tutoring, and other activities.

Therefore, despite researchers in Russia and other countries in theory spending almost the same amount of time on research, foreign scientists might have a time advantage.[15] Improving the provision of technical infrastructure, strengthening scientific data bases, and a reasonable reduction in the reporting requirements for research grants and targeted programmes would go some way toward making Russian researchers more competitive. In addition, it would make sense to provide a legal right to a year-long sabbatical after six or seven years of continuous research work, as is customary in many countries and as used to be the case in certain research fields in the USSR.

Institutional and organisational context

As already mentioned, measures to increase researchers' productivity should be accompanied by a package of institutional and legal changes which are often not directly related to S&T. Institutional and financial issues in the R&D sector have remained a subject of fierce debate for over two decades [*Gokhberg, Kuznetsova*, 2011]. Here, we only note the subject of restructuring the network of R&D organisations. According to the experts of our survey, in certain fields up to 90% of research teams work inefficiently, and many of them have no chance to improve their practices. For instance, in biomedicine, the experts felt that only 450 out of almost 4000 laboratories were productive. The 'empty corridors' problem in PROs still exists, although the solution is quite obvious.

Increasing remuneration on its own, which of course would be welcomed by researchers, is hardly likely to improve the overall situation in Russia's PROs. A significant increase in scientists' wages without wider systemic changes may even be a disastrous policy. It would not help to get rid of the 'dead wood'. Instead, these inefficient researchers would then have to be paid higher salaries.

Institutional reforms should be combined with a radical modernisation of R&D infrastructure (including premises and equipment), which has deteriorated significantly since the fall of the Soviet Union. The 'sticking plaster' approach is not conducive to solving accumulated problems.

Awareness of government policies

The issue of public awareness of government S&T policies has several facets in Russia [*Gokhberg et al.*, 2010, 2011]. Public awareness reflects the quality of policies, which should be modified in a timely manner based on constant feedback and interaction with the research community and specific targeted groups. On the other hand, this information is important to the stakeholders in the S&T sphere — PRIs and universities — who strive to increase their productivity under specific limitations.

Our survey data show that overall Russian scientists are largely passive, even about issues that directly affect them. 16% of managers in PROs and 36% of researchers only learned about the changes to remuneration mechanisms from the survey questionnaire. This seems to be rather surprising given the extent of lively public debates and the wide media coverage. Researchers employed by universities, which are ahead of PRIs in terms of transitioning to an efficient contract system, were the best informed.

Public authorities should clearly make more efforts to publicly disseminate information about planned reforms in S&T policy.

[15] However, this hypothesis still needs further testing.

Discussion and conclusions

Our analysis leads us to conclude that a rapid transition to a PRP system without simultaneously undertaking much-needed institutional reforms would be inadvisable. The government and most of the Russian scientific community both agree that reform and a performance-based remuneration system are needed. However, it is first necessary to address the systemic problems. Regular business processes should be restructured so that researchers do not have to carry out irrelevant responsibilities. To achieve this, various brokerage structures should be established to support R&D projects at all stages and eventually help with commercial application of researchers' ideas. Another option might be to set up structures to manage R&D organisations' property, equipment and facilities.

It is certainly necessary to continue increasing R&D expenditures, including raising researchers' salaries. However, that will have little effect if researchers do not see professional and personal opportunities for themselves in the future and if their profession's prestige remains low [*Austin, Larkey*, 2000; *Gokhberg et al.*, 2010]. An incomplete list of needed S&T policy reforms includes: restructuring the public R&D sector and identifying the best performing PROs; improving funding mechanisms; attracting non-budgetary funds; improving the work of public science foundations; upgrading facilities and equipment; implementing targeted measures to preserve disciplinary schools in science; and attracting young people to science.

Scientists' generally low enthusiasm towards the planned reforms may be explained by a general low level of trust in executive authorities by all strata of Russian society (especially by intellectuals), the conservative inertia of the scientific community and a desire to retain the status quo on the one hand, and by the *de facto* failure of previous attempts at reform on the other hand. Diverse approaches to researchers' remuneration carried out in the last 20–25 years led to scientific organisations selecting priorities unsystematically and often formally reporting on key performance indicators. Lack of transparency regarding allocation of performance-based payments and bonuses at PRIs and universities was also mentioned by our survey respondents as a current problem. There is neither external control over such payments nor clear and transparent policies within PROs. The circumstances described above make researchers more wary towards any remuneration reforms.

The survey and focus groups findings suggest that, overall, Russian scientists see introducing efficient remuneration mechanisms and increasing research productivity as key challenges. At the same time, they still view the government as the major R&D funder. The experts pointed out that research productivity should be interpreted more widely, to include researchers' educational, administrative and other responsibilities. The package of indicators used to evaluate R&D productivity should take into account the particular features of different scientific disciplines and areas of work. This conclusion must be taken into account when designing new remuneration mechanisms for researchers.

PRP mechanisms can only be efficient if a decent basic salary is provided (in some organisations this currently accounts for no more than 10% of researchers' final salary). Negotiating such imbalances could make the R&D sphere attractive again to talented young people as well as to experienced professionals. Such measures should be reinforced by suitable legislation.

It is really important to address the problems analysed in this paper associated with introducing new systems for remuneration as part of a strategic shift towards contemporary ways of organising and supporting science in Russia. The tempo of reforms must not slacken: it is crucial to show real results of the reforms by 2014–2016. This should include achieving the targets written in the main S&T policy documents.

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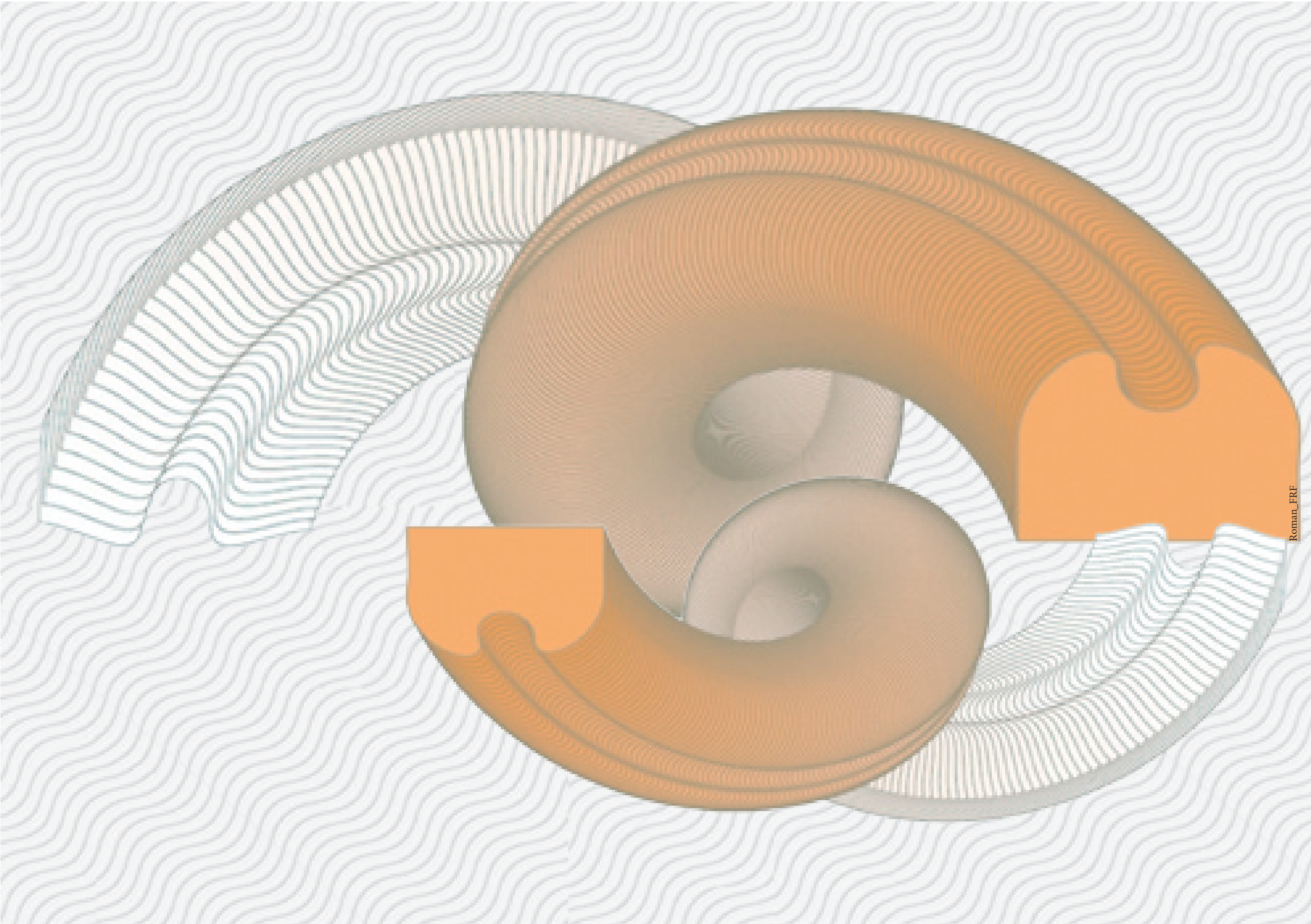
Commercialising Public Research under the Open Innovation Model: New Trends*

Mario Cervantes, Dirk Meissner



Being influenced by increasingly heightened global competition, companies are entering into partnerships with other companies, universities or public research institutions (PRIs) to leverage external competences to foster innovation. The search for partners and the management of cooperation itself are new challenges especially in terms of administering intellectual property rights.

The paper highlights recent trends related to knowledge and technology transfer from public research and education to industry. It considers legislative initiatives to target industry engagement, new technology transfer office models, collaborative intellectual property (IP) tools, and initiatives to facilitate access to public research results.

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Keywords

open innovation; technology transfer; commercialisation; public research institutes; universities; industry; co-operation

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The paper partially draws on cross-country comparative analysis of public research commercialisation practices [*Cervantes et al.*, 2014].

Recent years have witnessed intensified discussion on the role and function of actors in the Triple Helix Concept, sometimes also referred to as the Knowledge Triangle. This concept pays particular attention to the role of universities (also referred to as Higher Education Institutes - HEI) and Public Research Institutes (PRI) and their contribution to innovation. Against the widespread belief that knowledge and technology transfer activities might impact the academic work of scientists several studies found evidence that the engagement of scientists in technology transfer and commercialization activities does not have negative impacts on the quality and quantity of scientists' academic work. On the contrary, studies show that scientists who are actively engaged in technology and knowledge transfer, i.e. through patenting, also enjoy a high scientific reputation and in most cases do excellent scientific work [*Van Looy et al.*, 2006; *Carayol*, 2007; *Calderini, Franzoni*, 2004; *Breschi et al.*, 2006]. Evidence shows that post-invention, researchers' publication activity actually increases. Thus there does not seem to be a fundamental incompatibility between engaging in knowledge and technology transfer and producing new scientific knowledge.

There is also no clear evidence that patenting by researchers shifts the focus of research toward more applied work. Indeed, some evidence suggests researchers' patenting activity has strong positive effects on subsequent publication output as well as on their citation records [*Buenstorf*, 2009]. In engineering disciplines, high-profile scientists accounted for most of the academic patenting activity [*Meyer*, 2006]; Fukugawa shows that the quality of research staff has a strong influence on knowledge and technology transfer [*Fukugawa*, 2009]. Firms that undertook R&D on a continuous basis were more likely to have linkages with knowledge providers (HEIs and PRIs) [*Tether, Tajar*, 2008]. This implies that such links tend to complement rather than substitute the firm's own innovation activities, an idea expressed in the Open Innovation Model [*Chesbrough*, 2006].

In addition, there appears to be a positive relationship between using specialist knowledge providers and the level of the company's investment in innovation. A firm's expenditure on innovation is positively associated with the use of consultants and collaboration with private research organizations, but only slightly associated with using the public research sector [*Tether, Tajar*, 2008]. The weaker involvement with public sector research contrasts with the strong links between firm and consultants (and to a lesser extent private research organizations). The geographic focus of the company is another important dimension: companies with an international outlook have significantly more and stronger links with private and public research organizations than domestically oriented firms.

A challenging innovative business environment brings new problems to the surface, putting firms incapable of entering a new era on the edge while giving a chance for the most flexible companies to seize the new opportunities [*Nayyar*, 2006, *Teece*, 2007]. Inter alia, emerging new technologies arise and continue to show significant spillover effects on all areas of the economy, fostering the search for new forms of innovation activity [*Meissner*, 2012]. Consequently, it is assumed that HEIs and PRIs can lead innovation activities and wider collaboration based on their expanded networks. Accordingly, the complexity of knowledge and technologies increases and equally importantly, their availability and place of origin becomes more diverse. **Thus the commercialization of public research is a major goal of national science and technology policies and a key function of HEI and PRIs, alongside teaching, education and knowledge dissemination.**

Public research has been the source of many of today's innovations, sometimes as a by-product of basic research and sometimes without any prospect of a direct business application. Well-known examples are the techniques of recombinant DNA, the global positioning system (GPS), MP3 technology and

Siri, Apple's voice recognition technology. Data on scientific sources of many of today's nanotechnology, ICT and biotechnology patents provide additional evidence of the linkages between technological innovations and public research [OECD, 2013a].

Knowledge and research generated by the public research system diffuses through a variety of channels, including mobility of academic staff, scientific publications, conferences, contract research with industry, and licensing of university inventions. Nevertheless, much policy attention in OECD countries has centred on promoting knowledge transfer and spillovers through publications, the patenting and licensing of academic inventions, and the promotion of academic start-ups. More recently, these channels have been complemented by public-private partnerships, open science initiatives and entrepreneurial channels, such as student-based start-ups and related financing and mobility schemes. In the United States, for example, start-ups created by university graduates are more numerous and more dynamic than those founded by faculty and researchers.

The rationale for public support for commercialization has its roots in market and system failures. Weak commercialization of public research may have several sources [*Meissner, Zaichenko*, 2012]:

- asymmetric information, as potential users may not be aware of university inventions;
- risk or non-appropriability of the results of public R&D because ownership of university inventions may not be clear enough for industrial partners to engage in commercialization;
- demand for research may be weak as companies, especially SMEs, may not carry out their own R&D;
- coordination problems among R&D participants as firms' and universities' incentives may be misaligned because of their different missions;
- lack of finance for developing prototypes and demonstration projects that would help attract private finance for commercializing academic inventions.

A recent OECD report on new trends and strategies for the transfer, exploitation and commercialization of public research shows that this area has undergone much change and experimentation in recent years [OECD, 2013b]. There is evidence of a levelling off in key performance indicators of PRIs, such as academic patenting. At the same time, governments as well as universities and PRIs are seeking new strategies and approaches that can boost the effectiveness of PRIs in providing better services to fulfil their missions, one of which is engagement in commercialization activities which are increasingly requested by companies under the open innovation paradigm.

Managing innovation under the «open innovation model»

The basic principles of the innovation management process have not changed considerably over the last decades. What has changed and continues to change is the role and meaning of different sources of innovation and the increasing importance of some exploitation paths. At the same time, shareholders' expectations regarding companies overall performance have continued to increase. Their expectations now reflect a better understanding that innovation increases the value of their investment in the short and long term and that innovation is more than R&D. The management of interfaces — both company internal interfaces between different departments and functions but also interfaces to external organizations — becomes crucial. Doing so means that the company can screen and use external sources and capacities that are complementary to, and in some cases substitute, its existing internal competencies. As a consequence, innovative firms have to learn how to manage even more complex business processes, adapting solutions to the nature of markets and technological know-how (Table 1).

Traditional innovation management processes used to put special emphasis on R&D as the most important determinant of technology-based non-price competitiveness. Although different sources of innovation such as benchmarking with competitors, customer orientation and, to some extent, collaboration with suppliers, competitors and the public research base were recognised as useful, the management of the interfaces with these sources of complementary competences was not stressed a strategic objective. Within the 'open innovation paradigm', managing innovation now emphasises more strongly outputs regardless of the origin of the inputs to the innovation. It aims to efficiently generate and use knowledge and competences required to make new or improved solutions to solve known or unknown problems, and/or new ways to better satisfy needs. This includes products, processes and services traded on markets or delivered through non-commercial channels. In sum, innovation management is now about optimising all aspects of innovation processes and also providing the framework conditions (both in and outside the organization) conducive to innovation.

The widespread emergence of open innovation management approaches in companies offers PRIs and HEIs new roles and greater opportunities. Spillovers in different shapes are becoming ever more important when it comes to the generation of innovation. However a few critical issues need a closer look when discussing the potential contribution of the public research base to company innovation. First, it needs to be mentioned that the absorptive capacity of companies is crucial for open innovation. Second, public research has in principle other missions and duties to fulfil beyond innovation broadly defined. Third a key challenge for companies is identifying relevant new ideas developed externally, encouraging their creation and gaining access to them. Whilst some of these external ideas can be found and accessed without forging relationships (e.g. through the internet or social media platforms), it is more often the case that some form of interaction will occur such that both parties are aware of their involvement. Thus, rather than remotely recognising, reading and using knowledge produced by the science base, firms following open innovation strategies are more inclined to forge relationships with key scientists or research groups in the public science base, and to influence the work that they undertake. Companies hence recognise and understand potentially valuable knowledge outside the firm, assimilating valuable new knowledge through transformative learning and using the assimilated knowledge to create new knowledge and commercial outputs through exploitative learning.

Table 1. **Open innovation modes: technology and markets**

Markets	**Unfamiliar**	Joint venture Contract R&D	Venture capital Internal venture fund	Spin-off Sell
	Non-core	Joint development Acquisition	Licensing Equity stake	Venture capital Internal venture fund
	Core	Acquisition Internal development	Internal development Licensing Acquisition	Joint venture Contract R&D
		Core	**Non-core** **Technology**	**Unfamiliar**

Source: [OECD, 2008].

Since its inception, open innovation has become common practice among innovative companies. Building on the basic principles of open innovation, there are three major types of open innovation: 1) inside-out, 2) outside-in and 3) the totally open model. The **inside-out model** is relevant for only a few companies and is usually the exception not the rule. Companies following this model aim to increase their revenues by spinning out non-core in-house technology to the market. Outward licensing to partners reflects mostly opportunistic activities by global companies due to limited potential for developing the technology internally. Outward licensing is to both small and big companies. Companies following an **outside-in model** make use of a broad range of competences and sources for their innovation activities. Customers are the most relevant and increasingly important source of ideas. Often the focus is on lead users. Customers are also becoming more involved in the financing of innovation. There are some limitations since it is not always possible to define emerging needs. Universities and public research institutions are an important source for companies when it comes to hiring qualified staff and obtaining know-how; here PhD programmes and new hires are particularly important. Most companies focus on a small number of links, but of high quality, to specific universities or individual professors. Start-ups, consultants, and engineering firms are a less important source for innovators and are only screened opportunistically. Rarely do global players approach start-ups, consultants, and engineering firms directly so it is up to the latter to approach the big companies. Suppliers are gaining in importance as a source for innovation since they usually possess specialised capabilities in materials and R&D.

In a **totally open model**, companies systematically apply the inside-out und outside-in model and expand that towards competitors (i.e. coopetition). Coopetition, the combination of cooperation and competition, is used in precompetitive research, to create a new market, to share costs and risks or to set industry standards.

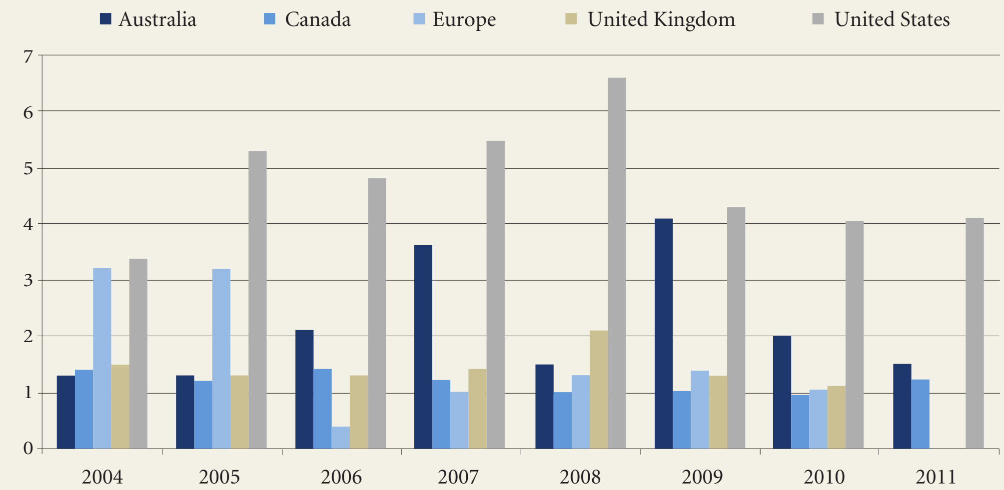
New research shows that companies' absorptive capacity is a crucial precondition for open innovation. Based on the expected role of scientific knowledge in the search process for innovation, as well as in creating innovations, and the inherent importance of externally generated scientific knowledge, it follows that firms enjoying enhanced access to university-generated scientific knowledge will demonstrate greater success in searching for new inventions [*Fabrizio*, 2009]. His analysis shows that patents in technology fields characterised by rapid advance will cite more recent prior art, e.g. scientific publications. In contrast, technology fields characterised by fast follow-on innovation and relatively rapid obsolescence of the knowledge base are characterised by quickly peaking distributions of backward citation lags with relatively low average backward citation lags. Patents relying on relatively older technology as patented prior art are characterised by a less peaky distribution with a higher average citation lag. It follows that the absorptive capacity of companies, expressed in terms of a company's internal capacity for basic research, has a significant impact on the uptake of state of the art and emerging scientific knowledge.

Responding to open innovation: commercialization approaches at PRIs and universities

Patent applications, licensing income and spin-offs as indicators of commercialization

Patents, licensing income and spin-offs are frequently used indicators to assess an institution's or a country's capabilities to turn public research into innovation. In terms of patent applications filed by universities in the US, the average annual growth rate fell from 11.8% (between 2001 and 2005) to 1.3% (2006–2010). PRIs experienced a negative growth of -1.3% over the latter period, compared

Figure 1. **Licensing income (as a percentage of R&D expenditures)**



Source: Authors' calculations based on data from Department of Innovation, Industry, Science and Research (DIISR) [DIISR, 2011, 2012]; European Commission [European Commission, 2012]; US and Canadian Associations of University Technology Managers (AUTM) [AUTM, 2009a, 2009b, 2010a, 2010b, 2011a, 2011b, 2012a, 2012b] ; Higher Education Funding Council for England (HEFCE) [HEFCE, 2009, 2010, 2011, 2012].

to 5.3% growth between 2001 and 2005. Data on invention disclosures (the first official recording of an academic invention, measured as number of disclosures per USD 100 million of R&D expenditures) show a slight drop on average from 2004–2007 to 2008–2011.

Numbers of university spin-offs have not significantly expanded either despite continued policy support in the United States. In the US, four spin-offs are created on average per year in one university[1]. The number of spin-off companies formed per USD 100 million of research expenditures fell on average in 2008 in large OECD countries, while the ratio stabilised in 2009–2011 to pre-2008 levels.

On the other hand, licensing income as a percentage of research expenditures has remained relatively stable in selected OECD countries and regions (Figure 1). Moreover, only a small number of universities account for the bulk of total licensing income. In Europe, 10% of universities accounted for approximately 85% of total licensing income.

While patents, licenses and spin-offs remain important channels for commercializing public research, other channels such as collaborative research (e.g. public-private partnerships), student and research staff mobility, as well as contract research and research staff consulting appear to be becoming more important; however, solid data are lacking. Evidence from the United States shows that recent graduates are twice as likely as the academic staff to create a business venture the graduates' spin-offs are also of the same quality [*Åstebro et al.*, 2012]. Similar results come from an analysis of Academic Enterprise Europe Awards finalists: the largest group of founders were doctoral students (38% of the 28 founders interviewed) [*Hoefer et al.*, 2013].

In addition, technological progress is transforming some of the traditional channels, especially those dependent on repeated personal contact and exchange of information. Virtual networks enable greater collaboration between researchers and industry in the exchange and sale of IP. Open access journals provide a complementary channel for diffusing scientific results, while open research data initiatives that make research available for further investigation or innovation represent a new knowledge transfer channel.

[1] Calculated on the basis of data from 157 universities

As a result of the importance of other channels and to better account for the impact of public research, universities and PRIs are now trying to devise new metrics and indicators: for example, student employment in funded projects, alumni in the workforce, services to external clients, and inter-sectoral mobility of doctoral holders.

Encouraging industry engagement by granting licenses on IP rights free of charge

One approach in promoting the commercialization of public research involves universities exchanging knowledge embedded in IP documents and contracts, particularly with industry. Industry-science relationships concerning IP rights have reached a critical point. Evidence suggests that universities pursue their IP negotiations with firms more aggressively than in the past.

The major issue of contention is on the value and income from IP and on overcoming the different perceptions of industry and universities. The University of Glasgow, for example, introduced the Easy Access Programme in 2010 to provide free access to university inventions on a royalty-free and fee-free basis. In March 2011, the UK Intellectual Property Office backed a proposal from the universities of Glasgow, Bristol and King's College London to develop a consortium of universities into the Easy Access Innovation Partnership. The University of New South Wales in Australia and CERN (European Organization for Nuclear Research), a major inter-governmental research facility, have also adopted versions of the Easy Access IP framework.

Legislative and administrative procedures targeting research and teaching personnel

As HEIs have some leeway with regard to national IP regulations and can develop their own, internal IP regulations and processes, some have experimented with alternate approaches. For example, some have decided to provide preferential treatment to academic staff and lecturers wishing to license the technologies they developed. Other HEIs allow their staff to establish new ventures, granting leaves of absence, or allow 'tenure clock stoppage' for academic staff, so that they can pursue commercialization activities. Some universities are considering taking into account the commercial track record of their academic staff when deciding on promotions to permanent positions (tenure).

HEIs in OECD countries increasingly face the issue of ownership of IP created by graduate students and other non-research or teaching staff who are engaged in R&D. In OECD member countries, graduate students and PhD holders account for a growing share of non-research or teaching staff carrying out R&D in universities. Owing to these changes and to avoid IP disputes between students and universities, the University of Missouri in the US established a policy in 2011 that generally allows students to own any invention made during their enrollment.

Mobility of researchers is an important channel for the circulation of knowledge. Programmes such as Belgium's 'Doctoris' programme and France's industrial agreements for training through research (Conventions Industrielles de Formation par la REcherche, CIFRE) are two examples of policies to foster mobility and the development of competences of doctoral students.

New forms and models of technology transfer offices

Increasing numbers of universities, PRIs as well as governments (of all levels) have discussed steps to invest or experiment with new intermediation structures. Most of these discussions centred on replacing or improving technology transfer office (TTO) structures and services, including but not limited to Technology Transfer Alliances (TTAs), internet-based models, for-profit models or approaches to vest some rights with inventors while maintaining university ownership (e.g. the Free Agency model).

Given the limited ability of mid-sized universities to generate enough income to cover expenses of their TTOs, some proponents argue that it may be more efficient to share services in the form of TTAs. In France, the French National Research Agency (Agence Nationale de la Recherche, ANR) has established a fund to create Technological Transfer Acceleration Companies (Sociétés d'Accélération de Transfert de Technologies, SATT) to reduce fragmentation of technology transfer services at the regional level. These companies are mainly owned by a consortium of universities and PRIs, and will assist in proof-of-concept funding and IP commercialization. To date, 11 such companies have been created across France.

Some HEIs have turned to or established privately funded TTOs for cost or efficiency reasons. These are institutionalized in the form of limited liability corporations. The rationale is that private agents might be better positioned to commercialize university inventions. In Israel the majority of TTOs operate under a limited liability model, partly or wholly owned by universities. In addition to a traditional TTO, Stanford University has established a separate wholly-owned limited liability corporation (Stanford OTL-LLC) to allow Stanford's TTO to act as a licensing agent for other universities.

Advances in ICTs have also permitted mechanisms that complement existing internal TTO structures through Internet-based platforms. The France Technology Transfer (FTT) platform, created by the French TTO association and the French National Innovation Financing Agency (OSEO), has been established to better showcase technologies developed by French universities and PRIs to the corporate sector.

Discussions in the US suggest a new model of vesting ownership with inventors but maintaining university ownership. In this case, researchers would be given the choice between their university TTO or an agent elsewhere (i.e. Free Agency model). However, many academics and practitioners question the usefulness of such an approach. Concerns include, among others, the limitations of adjusting TTO performance through competition, the potential capacity constraints of external university TTOs, regional and local economic development issues, overlapping interests and unclear payout schemes.

Collaborative IP tools

Some OECD countries have started to sponsor the creation of patent funds specifically for PRIs, either directly or through state-owned banks, which fund the acquisition of patent rights among other activities. Patent funds with a focus on PRI-generated patents have been implemented in France (France Brevets), Japan (the Life Sciences IP Platform Fund) and Korea (IP Cube Partners).

A large share of HEI and PRI patents remains commercially unexploited; neither licensed nor used internally, nor held for purely defensive purposes. Allowing preferential access to unexploited patents is one way of addressing the issue of 'sleeping patents'. The French National Centre for Scientific Research (Centre National de la Recherche Scientifique, CNRS) has established a programme called 'PR2 - Enhanced Partnership SME Research Programme', in which patents will be offered to SMEs on favourable terms.

The creation of standard licensing agreements has also become a popular instrument among HEIs and PRIs. For example, the United Kingdom draws up licensing agreements using the 'Lambert Toolkit'; Germany has model R&D co-operative agreements; 'Schlüter' model agreements exist in Denmark; and DESCA model consortium agreements are used in the European Commission's (EC) FP7 projects to address industry claims of difficulties in negotiating licence agreements with PRIs. Licensing agreements often involve 'model' technology cooperation agreements that limit the potential of IP-related conflicts and disputes.

Facilitating access to public research results

Access to public R&D results has become a key issue, reflecting increasing interest in improving the accessibility of scientific research findings in general, and in particular the results of publicly funded research. Institutional and private users often have to pay to secure access to this research. Fuelled by advances in ICT technologies, the most common policy instrument is the requirement to publish in digital format. As of 2013, the Canadian Institutes of Health Research (CIHR) mandates in its open access policy that all research papers generated from CIHR-funded projects must be freely accessible through the publisher's website or an online repository within 12 months of publication. New Zealand and Spain also require publication of publicly funded research results in digitised format in an open access repository. The Office of Science and Technology Policy (OSTP) of the White House in the US issued a policy memorandum in early 2013 for federal agencies that spend more than USD 100 million on research to make published research results and digital scientific data more accessible to the wider public.

Open access also requires an enabling infrastructure. The EC has supported the building of repositories and infrastructure through the Framework Programmes for Research and Technological Development. Projects implemented include 'Digital Repository Infrastructure Vision for European Research' (DRIVER), DRIVER II, 'Open Access Infrastructure for Research in Europe' (OpenAIRE), and OpenAIREplus initiatives.

Financing of public research based spin-offs

The financing of innovation from invention through to commercialization requires long-term capital commitments. New ventures (particularly technology-based public research spin-offs) face the liabilities of newness and smallness, which limit their access to resources such as financial capital.

Many HEIs and PRIs complement government funding for start-ups by setting up their own gap funding schemes, either fully funded or co-funded with institutional resources. Europe has around 73 university- and PRI-oriented gap funding funds. Typically, most gap funding programmes also provide business and advisory services, incubator space, market research and educational training. Examples include the Chalmers Innovation Seed Fund, the Gemma Frisius Fonds KU Leuven, and the Genopole 1er Jour fund.

While venture capital tends to attract most attention from policy makers, there are also additional sources of finance for research and commercialization such as IP collateral-based funding, angel investors, and crowd funding for research. There is an active ongoing debate surrounding the potential of crowd funding to alleviate the financing gap faced by research-based ventures. External corporate venturing activities, such as joint venturing, acquisitions and corporate venture capital (CVC), also constitute a potential source of financial capital and managerial expertise for public research spin-offs. Lastly, spin-offs seeking debt financing may find that their most valuable property for use as collateral is their trademarks, copyrights, patents or prototypes.

Researcher and innovators' soft skills for knowledge and technology transfer

A case study of Belgian collective research centres found that successfully transferring relevant knowledge and technology to the companies requires a critical level of internal R&D. Thus it is an absolute necessity to build the company's own absorptive capacity and complement it with external R&D [*Spithoven et al.*, 2010]. The level of absorptive capacity also determines the choice of the transfer relationship, e.g. the configuration of the relationship between companies and PRIs [*Oerlemans, Knoben*, 2010]. Thus, the most significant factor that determines a firm's choice about the relationship configuration is the level of internal resource use along with the scope of a firm's innovative activities. Hence a strong internal resource base allows a firm to be an attractive partner, enabling the firm to successfully utilize knowledge and technology produced by external research organizations.

Scientist profiles

Several studies show that scientists' engagement in technology transfer by no means has a negative impact on the quality and quantity of their academic work [*Shmatko*, 2013]. There does not seem to be a fundamental incompatibility between engaging in technology transfer and being academically productive. Inventing commercially valuable technologies comes with increasing research output over and above those associated with academic inventions more generally. Meyer found that, in engineering disciplines in particular, it was the high-profile scientists who tended to engage more in patenting [*Meyer*, 2006].

Conclusions

The rise of the open innovation model not only intensifies the internationalization of business R&D. Innovation is more than R&D and its more open process involves crossing geographical, institutional and disciplinary borders. Led by multinational companies, open innovation now engages all the other actors of innovation systems, including smaller firms, public research organizations, and customers. It challenges market actors, and especially innovators, to be flexible. They must reinvent their business model to survive the increasingly knowledge-based global competition.

However, it challenges government policies even more. Policies often have traditional approaches and instruments, which may not be most effective in maximising national benefits from globalised innovation markets and networks. The single most important response should be proactive: promoting all forms of linkages to strengthen national or regional innovation systems, with particular attention paid to SMEs. Another important objective should be to improve the framework conditions for innovation, including appropriate specialised infrastructure (for example, the system of public research) to be able to retain or attract increasingly mobile investments in knowledge and talented people.

Drawing on the open innovation paradigm, a recent OECD analysis of commercialization activities of public research found evidence that many OECD countries are reviewing their institutions and infrastructure that support the networks and markets for transferring and commercializing the results of public research. Traditional approaches and models now face considerable limitations. For example, the narrow focus on research and teaching staff as inventors, the natural/physical sciences and patenting/licensing; the apparent mismatch between the supply and demand of public sector knowledge; harder financing for new ventures; limited evidence and metrics for assessing changes, and a lack of benchmarking institutions and international comparisons. All these are barriers to successful interactions between relevant actors and initiatives at different levels. Given these barriers and ongoing changes in organizational structures, orientations, linkages and other factors, it is important to regularly take stock and understand the changes well. Governmental and institutional support for new models of commercialization will have to ensure — possibly through pilot projects — quality, participation and adequate rewards to all who contribute to the research and commercialization effort.

Innovative linkages are driven by the supply and demand for technology and knowledge. The existing interfaces for technology transfer are thus contingent on technology supply and demand (technological development) as well as on the framework conditions, and consequently change over time [*Kroll, Schiller*, 2010]. Systemic thinking on the evolution of innovation may imply that national innovation systems may be characterized by fragmentation and isolation. The main point here is that the often quoted domestically anchored co-evolution of actors in an innovation system will only happen if the interfaces of technology transfer are anchored nationally and are thus able to tie together the actors in question. However, such networks among domestic actors do not necessarily form innovative linkages even when actors are located in geographical proximity. Nevertheless, if science and market forces are free to move technology, then the supply of knowledge will match regardless of the geographical dimension. It appears that thinking in terms of national innovation systems is increasingly challenged by an approach towards an idea of networks, which are spread globally but increasingly interconnected. It thus becomes increasingly important for governments to understand the nature and extent of these networks, not least as there is growing concern by governments that academic research be relevant and accessible to industry [*Tether, Tajar,* 2008]. Traditional analysis of industry–science links usually ignores complementary sources of specialist knowledge such as consultancies and private research institutes. Such knowledge-intensive services (KIBS) are becoming increasingly important in creating and commercializing new products, services and technological processes. Given the structures of most innovation systems, such institutions should not be neglected as they complement the capacities of universities and other public research organizations.

In terms of future research, a relatively unexplored area is the role of current and former students as key actors in the exploitation and possible commercialization of new knowledge, particularly in universities. Acknowledging this role, understanding the driving factors, and the main barriers could prove a particularly fruitful direction for future research. In the same vein, evidence on the effectiveness and impact of financial instruments to support academic entrepreneurs (university seed funds, etc.) could help in the search for new financing mechanisms.

The question of how researchers are incentivized to participate in knowledge transfer and commercialization by their institutional environment could be another interesting avenue for future work. It would be instructive to further analyze informal contacts, consulting and collaborative research as these channels are important for industry. Understanding researchers' involvement in these activities requires knowing more about their mindset, motivations and competences, and the institutional culture and leadership in their workplace. Some evidence of these factors is available, yet future research at the individual and institutional level could improve policy-making. F

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