NATIONAL RESEARCH UNIVERSITY
HIGHER SCHOOL OF ECONOMICS

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MONITORING INNOVATION ACTIVITIES OF INNOVATION PROCESS PARTICIPANTS (2011: R&D ORGANISATIONS)

BASIC RESEARCH PROGRAM

WORKING PAPERS

SERIES: SCIENCE, TECHNOLOGY AND INNOVATION
WP BRP 06/STI/2013

This Working Paper is an output of a research project implemented as part of the Basic Research Program at the National Research University Higher School of Economics (HSE). Any opinions or claims contained in this Working Paper do not necessarily reflect the views of HSE.

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MONITORING INNOVATION ACTIVITIES OF INNOVATION PROCESS PARTICIPANTS (2011: R&D ORGANISATIONS)[5]

"Monitoring innovation activities of innovation process participants" is a project which has been carried out by the Higher School of Economics (HSE) for several years to promote monitoring and analysis of innovation issues in general, and on specific activities of its particular actors from a scientific research perspective. The project is aimed at accumulating empirical knowledge about the nature and types of interaction between various actors of the national innovation system. In 2009-2010 the study was targeted at manufacturing and service sector companies while the 2010-2011 study targeted at R&D organisations. The specific objective for 2011 was studying various aspects of applied research organisations' involvement in the innovation process (application of R&D results in the economy).

The study yielded the following results:

- A concept for monitoring R&D organisations' innovation activities was proposed, including operational definition of such activities;
- Survey programme and tools to monitor Russian R&D organisations were developed, including advanced methodological and procedural approaches as well as practical experience;
- Results of R&D organisations' innovation activities survey were analysed and compared with available statistical data; the collected data also allows to identify and systematise various factors and conditions affecting innovation activities of these organisations;

Eventually areas for updating the survey's concept and tools were identified.

JEL Classification: O31, O32, O33, O38.

Keywords: R&D institutions, public research institutes, S&T results, knowledge transfer, technology transfer, innovation, research management, innovation management, microdata, Russia.

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Introduction

Russia, like many other countries, increases efforts to develop more efficient innovation policies to provide well-grounded targeted support to actors in the innovation system. International practice shows that the most important stage of such policy development is the specialised complex monitoring and analysis of the behaviour of innovation actors, based on internationally comparable data, advanced analytical and methodological approaches and new data sources. This allows:

- toidentify problems, limitations, conflicts and development prospects (growth points) of national innovation systems (NIS) more precisely;
- to prepare accurate political recommendations and
- to evaluate correctly the efficiency of government regulation of the innovation sphere; etc.

In 2009 HSE conducted the European Manufacturing Survey (EMS) in Russia, and initiated two rounds of complex surveys of innovation activities in Russia covering over 2,000 manufacturing and service sector companies [Brödner, Kinkel, Lay, 2009; Kuznetsova, Roud, 2011]. Previously, no attempts were made in Russia to analyse the mechanisms of creation and dissemination of innovation based on advanced information sources[6].

In most of the developed countries, organisation and performance of the NIS is determined by the fact that all economic actors are involved in the innovation process in some way (corporations, small firms, research centres, universities, government authorities, non-profit organisations), and they are integrated into networks (partnerships) which are commonly at least partially actively supported by the government. An important (or sometimes the most important) actor are research centres and universities, which do not only generate scientific outcomes but, in close cooperation with the business sector, ensure their subsequent transformation into new technologies, research and technology-intensive goods and services. The government's role in this process is to create favourable economic, legal, administrative and other framework conditions conducive to the emergence of flexible and dynamic partnerships between these actors including

- the transfer of intellectual property;
- the distribution of profits generated from its application and
- the dissemination of knowledge, technologies, best practices and skills; advanced training; etc.).

[6] The survey samples are representative for the whole Russian economy, which allows to substantiate the assessments of innovation activities' efficiency made using advanced econometric, statistical and sociological techniques

In Russia the situation is quite different. Traditionally (e.g. in the USSR period) actors in the innovation system (such as universities, R&D organisations, the real sector enterprises) were in effect acting autonomously; their interaction was sporadic and didn't have a reasonable meaning in their activities; or, alternatively, such cooperation was artificially imposed by authorities. In result fragmented, unstable innovation chains evolved, which quickly collapsed when environment changed (in particular, after the breakdown of the USSR in 1991).

During the past 15 years all industries of the Russian economy were subject of major reforms (the most crucial of which were privatisation efforts), but with different pace and degree of radicalism. Manufacturing and the service sector were restructured most radically; private companies and non-governmental organisations became dominant in these industries. The education sector also was modernised, albeit not completely. The network of R&D organisations was least affected by the reforms. A significant proportion of them are still funded from the state budget[7], which implies serious limitations (financial, economic, organisational, property-related etc.) on their entrepreneurial activities, including innovation. This peculiar (and rather unique in the international comparison) legal framework is based on the right to manage government-owned property granted to the organisations; it implies strictly purpose-dependent, rigidly regulated legal capacity. All this limits the R&D organisations operations' efficiency in the market economy, and their cooperation with the real economy sector companies, including the "production" of scientific products for subsequent conversion into innovations, and respective commercialisation. For the same reasons the business sector's interest in science remains quite low: companies find it hard and unprofitable to cooperate with research organisations and universities, to invest in joint projects, etc.[8]

Today, while Russia is in the process of switching to an innovation-based economic model the existing situation becomes totally unacceptable. Even the low demand of the real sector companies for R&D results and new technologies in most cases is not fully met. This is one of the reasons which force industry to implement the extremely inefficient imitation model, with its weak knowledge generation component, low level of cooperation with other actors in the innovation process, orientation towards procurement of "embodied" technologies, etc. The result is the domination of "irregular imitators" in the Russian economy. It's no secret that that ultimately leads to growing technological dependency on foreign countries (including direct

[7] According to 2009 statistics, 47% of all R&D organisations were funded by the federal budget. Almost 13% were government-owned enterprises whose legal structure is generally believed to be extremely inefficient. Only about 27% of R&D organisations in the country have "normal" market forms such as corporations, limited liability companies etc. [Indicators of Science, 2011, p. 31]

[8] According to the results of the innovation activities survey conducted by the ISSEK HSE in 2009 only 16-18% of industrial enterprises cooperated with R&D institutions when they develop product or process innovations, less than 10% cooperate to develop organisation or marketing innovations.

economic competitors), and threatens national security [OECD, 2008; Gokhberget. al., 2011; Gokhberg, et. al. 2010].

Domestic approaches of reforming R&D organisations and research departments of universities (including promoting their active involvement in the innovation process) include a number of different often not interrelated or connected initiatives. They "broadcasted" rather more general decisions concerning the clarification of the organisations' legal status', increasing efficiency of government appropriations, and streamlining the composition and structure of the state sector (both in the economy and the R&D). In other words, these reforms essentially reflected only direct and indirect consequences (effects) of external measures on the R&D organisations and universities[9]. At the same time the limits, adequate forms and mechanisms, and expected results of R&D organisations' involvement in the innovation process are not at all obvious (or at least not specified in the legislation).

This problem hasn't been completely solved in foreign countries either. However, their legislation specifies the types of legal entities adequately to specific features and content of scientific research (and specifically designed for these activities) – which provides a variety of legal models for research, development and other related activities. In international practice, monitoring of research centres' and universities' activities is an important element of public policy. A very good example of such monitoring is surveying organisations – members of the scientific communities in Germany, and CNRS in France[10]. Monitoring here covers a number of aggregate indicators describing the quality, efficiency and productivity of such organisations, or of specific R&D projects. The relevant criteria in effect also cover the innovation sphere, though for a number of reasons (problems with adopting new statistical and organisational standards, specific features of organisations' declared functions and objectives, etc.) international examples of direct monitoring of R&D organisations' innovation activities remain relatively scant. In this respect the research being done in Russia is interesting not just domestically, but in the context of international comparisons.

[9] No radical improvement has been noted since the passage of the special federal law of 02.08.2009 №217-FZ "On Amending Certain Russian Federation Laws Concerning Establishment of Economic Associations by Research and Educational Organisations Financed out of the Government Budget, for Practical Application (Implementation) of Intellectual Activities' Results". Formally, the law contains certain important provisions extending R&D organisations' and universities' opportunities to take part in innovation process. At the same time the developers didn't manage to eliminate all barriers created by the budget-related laws. I.e. the problem hasn't been completely solved to all practical purposes.

[10] In the USA they survey organisations performing R&D in the course of projects sponsored by national agencies, NSF, etc. [Gokhberg, et. al. 2011].

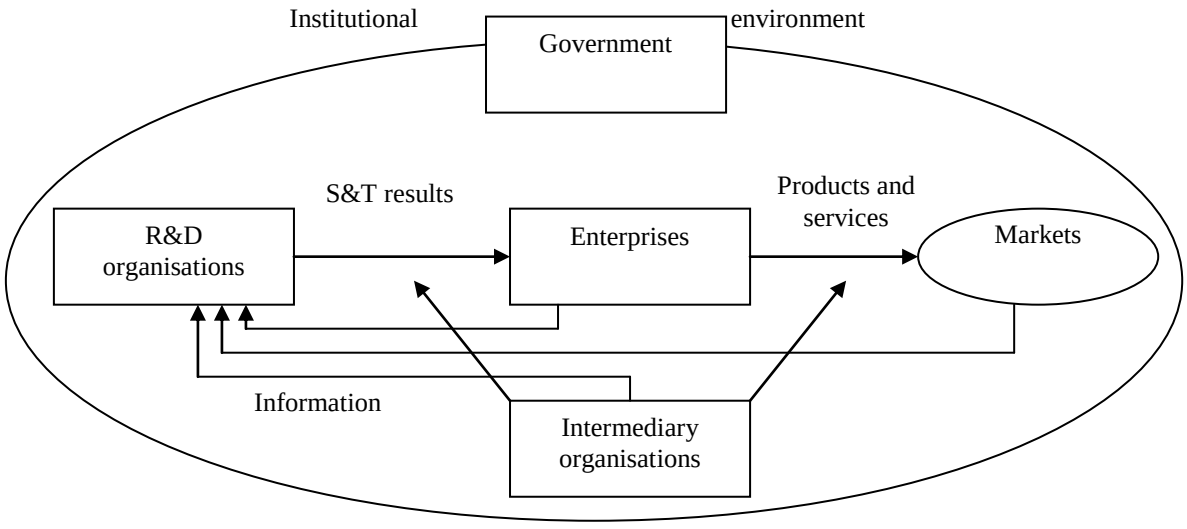
Monitoring R&D organisations' participation in the innovation process: the concept

Approaches to analyzing R&D organisations' involvement in the innovation process

In course of developing the concept for the survey, first the dual nature of R&D organisations' involvement in the innovation process (i.e. development of goods and services vs. creation of knowledge as a product) and the role of this process's creative component was determined.

Recent literature devoted to innovation activity research uses a broadly accepted terminology briefly described in the Oslo Manual [OECD, 2005] and in other related conceptual, methodological and procedural documents. For the purposes of this discourse, the innovation process is seen as a mechanism for creating added value in the course of production of goods and provision of services. In terms of R&D activities the most interesting outcomes are product and process innovations by industrial enterprises created on the basis of R&D results. In this case innovation activities of research centres can be studied in the context of transfer of their S&T results for application in the economy (see figure 1 below), particularly, by industrial companies. In other words, given this obviously simplified definition, activities of R&D organisations in the innovation sphere can be reduced to the process of transferring new technologies (developed taking into account enterprises' demand for them, the situation on the end products market, etc.).

Figure 1 – Simplified representation of R&D organisations' participation in the transfer of S&T results



The key factors in this model are the availability and efficiency of intermediary organisations which support the interaction between actors of the NIS, and the government's ability to set framework conditions for strengthening relevant links in the uniform institutional environment (legislation, government policy initiatives, etc.). Eventually the analysis of scientific literature

allows considering the above model ‘traditional’. In particular, in many countries where the R&D potential is mostly concentrated at universities, their third mission (after education and research) is technology transfer [Göransson, Brundenius, 2011]. The context described here matches the traditional linear innovations model [Godin, 2006][11].

At the early stages of organising and conducting the monitoring survey, 11 cases of technology transfer from R&D organisations into the real sector of the economy (and their subsequent industrial application) were analysed (in-depth interviews with top managers using a specially designed guideline). The results allowed to identify three main organisational forms of transferring S&T results: establishing a start-up company; financing R&D with funds provided by foreign customers; financing R&D with funds provided by state-owned corporations.

In most cases technology transfer was undertaken by the R&D organisations themselves. The key role in this process played knowledge and practical experience of the researchers including their commerce-related skills. In rare cases the role of innovation infrastructure institutions was noted (such as technological centres, technology commercialisation centres, etc.). the major barriers hindering technology transfer was the institutional environment or rather, its unfavourable nature most frequently quoted by the respondents.

The main drawback of this approach is the presumption that science is “subordinate” to creators of technological innovations. In other words, in this model the central innovation process actors are the real sector companies (primarily industrial firms) while R&D centres are supposed to generate knowledge as potential basis for future innovations.

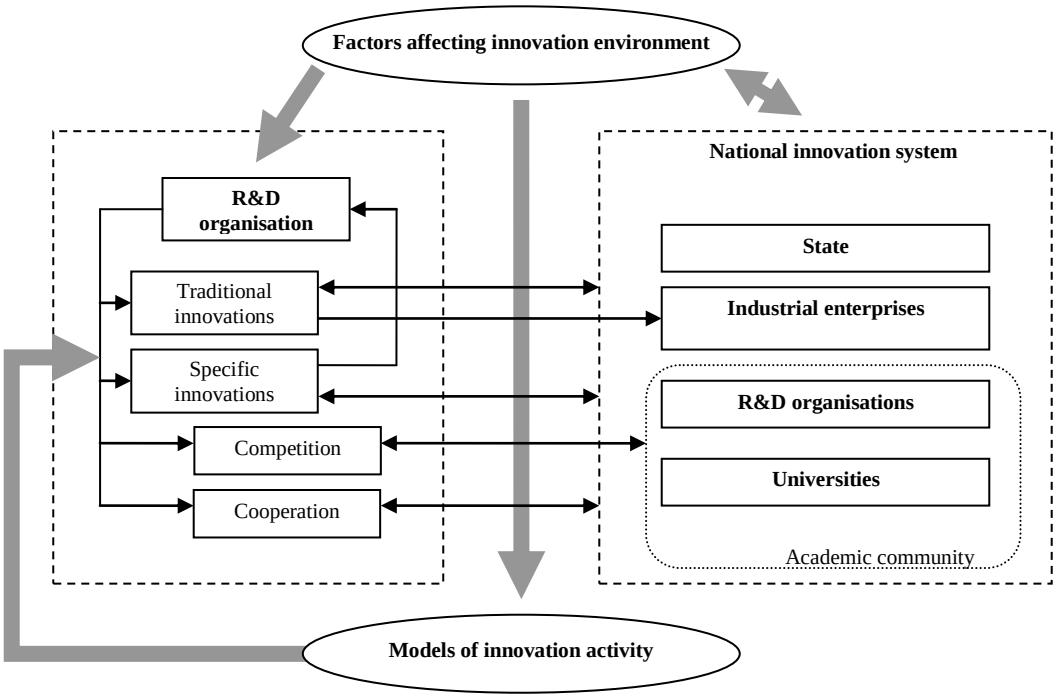
A more comprehensive approach to assessing the role of R&D organisations in the innovation process can be suggested on the basis of the social innovations theory [*Murray et al., 2010*]. In this case innovation in science is based on new ideas, concepts and ways to organise activities in the R&D sector, allowing to meet the whole range of the economy’s and society’s needs in the most efficient way. Descriptions of this approach can be found not just in the recent, but also in earlier studies, e.g. in the early 1970s, American economists became interested in new ways to organise research employed by industrial research organisations in the USA [Baker, Freeland, 1970]. Another example is the study of the former socialist countries’ R&D complexes’ adaptability to socio-economic transformation [Balazs, 1995] and the analysis of the application of new organisational forms and techniques at closed government-owned R&D structures given by Meng [1995].

[11] Существуют и более продвинутые подходы. В частности, заслуживает внимания функциональная модель национальной, локальной и отраслевой инновационной системы, предложенная британскими учеными [Hales, 2001].

The second (specific) approach is different primarily in considering R&D organisations as institutions creating their own specific products (knowledge, technologies, skilled personnel, finished products[12]). Their innovation activities are performed through the introduction of new ways to organise R&D, develop human potential, launch experimental production etc., which ensure efficient generation of final results. The main drawback of this concept is a certain autonomy (isolation) of the organisational model for the R&D sector within the NIS structure, lack of conjugation with specialisation and interaction of the institutions – participants of the NIS.

Either approach taken individually cannot provide a comprehensive description of the R&D organisations' developments as participants of innovation processes. Accordingly, it seems advisable to combine the two analysis foci which would adequately reflect the role of the R&D sector in the NIS while taking into account various complex processes happening within it (see figure 2).

Figure 2 – Development of combined models describing R&D organisations' participation in the innovation process



In this paper the second (specific) approach to innovation activities of R&D organisations was not developed in full, but was taken in mind while the internal characteristics of these organisations were analysed. Otherwise the pilot study would have been oversized and too

[12] Which are normally created at experimental or prototype production facilities or directly in laboratories.

complicated, in particular it would be difficult to develop an adequate questionnaire to cover both types of innovation activity at the same responding institution. However in more focused and problem-oriented research the second approach could be unfolded as equivalent or even dominant to the "traditional" one.

The concept of innovation activity in the R&D sector

Two forms of R&D institutions' involvement in innovation processes could be applied for analysis purposes: 1) general and 2) specialised ones. In the first case the R&D organisation is an institution with a particular function in the innovation cycle, more specifically – as a direct "supplier" of knowledge for subsequent generation (development) of product and process innovations in the economy. In the second case we can consider innovations related to research and development activities, and knowledge as the R&D institution's product. In this paper we do not develop a deep investigation of R&D sector innovation component in the evolution of innovation concepts since this topic is widely discussed in specific studies [Kotsemir and Abroskin, 2013].

Obviously the general analysis principles can be applied to a limited group of R&D institutions which specialise in specific technological areas. At the same time, specific innovations linked with organisations' research activities (specific type of economic activity) can be analysed for all R&D organisations (including institutions conducting predominantly basic research).

The generalised definition of innovation activities describes it as an activity which involves the transformation of ideas (R&D results, scientific achievements) into technologically new or improved products or services introduced to the market, or into new/improved technological processes or ways to produce (provide) services, applied in practice. Here we can refer to the OECD Oslo Manual as a "fundamental standard" [OECD, 2005].

The more narrow definition of innovation activities in the R&D sector can described it as the transformation of accumulated scientific knowledge, ideas and competencies into radically new or improved scientific knowledge (theories, techniques) applied in practice by the research community; new, more efficient ways and procedures for conducting R&D, adopted by research teams in their experimental and analytical activities.

Certain types of innovation which must be taken into account while studying the role of R&D organisations in the NIS (included in the analysis) also require specific definitions. It has been done in the course of the "Analysis of behavioural models of innovation process actors" project, which is being implemented in the framework of HSE Basic Research Programme. To a large extent, the definitions were developed on the basis of the broadly accepted concepts introduced in the Oslo Manual. The result is a two-tier system of definitions which used universally

accepted concepts to describe external activities of R&D organisations within the NIS structure, and specific concepts to reflect internal activities in one way or another connected with innovation. The paper also contains detailed analysis of the innovation environment in which R&D organisations operate.

Survey methodology

Main hypotheses

For traditional surveys of R&D organisations' participation in the innovation process a "standard" system of logical units and corresponding hypotheses was developed (see table 1) which served as the basis for subsequent development of survey tools. The structure is sequential, based on the logical units' representation in the questionnaire (or in the course of an interview).

Table 1 – Analytical blocks of the R&D organisations' (RDO) innovation activities survey

Hypotheses and their order (H)	Analytical blocks (B)	Indicators (I)
H-1 (order 3) Presence and nature of correlations between: 1) Factors affecting STRT (B-1) and the choice of STRT model (B-2); 2) Factors affecting STRT (B-1) and its result (B-3)	B-1 Factors affecting STRT	I-1.1. Characteristic of RDO
		I -1.2. RDO's human resources
		I -1.3. RDO's material resources
		I -1.4. RDO's positioning
		I -1.5. RDO's structural mechanisms for STRT
		I -1.6. Potential for informational interaction
		I -1.7. RDO's S&T groundwork
		I -1.8. RDO's connections with funding sources
		I -1.9. Self-assessment of negative factors and competition level (competitiveness)
H-2 (order 2) 1) Structure of STRT models (B-2); 2) Efficiency of STRT models (B-2) in terms of result (B-3)	B-2 STRT models (strategies)	I -2.1. Industrial positioning
		I -2.2. Qualitative positioning
		I -2.3. Choice of customer and end user
		I -2.4. Choice of STRT form
		I -2.5. Choice of support tools
H-3 (order 1) 1) Productivity of various kinds of RDOs, by B-1 and B-2; 2) Structure of factors affecting STRT productivity	B-3 STRT results	I -3.1. Positive results of STRT
		I -3.2. Negative results of STRT
		I -3.3. Importance of STRT results to the RDO
H-4 (order 4) Interconnection between the state of the S&T sphere and the STRT potential	B-4 Overall perception of the situation	I -4.1. Assessment of major S&T trends and the effect of the economic crisis
		I -4.2. Assessment of the RDO's development trends and prospects
		I -4.3. Efficiency of government regulation initiatives

* *RDO – R&D organisation (observation unit);STRT – S&T results transfer*

According to the methodological context described in the previous chapter, the combined approach to the survey was chosen. The survey' focus are R&D organisations' activities related to transfer of S&T results (technologies) and performance of relevant functions within the NIS. However, the organisations' internal resources and activities related to the creation and transfer

of new knowledge are also analysed – in accordance with the principles of the second approach to analysis of innovation activities in the R&D sector.

As the main hypothesis (H-3)[13], we test dependency of R&D organisations' productivity on the chosen model of transferring S&T results, and factors affecting it. It allows us to identify the most efficient technology transfer strategies (models), and the most favourable combinations of factors. The relevant questionnaire section also includes indicators such as results of S&T transfer (positive results with subsequent practical application, and negative results, i.e. those which didn't lead to practical application). The importance of S&T results' transfer (STRT) to R&D organisations is studied separately. To assess it, we use characteristics describing the organisations' development strategies, application of STRT targets, and whether or not the organisations employ strategic analysis of STRT (and they do, than to what extent).

Content-based structuring of the identified strategies (models) of STRT is performed on the level of the H-2 hypothesis. The relevant block of indicators includes characteristics describing the main elements of the strategies. They include organisations' industrial specialisation; selection of the niche to match the quality and novelty of the transferred technologies; criteria for selection of customers and users of the technologies; opportunities to use various public support mechanisms; etc. Industrial positioning is based on the customer companies' economic activities. Qualitative positioning of R&D organisations in accordance with the suggested approach is based on distribution of products developed on the basis of the organisations' S&T results, by novelty level (radically new; new for the manufacturer; modified). The respondents also specify the types of S&T product users (customers) they consider the most important, in the context of the existing administrative and organisational links. Forms of STRT include common ones (such as R&D services, patents, know how, industrial designs etc.) and less formalised (e.g. sale of equipment, project cooperation, exchanges of specialists etc.). Also noteworthy are various forms of government support used in the course of S&T results' transfer (subsidies, government programmes, support provided by various foundations etc.). Importantly, the structure of these mechanisms and division of quality control responsibilities for STRT are also taken into account.

The H-1 hypothesis determines the degree and the nature of various factors' influence over the choice of the STRT strategy. The corresponding block of indicators describes qualitative and quantitative characteristics of organisations' internal resources (including financial, material, human, organisational resources). Internal resources also include S&T groundwork, contacts and networking with potential partners, information and funding sources.

[13] Numbers of sections in the table reflects their "position" in the questionnaire.

The competitive environment is taken for each R&D organisation individually, as an external factor. In this block R&D organisations are characterised using such indicators as research field, balance of basic and applied research (and development), the share of innovative technological projects in the turnover, and the level of existing R&D groundwork.

Human resources are characterised through the functional structure of the research personnel and staff turnover. To assess material resources, basic financial indicators (internal R&D expenditures and their turnover) were used.

R&D organisations were positioned within the NIS on the basis of the innovation services they provide. Structural mechanisms of STRT are described by existing structural departments whose functionality enables these activities (e.g. technoparks, marketing services, etc.), or similar services provided by external organisations. The potential for informational interaction is evaluated through the analysis of sources of information on new technologies and innovative products, using relevant benchmarks. Special attention is paid to the accumulation of various financial resources. Here, the objects of analysis are the structure of R&D funding sources including funds made available through tenders and revenues from selling technologies, etc. [Perani, Sirili, 2008].

The respondents were also asked to build a distribution of three sets of factors, e.g.those hindering the creation of S&T results; factors hindering their transfer and application; and reflecting the level of market competition in the R&D results and ready-made technologies field.

The additional block of indicators is used to obtain R&D organisations' managers' opinions about the current state of the S&T field. Here the accent is put on the changes taking place in scientific research (in particular in the field the organisation specialises), and their effect on the organisation's current situation and development prospects. Special attention is given to evaluating the efficiency of various government policies which directly or indirectly are aimed at promoting research and supporting transfer of S&T organisations' results. The hypothesis for this block (H-4) assumes that there's a connection between the current state of the organisation in question (including its STRT strategies and their productivity) and the evaluations of the current situation in the R&D sphere, within the organisation's profile.

Survey programme and tools

The survey programme and tools were developed taking into account advanced methodological and procedural approaches of organising such surveys; the original approach of the analysis of R&D organisations as actors of innovation process suggested by the developers; and the practical experience of surveying the real sector's innovative enterprises in 2009-2010.

Developing the survey programme, "technical" and other characteristics of the sample were defined first of all.

- It was decided to survey initially at least 300, and subsequently at least 1,000 public organisations operating in the entrepreneurial segment of the R&D sector which includes all organisations whose main economic activity is connected with producing products or services for sale (except educational services). In particular it includes some of the organisations supervised in one form or another by the government, private non-profit firms, etc.
- The survey is based on a quota sample representative for the Russian federal districts proportionally to the number of R&D organisations located in their territories, and for the types of R&D organisations determined in accordance with the Local Classification of Activity Sectors and Corresponding Types of Organisations[14]. Moscow and St. Petersburg were treated as separate strata. The enterprises were selected for inclusion into the sample randomly. However, we couldn't get primary (quantitative) data for all organisations.
- Organisations engaged in technology transfer were identified on the basis of whether they reported any cases of such transfer during the three reporting years. "Technology transfer", itself, was defined as a process of transferring new technologies, individual technical solutions or other important R&D results by R&D organisations. Whether or not the organisation had results of such technology transfers, was determined through existence of completed business deals on selling or transferring S&T knowledge and experience; providing S&T services; applying technological processes; manufacturing products and providing services, with or without specific contracts signed by the parties.
- The survey format was interviews with heads of the R&D organisations or other competent staff members (deputy heads, academic secretaries). Two interview modes were used: personal "face to face" interview using two questionnaires (for better convenience, the interviewers gave the respondents a blank copy of the questionnaire, so it would be easier for them to answer the questions); and by email (sending over the questionnaire and various additional documents encouraging the respondents to fill it in).

[14] Organisation types included into the sample had the following codes: 4-9 (industrial research institutes; design and technological organisations; design and survey organisations; industrial enterprises; experimental bases; other).

Table 2 – Territorial distribution of the sample

	Federal District	% of the total number of organisations	
		Sample	Universal set
1	North-Western	4.7	3.3
2	Central	18.0	18.0
3	Volga	15.0	15.4
4	Southern	8.7	8.5
5	Urals	6.0	5.6
6	Siberian	11.7	11.5
7	Far Eastern	4.7	4.9
8	Moscow	21.3	22.3
9	St. Petersburg	10.0	10.5

The survey was conducted through formalised "face to face" interviews. The questionnaire (survey tool) includes about 50 questions on various aspects of R&D organisations' participation in innovation processes. The main representativeness criterion set in advance – the territorial coverage – was met with minimal deviations (see table 2). The distribution shows that almost a third of all surveyed organisations were located in Moscow and St. Petersburg.

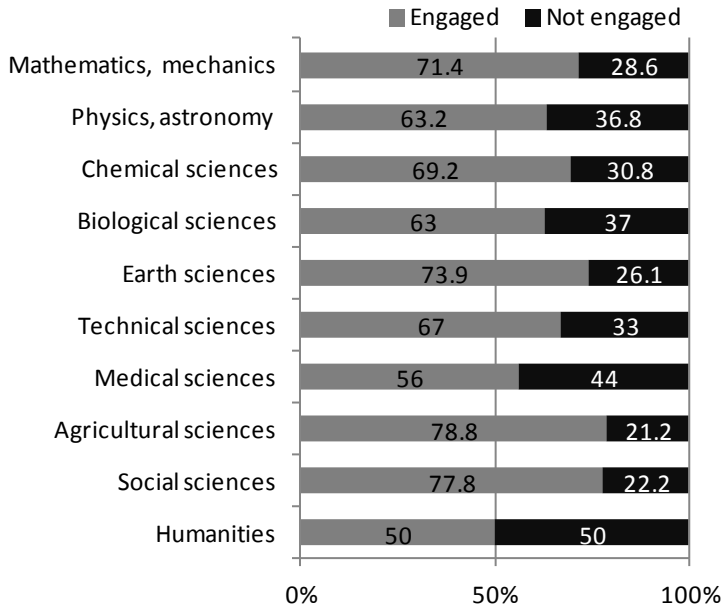
Preliminary results

Results of S&T products' transfer

According to the survey results, about 64% of reporting organisations did transfer their S&T results. This share is probably due to predominance of technologically oriented organisations in the sample (see figure 3). The spread of this indicator values by scientific fields is not too wide. Interestingly, even organisations engaged in humanities research transfer their research results, in some of the forms mentioned in the questionnaire[15].

[15] We'd like to remind that by transfer of S&T results the survey meant not just technology transfer in the form of intellectual property but also other forms of transferring knowledge to external organisations, including, for example, personnel exchanges, organisational integration, etc.

Figure 3 – Relative distribution of R&D organisations engaged and not engaged in STRT by scientific fields, %

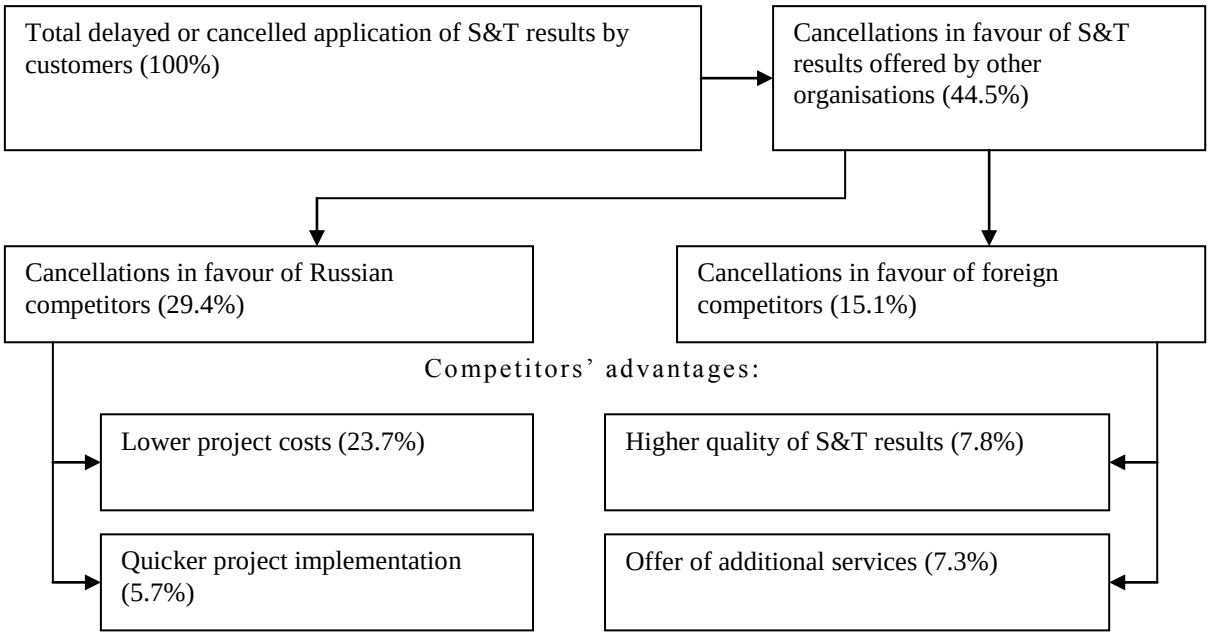


Of particular interest are the negative results of STRT, or rather, instances of incomplete transfer (when practical application of results was delayed or cancelled), and the reasons for that. For the whole sample, 17.3% of organisations engaged in STRT have experienced such situations (see table 3, figure 4). Almost half of them explained it by activities of competing R&D centres (significantly, predominantly Russian ones). The main reason of customers' cancelling their original plans in favour of competitors was lower project costs. Foreign competitors won by offering higher quality and additional services.

Table 3 – Share of negative (incomplete) STRT results in the total number of STRT cases, %

	Share of organisations engaged in STRT, %
Delayed or cancelled application of S&T results by customers	
Total	17.3
In favour of S&T results offered by other organisations	7.7
Cancellations in favour of S&T results offered by other **Russian** organisations, by following reasons:	
– quicker project implementation	1.0
– lower project costs	4.1
– higher quality of S&T results	0.0
– offer of additional services (after sale support, upgrades etc.)	0.0
Cancellations in favour of S&T results offered by **foreign** organisations, by following reasons:	
– quicker project implementation	0.0
– lower project costs	0.0
– higher quality of S&T results	1.0
– offer of additional services (after sale support, upgrades etc.)	1.0

Figure 4 – Distribution of factors affecting S&T results' transfer



First of all, STRT results must match the needs and requirements of the organisation to transfer the results generated. The survey questionnaire was based on the hypothesis that the need to transfer S&T results should be manifest in the form of a specially designed strategy. To illustrate, let's take a look at various forms and levels of knowledge transfer (positioned by novelty of results). Radically new products were offered in about one third of all STRT cases (see table 4). In other words, only a third of all STRT cases can be qualified as full-fledged innovations. Sales of equipment deserve a special note. Though the total share of this STRT form remains under 20%, it turns out to be the most "innovation-intensive" one (high relative number of practical applications of radically new products after transfer of S&T results).

Only 67.2% of the surveyed institutes had formalised development strategies; about a half of those included a provision on technology transfer's priority role in their development prospects. Comparing the evaluations of transfer's importance and the number of organisations which are actually engaged in it (see figure 3), one can conclude that a conscious need to transfer S&T results in general matches the potential of Russian R&D centres.

The most popular forms are R&D, design and other similar services (81.6%); joint R&D projects (29.6%); transfer of industrial designs (29.1%); and engineering services (24.5%).

Factors affecting the choice of technology transfer model

In course of the study, factors affecting the rate of transferring S&T results (identified by the respondents directly) were divided into three groups. The first comprised barriers hindering creation of S&T results, i.e. external phenomena adversely affecting R&D centres' opportunities to participate in the innovation process (even before the transfer begins). These include the low demand by customers and consumers (stated by 70.4% of the respondents); lack of R&D personnel (58.2%); and lack of equipment (54.1%). In a way these results are evidence of Russian R&D organisations' certain "inadequacy" for technology transfer: in most cases it happens in the situation of low demand for new knowledge, and inadequate (weak) supply. The latter is only to be expected, given the lack of research personnel and equipment (see table 5).

Table 4 – Shares of various STRT forms, by novelty of offered products, %

	Novelty of products manufactured using transferred S&T results			Share
	Radically new	New to organisation applying results	Modified	
Total	37.8	64.3	64.3	100
Commercial agreements covering:				
- R&D	32.7	53.6	54.1	81.6
- patents for inventions	8.2	14.3	12.8	19.9
- unpatented inventions	3.1	4.6	5.1	5.6
- utility models	6.1	9.2	9.2	13.3
- patent licenses for inventions	2.0	4.1	3.6	5.1
- know how	7.1	8.2	9.2	13.3
- trademarks	1.5	2.0	3.1	4.6
- industrial designs	10.7	19.4	21.4	29.1
- engineering services	7.7	16.3	16.8	24.5
Other forms of transfer:				
R&D cooperation (contract-based)	10.2	19.4	20.9	29.6
Sales of equipment	9.2	14.8	13.8	19.9
Exchange of skilled personnel	3.1	4.1	5.1	7.1
Informal ways to transfer results (scientific conferences, exhibitions, researchers' informal contacts, etc.)	7.7	15.8	13.8	20.4
Other	0	1.0	1.0	2.1

The actual process of transferring and applying R&D results (the second group) is affected by other negative factors (see table 6). In particular, the main limitations mentioned by the respondents included lack of funding at customer organisations (77%); high economic risks of applying S&T results (45%); legal and administrative barriers hindering transfer and application of S&T results (41%). It should be noted that the last two factors can be directly linked with each other. Interestingly, very similar reasons like legal (administrative) barriers (41%) and inadequate legislation in innovation sphere (21.4%), were placed quite far from each other in the rating of factors hindering technology transfer.

Table 5 – Rating of factors hindering creation of S&T results: frequency of mentioning by organisations engaged in STRT

	Frequency of mentioning, % (rank)
Low demand for S&T results by potential customers and consumers	70.4 (1)
Lack of personnel at your organisation	58.2 (2)
Lack of advanced research equipment at your organisation	54.1 (3)
Insufficient level of testing and experimental facilities at your organisation	38.3 (4)
High competition from foreign R&D products	27.6 (5)
Lack of clearly defined terms of reference provided by customers	23.0 (6)
Other	19.9 (7)
Insufficient skill level of personnel at your organisation	19.9 (8)
High competition from other domestic R&D	19.4 (9)
Underdeveloped R&D infrastructure (scientific information centres, shared equipment centres, industrial parks, etc.)	17.3 (10)
Weak cooperation links with partner R&D organisations	14.8 (11)
Insufficient quality of management at your organisation	13.8 (12)
Lack of information about cutting-edge international research	11.2 (13)
Lack of information about new technologies	9.7 (14)

Factor such as customers' and/or implementing organisations' insufficient awareness of new technologies (33% of the respondents) can directly affect the main barrier hindering technology transfer, namely low demand for S&T results by potential customers and consumers (included in the first group).

Table 6 – Rating of factors hindering transfer and application of S&T results: frequency of mentioning by organisations engaged in STRT

	Frequency of mentioning, % (rank)
Lack of funds at implementing organisations	77.0 (1)
High economic risks of applying S&T results	45.4 (2)
Legal and administrative barriers hindering S&T results' transfer and application	41.3 (3)
Insufficient awareness of customers and/or implementing organisations of new technologies	33.2 (4)
Lack of skilled personnel (engineers, technologists) at implementing organisations	29.1 (5)
High competition from foreign R&D products	28.1 (6)
Lack of guaranties that production based of your organisation's S&T results would operate smoothly	27.0 (7)
Inadequate legislation regulating innovation activities	21.4 (8)
Lack of skilled personnel to support S&T results' transfer (economists, lawyers, managers, etc..)	19.9 (9)
Insufficiently developed innovation infrastructure (broker, informational, legal, banking etc. services)	19.9 (10)
Insufficient readiness of your organisation's S&T results for practical application (need for further work, modifications etc.)	18.4 (11)
High competition from other Russian R&D products	17.3 (12)
Other	17.3 (13)
Competition from new products imported from abroad	16.8 (14)
Insufficient quality of management at your organisation	15.8 (15)
Prototype and experimental R&D results do not match cutting-edge S&T achievements	12.8 (16)
Lack of cooperation links with customers and/or implementing organisations	11.2 (17)
Lack of information about market demand for new technologies at your organisation	10.7 (18)
High competition from other Russian manufacturers of finished products, providers of services	10.2 (19)
Insufficient quality of management at implementing organisation	9.7 (20)

The importance of competition from foreign R&D products in both groups was estimated at about the same level (mentioned by 28% of companies). Competition in the technology field was rated higher than competition on markets for finished products and services produced with the help of transferred S&T results (10%).

Table 7 – Rating of R&D organisations' potential competitors on technology markets at the R&D stage

Potential competitors of the R&D organisation on technology markets	Level of competition at the R&D stage (frequency of mentioning, %)		
	No competition	Medium competition	High competition
Russian R&D organisations	25.9	51.5	22.6
Foreign R&D organisations and universities	55.7	21.6	22.6
Russian real sector enterprises	44.6	39.7	15.7
Foreign real sector enterprises	57.4	23.6	19.0
Russian technological (engineering) companies	57.0	33.1	9.8
Foreign technological (engineering) companies	64.9	21.6	13.4
Russian universities	61.3	32.8	5.9
Other	99.3	0.3	0.3

Table 8 – Rating of R&D organisations' potential competitors on technology markets, at the technology commercialisation stage

Potential competitors of the R&D organisation on technology markets	Level of competition at the technology commercialisation stage (frequency of mentioning, %)		
	No competition	Medium competition	High competition
Russian R&D organisations	38.4	47.2	14.4
Foreign R&D organisations and universities	56.7	22.3	21.0
Russian real sector enterprises	43.6	39.3	17.0
Foreign real sector enterprises	50.5	23.6	25.9
Russian technological (engineering) companies	57.7	31.1	11.5
Foreign technological (engineering) companies	62.3	19.3	18.4
Russian universities	69.2	25.9	4.9
Other	0.0	0.0	0.0

Estimates of the competitive environment were grouped into the third block of factors (see tables 7-8). In particular, at the R&D stage R&D organisations were named as the main competitors, primarily Russian ones. The real sector companies in effect are not seen as competitors. The

most likely reason for that is a rather low development of corporate research in Russia, and orientation of the foreign corporate R&D sector towards meeting demand primarily of their home base companies. University research centres in Russia are seen as serious competitors only by 6% of the surveyed[16].

At the commercialisation stage the situation changes (see table 7): the role of Russian organisations becomes less important while pressure from foreign competitors increases (primarily foreign real sector companies). There are at least three reasons for that:

- Foreign R&D and industrial companies at commercialisation stage have more solid positions regarding the protection of intellectual property;
- commercialisation is the stage where Russian R&D organisations get engaged into direct competition; they gain practical experience of competing with foreign R&D centres, universities and companies;
- Also, Russian R&D organisations apply international sources of information insufficiently, which adversely affects the quality level and competitiveness of their products. Note that among sources of information on new technologies and promising areas of applied R&D, international publications have the 11th place; international conferences, seminars and symposiums - the 14th; exhibitions and fairs - the 17th (see table 8).

The fact that in terms of information flows, R&D organisations to a large extent remain self-contained, is confirmed by the fact that own R&D results are their most important information source - far ahead of all others, and with minimum variance of answers. Also high in the rating is information R&D organisations receive from government customers.

[16] Probably in future this estimate will increase, since the Russian government made serious efforts to support university research centres.

Table 9 – Rating of R&D organisations' sources of information on new technologies and promising areas of applied R&D: frequency of mentioning by importance, %

	Rank	Importance (frequency of mentioning, %)				
		Min	«2»	«3»	«4»	Max
R&D results obtained by internal R&D departments at your organisation	1	1.6	1.3	11.1	23	60.3
Users of end products and services	2	6.9	6.2	18	26.9	37.7
Results obtained by other internal departments at your organisation	3	12.5	6.2	14.1	26.6	34.1
Government organisations – customers	4	11.8	7.9	13.8	29.8	31.8
Patent information	5	11.8	13.4	19.3	26.9	25.6
Russian and international (hosted in Russia) conferences, seminars, symposiums	6	9.2	7.9	28.2	28.5	24.3
Russian scientific publications	7	5.9	9.5	21	37	25.6
Russian and international (hosted in Russia) exhibitions and fairs	8	11.8	10.8	25.6	28.9	20.3
Enterprises and organisations which apply S&T results obtained by your organisation	9	8.5	4.3	22.6	33.1	27.2
Informal contacts between researchers	10	12.5	7.2	21.3	31.8	23.6
International scientific publications	11	10.2	11.1	24.3	30.8	22.3
Competitor R&D organisations (operating in the same industry or research field)	12	10.2	10.2	30.5	29.8	14.4
Universities	13	14.1	14.4	28.2	25.6	14.1
International conferences, seminars, symposia (hosted abroad)	14	22	9.2	23.6	22.3	18
Organisations – members of the same group (association, union, holding company, consortium) as your organisation	15	23.9	8.9	21.6	18.4	16.7
Consulting and information companies	16	33.4	14.8	18.7	19	7.2
Exhibitions and fairs hosted abroad	17	29.2	10.2	22.3	18.4	14.8
Other sources	18	0.3	1.3	1	1	0.3

Table 10 – Existence of specialised departments at R&D organisations (frequency of mentioning, %)

	Total	Engaged in STRT
Experimental and pilot production facilities	65.9	68.4
Technology transfer centres	5.2	5.6
Technological innovation centres	15.7	18.9
Industrial parks	6.9	7.1
Business incubators	2.3	3.1
Small innovative enterprises	9.5	10.7
Engineering services	24.9	26.5
R&D equipment and experimental facilities share centres	21.6	25.5
Marketing services	35.4	34.7
Research and educational centres, external university departments	35.7	37.2
S&T information centres (libraries, patent services, etc.)	70.5	72.4
No such departments	8.9	6.6

A positive aspect of the technology transfer situation is the fact that the R&D organisations consider users of end products and services the second most important information source[17].

In addition to external factors, a number of key internal organisational aspects should also be considered when analysing STRT. First of all, such activities go more smoothly (in certain cases radically more so) if an R&D organisation has certain specialised departments.

The survey revealed that the existence of such organizational units increases the probability of organisation's involvement in STRT by approximately 1.5 times (see table 9). Technology innovation centres and business incubators are of particular relevance here. Unfortunately, these forms are not yet very popular in Russia (in the sample, 15.7% and 2.3%, respectively). A rather strange effect was observed concerning marketing services: the share of R&D organisations engaged in STRT which have such departments was even smaller than the average for the whole sample.

It needs to be noted here that not all R&D organisations are large enough to set up specialised departments to support STRT. In such cases it makes more sense to procure services offered by external R&D organisations (see tables 10-11). In this context "innovation-oriented" R&D

[17] Poorly developed are such information channels as consulting and information companies (16th place) and implementing enterprises (9th place).

organisations stand out due to their more active use of external technology transfer centres' and small innovative firms' services.

Very likely structural mechanisms of STRT are by nature not internal but external or network-based. An indirect evidence of that provides the answers to questions about R&D organisations' membership in technological groups or networks (see table 12).

Table 11 –Use of services provided by specialised departments of external R&D organisations (frequency of mentioning, %)

	Total	Engaged in STRT
Experimental and pilot production facilities	36.4	40.3
Technology transfer centres	4.6	6.1
Technological innovation centres	9.2	10.7
Industrial parks	7.9	8.2
Business incubators	1.3	1.5
Small innovative enterprises	15.7	18.9
Engineering services	10.8	12.2
R&D equipment and experimental facilities share centres	18.4	21.4
Marketing services	11.1	11.7
Research and educational centres, external university departments	42.3	45.9
S&T information centres (libraries, patent services, etc.)	42.3	46.4
Do not use any services provided by such departments of external R&D organisations	23.3	17.9

The most popular and frequently used option is membership in an officially established group of organisations. Such groups often emerge when large research institutes are separated into smaller organisations which still retain certain administrative links (chain of control). If we compare the sub-sample of the surveyed organisations engaged in STRT with the typical situation, the biggest difference is in membership in international networks: it's 1.5 times higher for organisations engaged in STRT. At the same time membership in international groups and networks was extremely rare (about 3% of the respondents).

Table 12 – Membership of R&D organisations in S&T associations, networks, holding companies (frequency of mentioning, %)

	Total	Engaged in STRT
Member of a formally established group of Russian organisations	25.2	28.6
Member of a formally established international group of organisations	2.3	2.6
Member of Russian S&T networks comprising independent organisations	12.8	13.3
Member of international S&T networks comprising independent organisations	1.6	2.6
Member of a Russian group of independent organisations with other forms of obligations	10.2	11.7
Member of an international group of independent organisations with other forms of obligations	1.3	2.0
Doesn't belong to any group	54.8	50.5

Forms of public support

Another important aspect analysed in connection with STRT is government support. According to the survey results (table 13), R&D organisations engaged in technology transfer were particularly in favour of such government policy initiatives as targeted federal programmes (30% of organisations engaged in STRT); direct government budget subsidies (16%); and regional programmes (12%). Less popular among these organisations were support by state science foundations (3%); indirect forms of support (customs benefits, accelerated depreciation rules, tax breaks); public-private partnership mechanisms (in particular state corporations).

A broader approach to analysing the role of government in promoting the innovation potential of R&D organisations provides the assessment of general S&T and innovation policy initiatives (table 14). Interestingly, despite the fact that all government policy initiatives received a number of negative assessments, none of the overall scores were lower than neutral ("0"). The largest number of negative marks received establishment of autonomous government-funded institutions, reforming the RAS system, and (especially) privatisation and incorporation of R&D organisations.

Table 13 – Use of government financial support mechanisms (frequencies for the sub-sample of R&D organisations engaged in STRT, %)

	Frequency
Direct subsidies (grants) from Federal and municipal budgets	15.8
Federal targeted programmes	30.1
Regional programmes	12.2
Tax breaks (general taxation)	4.6
Breaks on land and property taxes	5.1
Breaks on profit tax to organisations performing R&D in particular S&T fields (the RF Government Regulation of 24.12.2008 #988)	5.6
Preferential credits to finance S&T and innovation projects	4.1
Support by state science foundations, including Foundation for Assistance to Small Innovation Enterprises	3.1
Support by non-government foundations	2.0
Support by venture funds (RVC, industrial and regional venture funds)	2.0
Support by state corporations (Rusnano, Rustechnology, Rusatom, VEB etc.)	6.1
Support by other kinds of public-private partnerships (major innovation projects of national importance, participation in technology platforms, etc.)	6.6
Customs benefits to import research equipment	1.5
Mechanisms for accelerated depreciation of tangible assets	3.1
Mechanisms for accelerated depreciation of intangible assets	0.5
Other mechanisms *(please specify)*	2.0

Positive scores («++») received such initiatives as improving government procurement system, promoting the integration of science, education and industry. Moderately positively («+»)assessed were the transfer of intellectual property rights to developers when the R&D was funded by the federal government; development of innovation infrastructure; establishment of national research centres; development of training and certification system for R&D personnel.

Table 14 – Assessment of government S&T and innovation policy initiatives (frequencies for the sub-sample of organisations engaged in STRT, %)

	Typical score
Extending R&D organisations' rights to establish small innovation enterprises (Federal Law of 02.08.09 #217)	0
Transfer of intellectual property rights to developers when the R&D were funded by the federal government	+
Improvement of government-funded institutions' legal status (Federal Law of 08.05.2010 #83), including establishment of new types of public institutions	0
Establishment of autonomous R&D institutions (Federal Law of 3.11.2006 #174)	0
Development of innovation infrastructure (venture funds, technology transfer centres, technology implementation zones, shared access centres, etc.)	+
Improvement of government procurement system	++
Adoption of the law "On Procedures for Acquiring and Using Special-Purpose Assets by Non-Profit Organisations" (of 30.12.2006 # 275)	0
Development of procedures to measure productivity of R&D organisations (the RF Government Regulation of 8.04.2009#312)	0
Establishment of national research centres	+
Establishment of national research universities network	0
Reforming of state academies of sciences	0
Privatisation and incorporation of R&D organisations	0
Development of training and certification system for R&D personnel	+
Promoting integration of science, education and industry	++
Activities of state corporations (Rusnano, Rustechnology, Rusatom, etc.)	0

Conclusion: prospects for further research

Further analytical research of the collected data, on the basis of the previously developed methodology involves obtaining two results regarding the modelling of the innovation behaviour of R&D organisations which seem particularly important. Specifically, there is a need arising to develop the following statistical models:

- *STRT strategies*. Using statistical classification techniques and exact methods, a typology of the most popular STRT strategies (methods) will be built, from the perspective of choosing transfer forms, positioning results, selecting customers, etc. Various strategies' productivity will be assessed. The strategy design will be based on the same principles as ones developed for innovative enterprises'

taxonomy [Gokhberg et al, 2010; Kuznetsova and Roud, 2011; Gokhberg et al, 2012].

- *Choice of STRT strategy.* The strategies identified at the previous stage will be classified and integrated with the existing set (obtained by analysing the survey data). On the basis of these strategies regression models will be built, describing how various external and internal factors affect the choice of particular STRT strategies, and the results of their practical application. Some preliminary results of strategy analysis on the institution level were represented for discussion, but still need further investigation [Zaichenko, 2012]. Locally aggregated strategies are also a hot topic for descriptive analysis and modelling [Meissner, Zaichenko, 2012].

Analysis of the collected data allowed identifying ways to improve the existing tools, especially keeping in mind the objective of modelling R&D organisations' behaviour.

First of all, it was discovered that making "quantitative" assessments was harder for the respondents than choosing a scaled answer[18]. Analysis of financial data revealed additional problems with scales (instead of thousand roubles the respondents and interviewers would use roubles, millions of roubles, etc.). Writing/reading/typing errors were discovered concerning numbers ("extra" numbers, missing numbers, etc.). Still, even these sections of the questionnaire proved to be relatively accurately filled in. The following topics turned out to be the most challenging: capital assets (approximately a third of the respondents chose not to answer them); revenues from technology transfer (approximately one fifth of the sample didn't answer); and the costs of services provided (approximately a quarter of the respondents couldn't answer). At the same time questions about key indicators of R&D activities reflected in typical reporting and accounting documents regularly submitted by the organisations (e.g. internal R&D expenditures, funding sources and their structure, etc.) were answered by almost 100% of the respondents. It was decided that in future some of the questions requiring quantitative answers would be dropped, or seriously amended.

Secondly, information about customer companies' industry is particularly important for building statistical models. Keeping in mind that probably many very different customers were served, the respondents were asked to specify economic activities of the five most important of them. The response rate for this section of the questionnaire was about two thirds of the sample. Note that there were practically no cases of going beyond the specially prepared list of economic

[18] A possible explanation is unwillingness to reveal absolute figures due to the fear these might be used "inappropriately" (i.e. would harm the organisation).

activities' codes (TEA)[19]. Still, the lists of economic activities offered to the respondents were adjusted.

Interestingly, the respondents most frequently indicated agriculture and mining as their customers' economic activities. Also quite often manufacturing of machinery and equipment, electronic components, radio, TV and communication equipment, medical products, instruments, control and testing equipment, optical instrumentation, spacecraft and aircraft were mentioned. Transfer of S&T results is happening comparably frequently in the food industry and metallurgy.

Thirdly, questions related to several aspects of the survey were clarified and extended, e.g. the question about S&T results' quality control procedures applied at the organisation can provide information both on the STRT quality, and customers' specific requirements. Certification centres as a specialised element of the STRT infrastructure (including internal and independent centres) were used by almost 40% of the surveyed organisations, which is evidence of a high level of institutional quality control. We intend to collect more detailed information about presence (or lack) of symmetrical interest in ensuring sufficient quality level by both customers and developers; about the role of standards; etc.

Also, we know that the quality control procedures for S&T products can be analysed using data on target markets and other indirect information. So far the survey tools do not allow to collect any significant data to analyse the behaviour of R&D organisations. This is expressed by the fact that more than a third of the respondents were unable to describe their organisation's market analysis and positioning activities.

Planning future research in this area, it should be taken into account that activities of R&D organisations are not a set of actions which randomly transform into innovations and ready-made technologies. On the contrary, all characteristics of these organisations identified in the course of statistical observation must be analysed in the framework of a single methodology, according to which the R&D organisation is an integral part of the innovation system performing a set of necessary functions, which closely tie it to all other participants of the NIS (an example of such approach is suggested in [Hales, 2001]).

Finally, another major aspect of analysing and interpreting the obtained results in the course of subsequent research will be identification of best practices (strategies). This information can be used to substantiate policy initiatives to support the best R&D organisations (including formulation of criteria to evaluate and select such organisations and practices). It will also be

[19] The full list of types of economic activity codes (TEA) is too long to be used during the survey directly.

useful for R&D organisations themselves - when they work out their development strategies[20], and for on-going management. The best R&D organisations should be supported on the basis of the best Russian and international experience and tried approaches[21].

[20] This information may be useful also to certain state-owned companies which develop and implement innovation development programmes.

[21] See [RF Government, 2009]. Extended review of assessment of best R&D organisations' strategies is given in [Rush et al, 1996; Tidd, 2000; Intarakumnerd, 2011].

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