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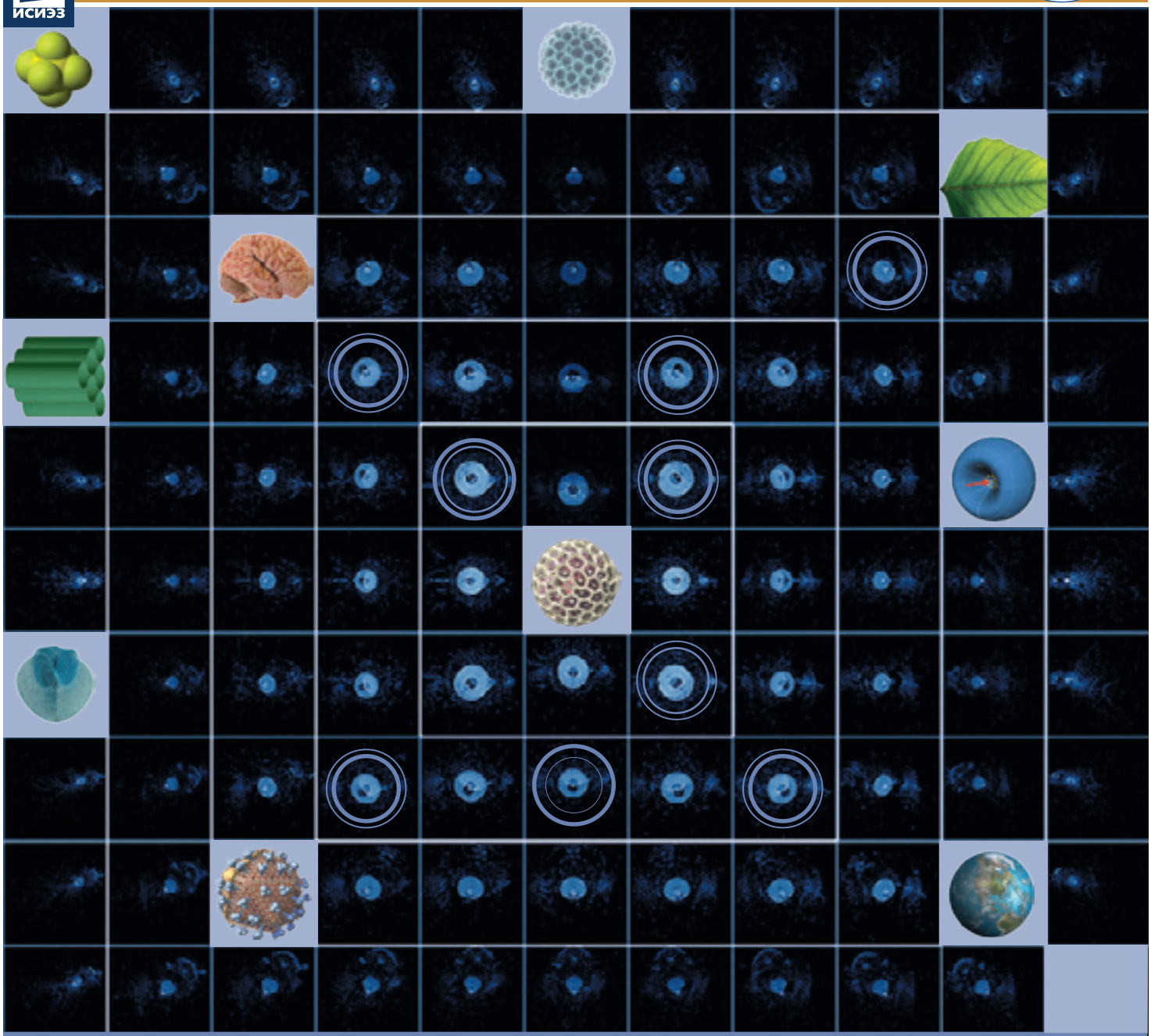

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Foresight-Russia

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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 through dissemination of the best national and international practices of future-oriented innovation development. It also provides a framework for discussing S&T trends and policies.

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Keywords

industrial policy; science, technology and innovation policy; priority industries; priority technologies; interest groups; policy evaluation; state institutions

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Traditionally industrial policy is under scrutiny worldwide. In recent years, issues of its elaboration have gained increased importance in Russia as well. Among the forefront tasks are the harmonization of domestic industrial policy with science, technology and innovation policy, taking into account the specificity of different sectors and technological areas, diversification of the national economy, the formation of new sectors, the development of human capital.

The article aims to discuss the practical problems and inconsistencies of industrial policy in Russia since 2000, to analyze positive and negative experiences, and to draw up some lessons which are essential for a new technology industrial policy.

The conceptual and practical aspects of formulating an industrial policy have attracted the attention of experts and politicians around the world for a long time. In the 2000s, discussions about the opportunities and characteristics of industrial policy and the causes of its success or failure became commonplace both in developed countries and developing economies, especially after the global financial crisis.

Since 2010, questions of establishing and implementing a state industrial policy in Russia took on particular importance. On the one hand, there was a clear need to reflect the specific characteristics of various sectors and technological directions in innovation policy. On the other hand, increasing concerns arose over the diversification of the Russian economy, the development of human capital, the creation of high-productivity workplaces, and the formation of new sectors in the economy. The attention devoted to drawing up a broadly defined Russian industrial policy — taking into account the science and technology challenges — increased significantly in 2014 as a consequence of the worsening external political environment and the restricted opportunities to import certain technologies.

The significant role of politics in decision making in Russia is an obstacle to the development of a balanced and pragmatic industrial policy. Based on an analysis of industrial policy practices, we believe it is possible to discuss certain problems and contradictions in this field and study the positive and negative aspects of the measures implemented. Our aim is not only to outline some policy recommendations but also to suggest possible ways to harmonize domestic industrial policy with science, technology and innovation policy.

Industrial policy: the evolution of models and changing government attitudes

Industrial policy has always been subject to high scrutiny from decision makers, business elites and experts. Various motives could explain this attention: from the urgent need to eliminate certain market failures or initiate specific structural changes to the relatively neutral coordination of various state initiatives.

Questionable steps taken by the state in implementing its industrial policy, combined with objective difficulties in assessing its real impact on social and economic development further complicate any attempts to conceptualize industrial policy. We describe below what we consider some of the most appropriate definitions of industrial policy:

1. The combination of state measures to promote structural shifts or prevent such shifts [*Price*, 1981].
2. Assisting the flow of resources into certain sectors that the state considers important for future economic growth [*Krugman, Obstfeld*, 1991].
3. Supporting certain sectors (associated firms) in achieving results that the state considers effective for the economy as a whole [*Chang*, 1994].

The following definitions are used by international development organizations (OECD, UNIDO):

'*Industrial policy is a state policy aimed at improving the business environment or structure of the economy for sectors and technologies that is expected to give rise to more favourable prospects for economic growth and social welfare compared to the absence of such measures*' [*Pack, Saggi*, 2006; *Warwick*, 2013].

Despite conceptual ambiguity and perceptible changes in approaches to implementing industrial policy, we believe that the following *essential characteristics* need to be identified:

- intensity and predictions;
- the existence of priorities and (or) non-priorities;
- a contrasting redesign of revenues by redistributing resources, rights, and control between sectors (industries);
- a focus on the long-term returns of the entire economy.

As a general rule, industrial policy draws together an extremely varied, but relatively standard, tool box of different areas of state regulation (fiscal, customs, monetary, etc.). However it does not have its own specific instruments which gives rise to difficulties in differentiating industrial policy from notions such as 'structural policy', 'sectoral policy' and 'competitiveness policy'.

There are a multitude of approaches to classifying industrial policy, according to any of the following:

- the nature of its priorities: sectoral, industrial, market or technological;
- its direction (whether targeting an increase of exports or import substitution);
- its focus (affecting traditional or new business, major companies or SMEs);
- the sources of the redistributed resources (budget, development institutes, company funds);
- the actors (domestic or foreign investors);
- the way in which it is formulated or implemented (state or national — state, business, social partnership — etc.)

There is also no consensus on *industrial policy models*. However, as a rule, discussion tends to centre on a comparison of two models: *vertical* and *horizontal*. The vertical model involves the state selecting and supporting certain firms and/or industries (*picking winners*) and implies the selectiveness of the measures implemented. A *vertical industrial policy* is aimed at boosting certain sectors and identifying sectoral priorities. The problem linked to identifying future 'champions', making active use of direct support mechanisms, expressing specific preferences and protectionism are all characteristics of this type of policy. It is important to stress that industrial policy does not have to support industry leaders: it could in fact involve supporting those who are lagging behind. Equally, it is not just about promoting progressive structural changes in the economy, and industrial policy sometimes allows resistance against negative trends.

A horizontal policy is generally linked to structural changes in industry (supporting research and development (R&D), deregulation, promoting competition) and the implementation of relatively neutral measures. A *horizontal industrial policy* to a large degree emphasizes the diversity of channels of influence, innovation,

and the formation of new sectors and companies. It is less geared towards direct redistribution of revenue and more towards reducing barriers to growth.

The consensus from such comparisons is that some experts believe that a third model is possible: *industrial policy in an open economy* [*Kuznetsov, Sabel,* 2011]. This model is characterized by the fostering of conditions for quasi-revenue (which requires special efforts by companies), a focus on supporting relations between agents (*matching winners*) and the widespread use of 'search networks'. At the same time, important aspects of this model remain undisclosed, in particular, the question of how to achieve (accumulate) a critical level of changes.

Throughout the history of its practical implementation in various countries, views on industrial policy have always been far from unanimous: periods of enthusiasm have given way to phases of cooling. From the perspective of evolving views on industrial policy and implementation approaches, four stages can be identified [*Aiginger*, 2007; *Naude*, 2010; *Aghion et al.*, 2011] (Table 1).

While in the 1950s and 1960s state policy priorities of many countries continued to involve industrialization, offsetting market failures, protecting emerging new sectors based on public sector potential, in the 1970s-1990s significant problems in the state's implementation of industrial policy started to come to the fore. These included failings in the implementation of certain initiatives, distortions in the competitive environment, and rent-seeking behaviour by agents. As a result, from roughly the 1980s onwards the ideology of liberalizing trade, privatization, and foreign direct investment started to dominate, and structured programmes took on special importance.

Until the start of the 1990s, states' industrial policies all involved direct support measures, including measures to support 'champions'. Amid the intensification of globalization processes during this decade, the development of transnational corporations and the redistribution of production factors, a change of focus occurred. Industrial policy started to be linked to creating the conditions to allow capital to flow into certain sectors by changing their investment appeal.

The 2000s saw the rethinking of the role of the state, a more balanced assessment of market failures, greater attention to stimulating innovation and the development of national innovation systems. In the first half of this decade, a profound disillusionment with the results of the previous industrial policy gave way to demand for an industrial policy from states, including EU countries. This was explained by a number of reasons [*Aiginger*, 2007], in particular the increased risks of de-industrialization due to relocation of plants to countries to take advantage of factors of underdevelopment (low wages, lack of strict environmental regulations, etc.) and unfair competition. Another reason was poor economic growth in Europe and moreover, the ineffectiveness of traditional market instruments (privatization, deregulation, etc.) under the new conditions. Evolutionary growth theory played its own special role, attributing special importance to training, col-

Table 1. **Main stages in the evolution of views on industrial policy around the world**

Stage	State policy priorities	Characteristic features of industrial policy	Attitude towards industrial policy
1950s–1960s	Industrialization, import substitution, protection of emerging industries, public sector administration	Strict vertical policy, offsetting market failures, high level of selectiveness	Rapid growth in popularity in various countries
1970s–1990s	Trade liberalization, privatization, attracting foreign direct investment, *laissez-faire*	Limited use, renunciation of strict tools (protecting markets, supporting national champions) in favour of 'softer' tools (conditions for inflow of capital)	Doubts as to its justification in the face of state failures, distortion of the business environment, rent-seeking behaviour under conditions of globalization
2000–2009	Re-industrialization, stable innovative development, improvements of national innovation systems	Soft horizontal policy, offsetting systemic failures and supporting receptiveness to knowledge, guaranteeing beneficial dynamics, achieving demonstrable effects, self-exposure	Re-thinking the role of the state and the implementation format, market and state failures, the growth of influence of China and India, the backwardness factor, the marked impact of evolutionary theories of growth
2010 — present	Protecting national sectors, guaranteeing employment, searching for new sources of sustainable growth	Technological industrial policy, cluster industrial policy, stimulating links between agents, supporting partnerships, accumulation of critical changes, constructing a sectoral policy that is conducive to competition and to raising the quality of growth	Ideological crisis of the Washington Consensus, new post-crisis realism with a growing and more defined role of the state, a search for new models and experiments in devising a new industrial policy

Source: compiled by the authors using material from [*Aiginger*, 2007; *Naude,* 2010; *Aghion et al.,* 2011].

laboration, and receptivity to knowledge: the impact of this theory was buoyed by the emerging technological dynamism and intensive formation of new technological industries.

Globalization reduced the potential of a vertical industrial policy and its traditional policy instruments such as tariff regulation, subsidies, local market regulations, etc. As a result, there has been regular growth in demand for a new industrial policy geared not so much towards offsetting statistical market failures but more towards guaranteeing successful trends, supporting innovation and improving education, with a clear focus on training and achieving demonstrable effects. Subsequently, in the most acute period of the global financial crisis in 2008–2009, there was an expansion in the scope of the industrial policy tool kit and an increase of protectionist and preferential measures. The changed role of the state in many economically developed nations, the search by governments for new sources of sustainable growth and increased employment were just some of the after-effects of the crisis.

On account of these political and economic reasons, industrial policy came to be one of the areas witnessing a radical change in guidelines and more complex ideas on the role of the state in economic development. We will now enumerate the key changes in approaches to industrial policy in the last decade.

1. *Rapid rapprochement with innovation policy.* Industrial policy is becoming more horizontal, while in contrast innovation policy, by transforming into a component of industrial policy, is becoming more vertical and specialist. The contradictory lessons learnt from the crisis have led to industrial policy being proclaimed the most important structural element of state policy that has a systemic, coordinating role in the post-crisis period of unstable global economic development.
2. *Industrial policy is complemented by industrial organization policy*, including aspects such as the position of companies in a market, optimal firm sizes, and value-added chains. This was brought about by the problems inherent in restructuring natural monopolies, introducing balanced approach rules, and developing technology regulation rules [*Avdasheva, Shastitko*, 2003]. Modern competition and industrial policies can be active and co-exist harmoniously [*Aghion et al.*, 2012].
3. *Ideas about the risks of state (non-) intervention* have significantly shifted *in favour of the application of more active, 'smart' instruments.* Specialists have identified 'innovation path dependence' and state investment to shift to clean technologies as key factors in industrial policy [*Acemoglu et al.*, 2010]. Even a contentious tool such as domestic market tariff protection has been recognized as having positive features. For example, its effectiveness in 'skill-intensive' sectors has been observed where the tariff structure is tied to the required level of work qualifications [*Nunn, Trefler*, 2010].

Many studies have been devoted to extremely productive comparisons of the advantages and risks inherent in an industrial policy [*Kuznetsov*, 2001; *Rodrik*, 2004; *Pack, Saggi*, 2006; *Aiginger*, 2007; *Warwick*, 2013]. However, positive examples and arguments in favour of an active policy in this field are, as a rule, counterbalanced with numerous opposing examples. Often, countries such as Brazil, Finland, Japan and South Korea are cited as having implemented a successful national industrial policy. Unsuccessful examples include initiatives in this field by countries in Sub-Saharan Africa and, with some provisos, Latin America. On the whole, expert assessments of different industrial policy variants tend to show considerable discrepancies as it is relatively difficult to establish with any certainty the economic impact of specific state efforts in this field. As a result, an analysis of specific cases does not allow any meaningful conclusions to be drawn on the 'productivity' or 'ineffectiveness' of industrial policy.

At the same time, certain general patterns are evident. A smart industrial policy provides medium-term gains, but often causes harm to long-term sustainable development. A long-term industrial policy cannot fail to take into account the global context: the structures of global production chains, technology trends, the forms and channels by which skills are distributed, and the specific nature of international competition and inter-country alliances. Overall, *an industrial policy is a complex tool that opens up tempting prospects but comes lumbered with incredibly high risks.* Effective implementation of an industrial policy requires a state to be able to conduct a 'smart' policy, listen to impartial assessments, and, above all, publicly recognize mistakes and learn lessons for the future.

Russian industrial policy in the 2000s: vehicles of change and interest groups

Industrial policy in Russia is traditionally associated with excessive state intervention in the economy and protecting the interests of certain major players, i.e. it is perceived as a somewhat dangerous regression from market principles. Its harshest criticism came in the late 1990s and early 2000s in relation to the initial lack of faith in the possibility of its effective implementation when the quality of the state's administration was low; in addition, there were risks of secretive lobbying by various interest groups, as well as risks of distortion of competition.

The specific nature of Russian industrial policy and the transformation of approaches to industrial policy were largely shaped by factors such as changes in budget restrictions, the dominant model of state-business relations, challenges for further development, and first and foremost — the exhaustion of the former growth model. Taking this into account, we have identified four stages in the development of Russian industrial policy in the 2000s (Table 2):

- A policy of structural reformation (restoration growth, soft regulatory policy, priority of institutional reforms) — 2000–2003;
- A vertical sectoral policy (sectoral priorities, increasing the role of the state in the economy, scheduling changes) — 2004–2007;
- A compensatory industrial policy (direct support and preferences for companies in certain crisis-affected sectors) — from late 2008 up to and including 2009;
- A technology industrial policy (expanding the mechanisms to stimulate innovation, improving the business environment, priority for creating new high-tech work places) — since 2010.

Policy of structural reformation (2000–2003)

It is no exaggeration to say that the early 2000s opened up one of the most significant opportunities in Russian history, including in relation to domestic industrial policy. In May 2000, work was completed on the most important conceptual document, the Social and Economic Development Strategy of the Russian Federation up to 2010 [CSR, 2000]. Its main focus lay in support for market principles and institutions: various conditions for competition, deregulation, and reforms of natural monopolies, the tax system, the authorities, the administrative apparatus, etc.

Critical discussions between those supporting liberalization and the mobilized economic development scenario led to even the softest of initiatives in industrial policy being rejected. Such a course was also dictated by the limited resources to implement direct state support measures, the underdeveloped nature of market institutions, and the low potential of indirect regulatory instruments in industrial policy.

The general lack of acceptance of industrial policy ideas did not stop the state from at least trying to formulate and implement a new model in this area, in-

Table 2. **Stages in the formation of Russia's industrial policy in the 2000s**

Period	Priorities	Characteristic features	Resources	Relations model
2000–2003	Development of market institutions and structural reforms	Soft regulation of taxes and tariffs on natural monopolies and exchange rates	Restoration growth, limited budget funds	Intensive collaboration between large-scale business and the state, personalized nature of relations
2004–2008	Diversification of the economy, stimulating innovation	Vertical sectoral policy, long-term planning, creation of development institutions	Significant budget resources	Consolidation of 'power vertical', increase in state control, institutionalization of access, expanding the number of actors involved in creating industrial policy (development institutions)
2008–2009	Social stability	Vertical compensatory policy, support for large-scale companies, micromanagement style of governance, preferences	Drastically stricter budget restrictions	State support in exchange for social commitments by large-scale companies
2010 — present	Search for new sources of growth (innovation, modernization, structural privatization), reindustrialization, improved investment climate, assisting in the development of new high-tech sectors	Technology industrial policy	Moderate budget capabilities, high uncertainty	Increased access to decision-making centres and competition for access, emergence of new players, consolidation of science and technology interest group, new forms of communication (Agency for Strategic Initiatives, Open Government)

Source: compiled by the authors.

spired ad hoc by the success of India in stimulating its information and communication technology (ICT) sector. In February 2001, a special federal programme 'Electronic Russia (2002–2010)' was initiated, and later approved in early 2002.[1] The initial aim of the programme was to create the necessary conditions to raise the efficiency of the economy, state authorities and local government by introducing and rolling out ICT on a large scale, guaranteeing rights to search, obtain, transmit, produce and distribute information freely, and expanding specialist training in this field.

'Electronic Russia' became a rare example of a horizontal industrial policy geared towards development of the ICT sector, primarily by removing unjustified administrative barriers and stimulating additional demand. However, by 2004, the special federal programme was adjusted in favour of accomplishing the state's objectives and raising efficiency in the public sector. Such a noticeable change was caused by the fact that the idea of non-funded industrial policy in 2004–2005 was not justified enough: removing administrative barriers proved a far harder task than expected, which required considerable efforts and provided negligible benefits in terms of administrative growth. The Ministry of Economic Development of the Russian Federation, the initial instigator of the 'horizontal ideology' behind the programme, turned its attention to other, larger-scale projects. Since in the initial stages of implementing the special federal programme a strong consolidated interest group of ICT market players was not formed (largely because this market was characterized by small companies on the whole), its subsequent evolution as an ordinary departmental programme by the then Ministry of Information Technology and Communications of the Russian Federation was natural and expected.

Vertical sectoral policy (2004–2007)

The second stage was linked to the vastly increased role of the state in the economy and the turn towards a vertical industrial policy. The factors and prerequisites behind this shift were:

- the alignment of the 'power vertical', the reduced influence of large-scale business on the authorities, and purposeful planning of structural changes in the economy;
- the relaxation of budget restrictions, the increased financial capabilities of the state;
- the stabilization of conditions for business activity, the improvement in the performance of obligations making it possible to implement long-term projects.

Since 2005, there has been a sharp increase in the state's interest in long-term planning instruments. Work started on various development strategies, primarily sectoral, and the creation of a set of special federal programmes relating to science and technology. The reformers were particularly interested in opportunities to expand private co-financing and quantitative performance targets, i.e. indicators of the effectiveness and performance of budget spending. There was then a shift in favour of *sectoral designed industrial policy*, including in sectors where private companies tend to dominate.

In 2006–2007, the inadequacy of the state's existing tool kit for the updated structure of priority social and economic development objectives (diversification of the economy, innovation, etc.) became clear. As a consequence, several decisions were adopted that went beyond the standard regulatory framework and expanded both the opportunities and risks of implementing an industrial policy.

From 2006, intensive work began to *create vertically integrated holding companies in the public sector*, in particular in the military-industrial complex (MIC), the aeronautical industry, and ship building. All of this was dictated by the desire not only to reduce the administrative burden of managing a multitude of different enterprises, but also to improve the ability of the state and sectoral ministries to directly influence the development of certain sectors.

2007 was noted for its turn towards forming *financial development institutions* and expanding their resource base. This happened via the political decision to use a portion of the resources from the National Welfare Fund (approximately 300 billion roubles) to plough funding into certain development institutions (Vnesheconombank, Investment Fund, Russian Venture Company, etc.)[2] There

[1] Approved by the Resolution of the Government of the Russian Federation no 65, dated 28.01.2002.

[2] Message from the President of the Russian Federation to the Federal Council of the Russian Federation, dated 26.04.2007.

were a number of reasons underlying this decision, one of which was the attempt to reach a compromise between those supporting greater state investment in the economy and the proponents of macroeconomic stability who opposed higher levels of state spending [*Ivanov et al.*, 2012].

One noticeable administrative innovation at this stage was *the creation of large-scale state corporations* in response to past inability or unwillingness to find effective public-private partnership methods. Two state corporations — Vnesheconombank and Rusnano — were set up as financial development institutions to make up for 'market failures'; two others — Rosatom and Rostec — were viewed as instruments and agents to restructure state property, consolidate state assets and raise the competitiveness of certain sectors (the nuclear industry, military-industrial complex, automotive industry, air travel) [*Simachev, Kuzyk,* 2009].

Vneseconombank and Rusnano were the most important driving forces behind the industrial policy. While Rusnano reproduced a horizontal model (forming the nanoindustry, identifying technological priorities, investing in new high-tech companies), Vnesheconombank gravitated towards a vertical model, supporting large-scale projects within the framework of 'standard' sectoral priorities set for it (space, aviation, ship, machine building, timber, nuclear, electronics industry, military-industrial complex). The list of Vnesheconombank's priorities was later expanded considerably and now includes a number of technology directions alongside sector-specific priorities.[3]

Compensatory industrial policy (end of 2008–2009)

The most severe economic crisis at the end of the first decade of the 21st century forced the state to move away from strategic objectives in industrial policy to tactical objectives (including using 'micro-management' mechanisms) and to review once again the development priorities and funding opportunities for large-scale reformation of the structure of the economy. Industrial policy measures during this period started to become extremely selective [*Gorst et al.*, 2009]. The automotive industry, agricultural equipment manufacturing, military-industrial complex, agriculture, transport complex, and residential construction were identified as sectoral priorities. A substantial proportion of the measures adopted were aimed at offsetting the recession in the most vulnerable sectors and supporting large, strategically important companies [*Simachev et al.*, 2012]. In a number of cases, the anti-crisis initiatives went counter to the principles of a market economy: private demand gave way to public, in some sectors protectionist barriers were formed, administrative control over pricing intensified, and the mutual obligations of the state and large company owners were untransparent [*Simachev, Kuzyk*, 2012].

Although lessons from the crisis were learnt at the very highest political level, the practical consequences of these lessons turned out to be extremely divergent. At the start of 2009, a set of measures to stimulate innovative development and deregulate the economy were identified. In June 2009, the Presidential Committee on Modernization of the Economy included energy, energy efficiency, nuclear, information and space technologies and telecommunications, medicine, pharmaceuticals and nanotechnology in its list of strategic technology priorities.

Technology industrial policy (from 2010)

The ambiguity over the conclusions drawn by the authorities from the crisis predetermined the specific nature and inconsistency of industrial policy in the post-crisis period. Its reorientation away from a vertical, sectoral model towards a technological model during recent years is linked to the search for new sources of growth and the growing influence of interest groups from scientific, technological and educational spheres.

The fourth stage of industrial policy is characterized by state efforts to introduce new horizontal policy instruments [*Simachev, Kuzyk*, 2013]. Specifically, this means technology platforms, matching grants to stimulate partnerships between companies and universities, a more innovation-oriented stance in the system of public procurement and in state corporations' development programmes, and finally, support for the creation of regional innovation clusters, among other things. However, the principal obstacles to making many of these new instruments work

[3] In November 2008, amid the rapidly intensifying economic crisis, one additional priority was added to this list: the agro-industrial complex (Resolution of the Government of the Russian Federation no 1697, dated 19.11.2008), and within just one year additional technology priorities were identified for Vnesheconombank: strategic computer technologies and software, information and communication systems, medical equipment and pharmaceuticals. Available at: http://www.veb.ru/press/news/?id=5937 (Resolution of the Government of the Russian Federation no 1783-r, dated 26.11.2009. Available at: http://government.consultant.ru/page.aspx?1036042).

better include their appropriation by traditional interest groups, the difficulties in sharing positive experiences, and restrictions on accumulating a critical mass of stable, self-sustaining changes.

At the end of 2011, after protracted adjustments and revisions, the Innovative Development Strategy for the Russian Federation up to 2020 was approved [Ministry of Economic Development, 2012]. This declaratory reinforcement of the technological and innovative turn in industrial policy was filled out with substance, which was predetermined by serious changes in the global competitive environment, a critical assessment of traditional sectoral approaches and reduced opportunities for implementing such approaches.

The stricter budget restrictions combined with expanded social obligations in 2012 brought the task of *searching for new sources of growth* to the fore. The ideas of *re-industrializing* the Russian economy (in many respects inspired by the European example), creating new employment in high-tech, and fundamentally improving the business environment received widespread support. In January 2012, the need for an industrial policy was first discussed at a high political level. Among the possible priorities were pharmaceuticals, high-tech chemistry, composite and non-metallic materials, the nuclear and aviation industries, ICT, nanotechnology, and the space industry (the list was said to be open to further additions and adjustments) [*Putin*, 2012].

In May 2012, two fundamental landmarks were named as part of the long-term economic objectives for the country: i) increasing by 1.3 times the proportion of output from high-tech and science-intensive economic industries of total GDP by 2018 relative to 2011 levels; and ii) creating and modernizing 25 million highly productive jobs by 2020.[4] These were followed by administrative measures to distribute responsibility in terms of achieving these goals among core ministries and departments, alongside the regular monitoring of current figures. Discussions of state programmes, strategies and budget allocations went ever more closely in hand with assessments of their contribution to achieving priority target figures.

In 2012–2013, work continued to expand the number of industrial policy priorities (Figure 1), which led to a watering down of the very notion of 'priorities' and the loss of their original effectiveness as an instrument to concentrate efforts in certain areas. By this time, the poor performance of many sectoral development strategies had become clear. In our opinion, state programmes did not yield their expected results, and turned out to be yet another bureaucratic structure on top of other federal budget spending mechanisms.

In July 2013, action plans on the development of five technological sectors were approved in the new form of *road maps*, focusing on the implementation of practical measures up to 2018. These five sectors were: biotechnology and genetic engineering, ICT, engineering and industrial design, composite materials production, and optoelectronic technologies and photonics. It should be noted that the adoption of these road maps served as the first clear sign of the state's increasing attention to the development of new, promising and high-tech sectors, not just in industry but also in the services sector.

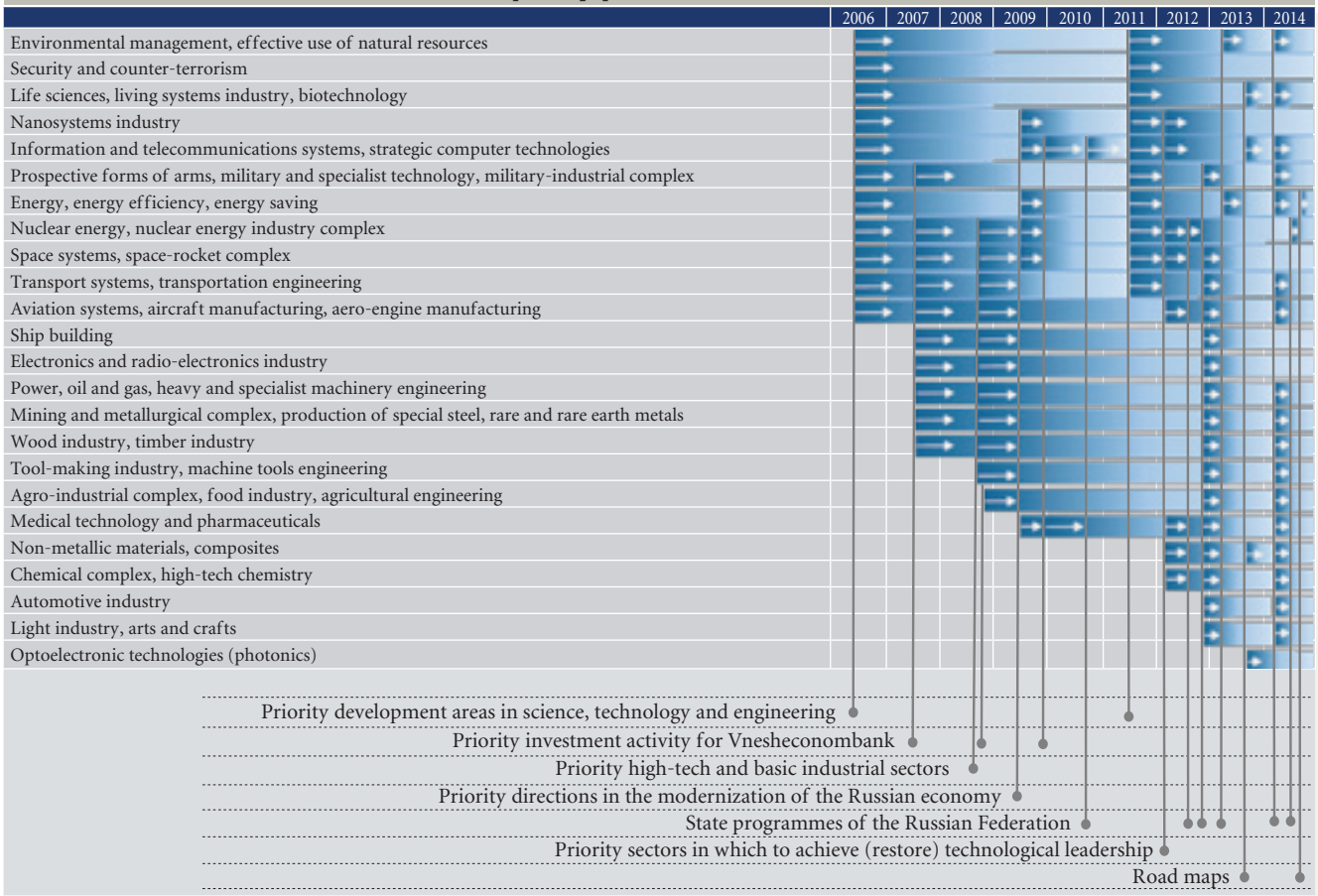
Demand for industrial policy in Russia and key interest groups

Society and the state in Russia have traditionally shown high demand for an industrial policy. Despite the widespread view among Russian experts on the negative consequences of the state intervening in regulation in this field, a large number of practical questions call for coordinated and centralized measures, the adoption of which lies solely within the remit of state authorities. Such measures include: defining priorities when making decisions to reduce (raise) the tax burden or change customs duties; agreeing on conditions for joining a foreign economic system (WTO, Customs Union) and terms for transitional periods and compensation for national producers; offering selective support to certain sectors in times of crisis; selecting preferential investment areas when the state has enough resources and expands its role as an investor (directly or through a development institution).

Domestic industrial policy is expected to overcome various economic problems and guarantee long-term growth through diversification of the economy, import substitution, increasing the volume of exports with a high level of processing, developing research and the use of Russian developments, and creating new economic sectors based on cutting-edge technologies. Besides these economic ob-

[4] Decree of the President of the Russian Federation 'On long-term state economic policy' no 596, dated 07.05.2012.

Figure 1. **Industrial policy priorities in Russia, 2006-2014**



Source: compiled by the authors based on materials from fundamental strategic and programme documents, statements by the President and Chairman of the Government of the Russian Federation.

jectives, the fundamental aim of Russia's industrial policy was and continues to be providing social stability, and supporting employment in certain regions, single-industry cities and big businesses.

Political stability remains an important factor and can be guaranteed by redistributing revenue among the powerful elites. The possibility of changing the status quo by invoking long-term and politically advantageous objectives and seeking support and preferences for certain sectors make industrial policy attractive to members of various interest groups.

In the period 2000–2003, the discussion of industrial policy was outwardly inspired by the problem of changing the structure of the Russian economy. However discussions in this regard were generally initiated by large businesses made up of the most powerful, consolidated industries (metallurgy, energy, railways, and extractive industry) and took place between the stakeholders themselves. Contradictions surrounding questions such as tariffs for services provided by natural monopolies, the conditions and expediency of joining the WTO, and the exchange rate policy of the Central Bank were all, among others, extremely delicate matters.

While in the early 2000s business was the main counterpart of the state, later in that decade state interest groups and competition between these groups shaped the developmental trajectory and configuration of industrial policy (Table 3). We have identified four of these interest groups: budgetary, structural, sectoral and science and technology. The specific nature — and advantage — of the proposed classification is linked to the stability of these groups and the fact that they all have a positive agenda. The position and influence of each of these groups is highly dependent on current budget restrictions, the level of social support from the population and the lessons learnt by the authorities from crises.

It seems unlikely that the various interest groups can be unified on rational terms when it comes to elaborating an industrial policy. Three of the four groups — structural, sectoral and science and technology — have a positive attitude to industrial policy, but differ significantly in their views on the principles guiding its implementation.

Table 3. **State interest groups in Russia's industrial policy: positions and stakes**

Interest group			
Budgetary	**Structural**	**Sectoral**	**Science and technology**
Key positions			
Guaranteeing macroeconomic stability	Diversification, development of new sectors	Guaranteeing social stability and control over the current situation and prices on the market	Guaranteeing the transition to an innovative development model
Neutral regulation, improvement of investment climate	Expanding mechanisms to stimulate exports and production of high tech products	Retaining (intensifying) direct influence over the development of certain sectors that are important to the population and to the development of the economy as a whole	'Supply of innovations' logic, expanding the range of breakthrough fields
Limiting opportunities to use additional income to intensify current budget spending	Increasing spending on economic development, new programmes	Implementing large-scale investment programmes, providing for innovative break-throughs	Increasing spending on science and education, forcing the public sector to collaborate
Limiting new initiatives	Expanding cooperation, signing new agreements between business and the state	Reforming major companies, integration, forming groups of 'national champions'	Creating national laboratories, research universities, developing scientific production partnerships
Attitude towards industrial policy			
On the whole — cautious, in the event of additional budget liabilities — hostile	Towards horizontal — positive, towards vertical — cautious	Towards horizontal — neutral, towards vertical — positive	On the whole — favourable, in the event of a technology industrial policy — very positive
Conditions to consolidate positions			
Stricter budget restrictions	Curtailment of traditional sources of economic growth	Social tension	Lower competitiveness of traditional products

Source: compiled by the authors.

There is still competition in Russia between the vertical and horizontal (technology industrial) models for the implementation of industrial policy (Table 4). The state (mostly represented by sectoral interest group members) gravitates towards a traditional (vertical) industrial policy. This orientation is determined by the following factors:

- the existence of instruments to exert a direct influence on public sector companies and the opportunity to make resolute decisions (especially with poorly developed education mechanisms);
- direct mutual obligations between the state and big business with the possibility of enforcement amid insufficient trust between the parties;
- the simplicity with which the consequences of decisions are modelled and assessed, the high speed with which the effects take hold.

Opportunities to elaborate a long-term industrial policy are the most radically restricted in times of crisis, while demand for an industrial policy only grows in a complex economic situation. However, as such demand is determined by the protection of existing production and employment levels it acquires a predominantly sectoral and situational nature. In periods of economic turbulence, demand for budget balancing and stability grows, the positions of the 'budgetary' interest

Table 4. **Characteristics of traditional (vertical) and new (horizontal) industrial policy**

Traditional (vertical) policy	New (horizontal) science and technology policy
Sectoral priorities	Technology priorities
Existing sectors and industries	New industries, creative sector of the economy
Production	Services and production
Import substitution	Exports and new demand
Big and mega business	Newly created small and medium-sized business
Public sector, state development institutions	Private sector, foreign investors
Integrated structures, holding companies	Science and technology networks, clusters, sub-contractor chains
Current interest groups	Search for new stakeholders
Redistribution of revenue	Future changes in the distribution of revenue
Investment, public initiative	Innovations, private initiative
Sectoral development strategies, special-purpose budget programmes, regulation on sectoral levels	Plurality of instruments, quasi-budgetary nature, regulation on company levels
Resolute decisions	Decision-making rules

Source: compiled by the authors.

group grow stronger, while the financial opportunities to implement an industrial policy shrink drastically. The convergence of sectoral and stabilization agendas in industrial policy make it necessary to resort to using a riskier set of tools (riskier in terms of the long-term consequences), tools that involve protective, quota-based and preferential measures. As a result, there is a general shift towards a vertical, sectoral policy with a focus on non-financial, restrictive mechanisms, and formal and non-formal state regulation of the conduct of the biggest companies.

The specific nature of relations between the state and business and mechanisms to assert and coordinate various interests have a considerable impact on the interaction between interest groups when formulating and implementing industrial policy. In the last five years, we have seen increased access to decision-making centres, the institutionalization of new channels for collaboration, and the increasing influence of science and technology interest group. At the same time, the newly emerging technology industrial policy still has some 'vertical' traits, including:

- an orientation towards the interests of large stakeholders, albeit with an increase in their numbers because of the scientific, educational and technological spheres;
- the low level of competition among public institutions with a tendency towards monopolizing views on possible approaches and assessments;
- under valuation of demonstrable effects and transmission mechanisms of best practices, reliance on (quasi-) public resources;
- lack of transparency surrounding decision-making processes and results appraisal processes despite relative openness towards proposals.

The lack of development of 'horizontal' expert instruments, the shortage of objective comparisons of proposals put forward by various interest groups, and the lack of fair distribution of responsibilities between stakeholders is giving rise to an *inconsistent and one-sided industrial policy.*

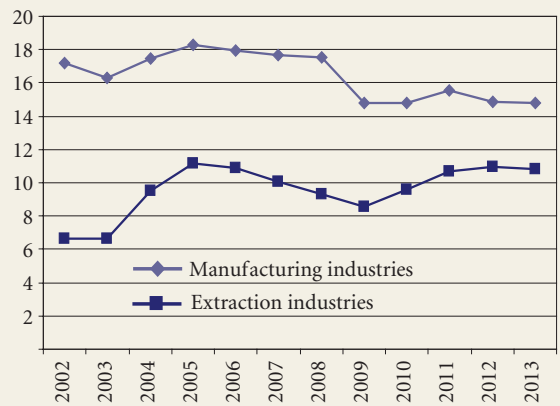
Results of industrial policy: are there any appreciable successes?

The results of Russia's industrial policy of the 2000s primarily show a lack of correspondence between economic realities and the objective declared by the state for over ten years to reduce the role of the raw materials extraction sector and support processing industries. The proportion of extraction industries as a percentage of gross value added shows strong upward trends, while the share of processing industries has been falling since 2002 (Figure 2). Of course, it is important to remember that the accelerated development of raw materials industries was caused above all by the situation on the external market, while processing industries are geared almost exclusively towards domestic demand.

The increased share of innovation output in aggregate output witnessed in recent years has not been accompanied by any perceptible growth in the proportion of research-intensive or high-tech sectors in the economy (Figure 3).

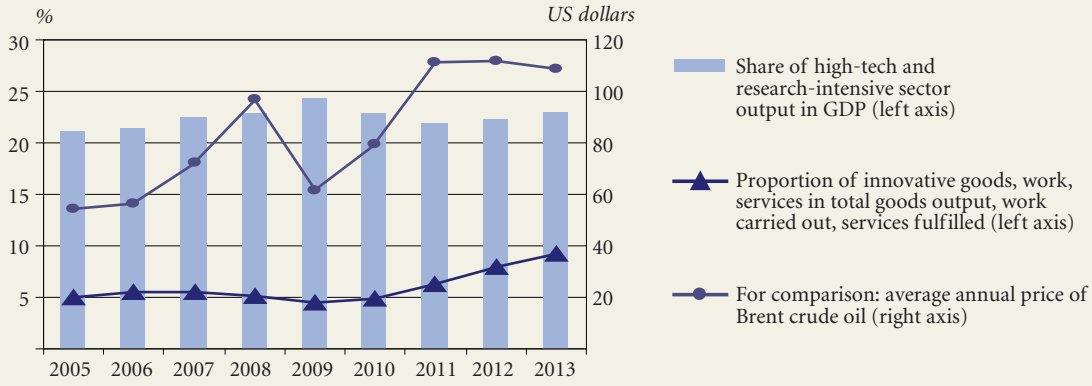
The lack of any clear successes in Russian industrial policy compared to the country's economy as a whole make the task of searching for and studying local achievements in certain sectors and industries all the more pressing. We have selected the automotive industry and nano industry as examples of industrial policy

Figure 2. **Percentage of extraction and processing sectors in gross value added in Russia (%)**



Source: Rosstat databases.

Figure 3. **Percentage of innovation output and output from high-tech and research-intensive sectors in the Russian economy**



Sources: [HSE, 2014a; *Polivanov*, 2014], Rosstat databases.

implementation in Russia. The two industries differ in terms of their initial conditions and development strategies; both are capable of achieving positive results.

The automotive industry is classified as a medium high-tech sector. Larger scales, the existence of large and extra large companies and consistently high interest from the state — these are the sector's characteristics which are in no small part due to the high social importance of a number of businesses for the labour market. The nano industry lags some way behind the automotive industry and is looked at, not from the perspective of supporting employment, but as a bridge to the economy of the future which opens up prospects to capitalize on cutting-edge R&D.

These examples illustrate two fundamentally different approaches to the implementation of a technology industrial policy (Table 5). The automotive industry is a traditional, large-scale industry which attracts investment from leading foreign companies (with a growing degree of new facilities built locally), and enjoys the support for domestic manufacturers (predominantly, to protect jobs). Industrial policy, in nano industry, involves a set of measures to form a new high-tech sector of significant size for the national economy and competitive on a global scale. The key to this is to create the necessary infrastructure (including financial), guaranteeing advanced R&D and striving to increase output of nano-technology.

South Korea can be thought of as a model country in terms of the implementation of industrial policy in the automotive industry, at least regarding the special-purpose aspect of the sector. The government in South Korea actively supported this industry in the 1970s–1980s. Repeating this experience under current conditions is extremely complicated on account of the high level of competition on the

Table 5. **Specifics of Russian industrial policy in the automotive and nano industries**

	Automotive industry	Nano industry
Scope of implementation	Traditional, large-scale, medium high-tech industry	Fundamentally new high-tech sector with the potential to transform into a key sector for the economy as a whole
Start of implementation	2005	2007
Country example	South Korea (1970s-1980s), China and India (1980s)	USA (from 2000)
Interest group / initiator	Structural	Science and technology
Focus	• Attracting foreign investment • Supporting collaboration • Creating new facilities, localization • Import substitution • Supporting employment	• Creating infrastructure • Advanced R&D progress • Commercialization, production of new high-tech output
Innovation model	'Evolutionary' — doing, using, interacting (DUI)	'Neoclassical' — science, technology, innovation (STI)
Policy type	Vertical with horizontal elements	Horizontal with vertical elements
Main instruments and measures	• Customs regulation • Stimulating demand • Financial support for existing manufacturers	• Kurchatov Institute national research centre • Rusnano • Special federal programme 'Development of nano industry infrastructure in the Russian Federation between 2008 and 2011' • Budget funding for R&D

Source: compiled by the authors.

Table 6. **Main outcomes of the implementation of industrial policy in Russia's automotive industry and nano industry**

	Automotive industry	Nano industry
Strengths / achievements	• Attracting foreign investment • Creating new facilities • Cooperation between Russian and foreign manufacturers • Improving production culture	• Creation of new tools and mechanisms to stimulate innovation • Growth in R&D spending and numbers of researchers • Launch of new plants, growth in output and services • Increasing Russian society's attention to advanced nano-technologies
Weaknesses / failings	• Weak impact on import substitution, deterioration of the trade balance • Diverse structure of the sector, retention of ineffective businesses • Lack of significant progress in raising research and design skills • Compromise, and increasing gap between the old and new segments in the sector	• Narrow circle of beneficiaries • Weak demonstration effect • Deficit of new potential projects • Orientation towards state support, limited inflow of private resources

Source: compiled by the authors.

global automotive market and various institutional restrictions, including international trade agreements within the WTO. In addition, some elements of the policy supporting the Russian automotive industry have clearly been borrowed from countries with more recent experiences in fostering automotive industry, primarily China and India. Distinctive features of the automotive industries in these countries include the existence of one or more large national automobile manufacturers, extensive development of joint enterprises, and the creation of assembly lines with a growing trend of extreme localization, for example.[5]

Considerable impetus for the development of a policy to advance nano industry in Russia and a model for its implementation came in the form of the US National Nanotechnology Initiative, announced in 2000.[6] It should be noted that despite the frenzied discussions about support for nanotechnologies in 2004–2006 (including at a governmental level), the state policy supporting the industry was only launched between the end of 2006 and early 2007.

The initiator of industrial policy in the domestic automotive industry was a structural interest group, while in the nano industry it was the science and technology group that was the source of the policy. The absence of significant practical steps to develop the nano industry in the first half of the past decade is in no small measure linked to the lack of a core department with a direct interest in the project's success.

In keeping with the differences in the focus of industrial policy, its target directives, and aspects, the tool kit used by the state also differed. The automotive industry was incentivized through customs tariff regulation, supporting demand for domestic output (including foreign producers), and various forms of budget funding for specific enterprises (primarily, AVTOVAZ). In contrast, the nano industry saw the formation of a large-scale development institution (Rusnano), the launch of a special federal programme to establish the necessary research and information infrastructure[7], the set-up of a national research centre with the corresponding profile, and budget funding for R&D.

If we look at the innovative development models chosen by the state in these two sectors, the nano industry applied a classic STI model with support for all stages of the innovation cycle: fundamental (through the efforts of the Kurchatov Institute national research centre and certain academic institutes), applied research (through direct budget funding, and to a lesser degree through funds from state development institutions and funds), and commercialization (primarily, through Rusnano). However, the automotive industry used a DUI model, based on close cooperation with leading foreign producers.

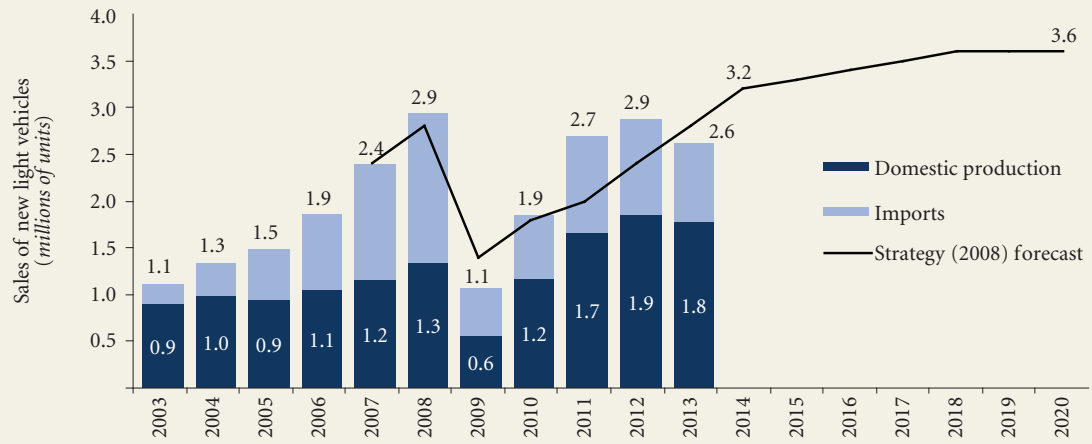
Neither of the examples analysed is a clear-cut vertical or horizontal form of industrial policy. However, the development of the automotive industry, oriented towards large-scale and mega stakeholders and clearly geared towards import sub-

[5] For more on country-specific industrial policy models in the automotive industry, see: [*Simachev et al.*, 2014].

[6] It is no coincidence that the document launching the active implementation of the nano industry support policy in Russia was named a presidential initiative, entitled the 'Nano industry development strategy' [Ministry of Education and Science, 2011].

[7] Special federal programme 'Development of nano industry infrastructure in the Russian Federation between 2008–2011' (approved by Resolution of the Government of the Russian Federation no 498, dated 02.08.2007). Available at: http://www.fcpnano.ru/, accessed 12.10.2014.

Figure 4. **Dynamics of the Russian light vehicle market**



Source: calculations by the authors based on materials from [Ministry of Industry and Trade (or Minpromtorg), 2010] and Rosstat databases.

stitution, definitely gravitates towards a vertical model in conjunction with the large-scale involvement of foreign investors which is characteristic of a horizontal policy. On the contrary, support for the nano industry as a fundamentally new high-tech sector, the creation of new businesses and stimulating exports are all predominantly horizontal measures, notwithstanding such vertical policy attributes as the overarching role of the state and state institutions.

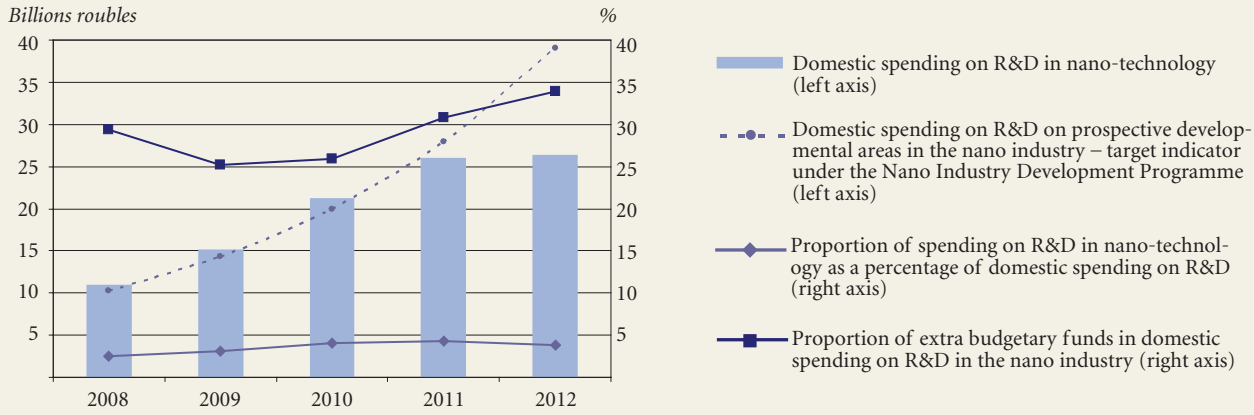
The result of support for the automotive industry was the immediate arrival in Russia of several leading global manufacturers, the formation of stable alliances between domestic and foreign companies, the launch of a number of new enterprises and, as a result, a rise in the overall culture of production and progress in industrial development in certain regions. State policy in the nano industry has made it possible to develop and introduce new instruments to stimulate the sector (including the specialist development institute, Rusnano), achieve growth in research activity in this field, set up new plants and increase the volume of output and services carried out, and has attracted the attention of the state and society to the issue of developing nano-technology in Russia.

Nonetheless, achievements in both sectors are limited. In the automotive industry, the measures undertaken by the state did not improve the trade balance: from 2000 to 2011 imports of vehicles in value terms increased by almost 40 times, while exports increased only four-fold. In essence, Russia is now occupying an intermediate position between countries where supply comes from foreign branded manufacturers and national players are virtually lacking (for example, Brazil) and countries where the automotive industry is developing in collaboration with international companies (India, China, etc.) However, according to foreign trade balance figures, automotive industry output in Russia is lagging far behind these countries. Although Russia is one of the largest importers of vehicles, for exports (in 2011) the country was far from the top of the list, surpassed by South Africa and the United Arab Emirates among others. The policy has not resulted in the development of research and design skills among Russian vehicle manufacturers. Previous players, whose competitiveness is largely because of state support, still continue to exist in the market.

In the nano industry, despite vast sums of state funding (over 200 billion roubles over the period from 2007 to 2012), the actual growth in R&D spending (Figure 5) and nano-technology output and services (Figure 6) are visibly behind the targets set out in the corresponding basic programme document, the Programme for the Development of the Nano Industry in the Russian Federation up to 2015 [Ministry of Education and Science, 2010]. While the gap between planned and actual nano industry output in recent years is showing signs of shrinking (despite the still relatively modest involvement of portfolio companies in Rusnano), the gap between actual and planned R&D spending (as set out in the development programme) is actually increasing.

The discrepancy between actual nano industry dynamics and the planned guidelines set by the state could suggest both that the policy is insufficiently effective and that the goals set in early 2008 (which have not been adjusted since) were excessively ambitious. We should be more wary that the group of beneficiaries of

Figure 5. **Dynamics of domestic R&D spending in nano-technology**



Source: compiled by the authors based on the materials [Ministry of Education and Science, 2010; HSE, 2010; NRU HSE, 2011, 2012, 2013, 2014b; Centre for Scientific Research and Statistics, 2009, 2013] and based on data from Rosstat.

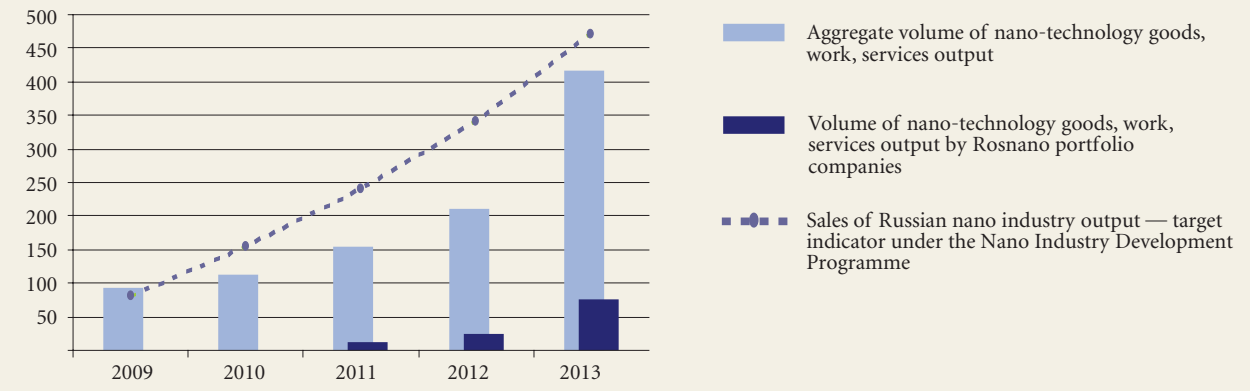
this support is too small, examples of success in this field are isolated and do not have any significant demonstration effect, and the main stakeholders and interest groups are focused on obtaining and exploiting state funds with relatively modest private investment.

On the one hand, the evidence presented above do not allow us to consider Russia's experience of industrial policy in the automotive and nano industries an unequivocal success. On the other hand, they do show signs of significant progress in both fields; the positive results, in our opinion, clearly outstrip the negative.

To conclude this section, we now make several recommendations, each of which has proven its effectiveness in at least one of the two sectors.

1. Implementation of measures in the initial stages that meet the interests of both old and new groups. This makes it possible to avoid any strong initial opposition, gain time to form new interest groups, clarify the real aims of the stakeholders, and lay down possible consolidation methods.
2. The application of new support instruments with limited use of traditional mechanisms such as special federal programmes. The use of the usual tool kit makes the traditional beneficiaries of state support active and provokes strong competition between them, which makes its use undesirable.
3. The lack of or a reasonable number of quantitative targets, which reduces the risk of distortions or manipulations in pursuit of the planned figures and makes it possible to focus on qualitative changes and to re-assess and hone constructive objectives.
4. The existence of a charismatic leader (political ministry) who combines personified responsibilities with far-reaching rights and powers. In an ideal world, this should be a figure with excellent professional competencies and who en-

Figure 6. **Dynamics of nano industry output** (billions of roubles)



Source: compiled by the authors based on the materials [Ministry of Education and Science, 2010; HSE, 2011, 2012, 2013; RUSNANO, 2012, 2013].

joys the trust of both the authorities and the population, which significantly restricts the number of potential candidates.

5. An orientation towards consumer demand, guaranteeing attention from all levels of the population, fair assessment, independent controls, and significant social support as a minimum from the very beginning.
6. Openness, globality, an orientation towards the global market (including technology and capital) and strategic foreign investors. All these should help to develop new skills, acquire new knowledge and capabilities, to carry out objective assessments, and benchmark the current state of the sector and existing work done.
7. Refusal to be geared towards rapid science and technology breakthroughs, which simplifies international collaboration, including in terms of technology and training transfers. This should also spare the country ineffective efforts in searching for and making practical use of its own strengths and conserving — often imaginary — local advantages.

Lessons for the future

At various times, Russia has made many attempts to implement an industrial policy. Due to the attractiveness of this tool in the eyes of politicians as a simple and effective mechanism for collaboration with society, redistribution of revenues and for satisfying the interests of economic actors, such attempts will be repeated. An industrial policy makes it possible to reformat the traditional set of measures to improve the investment climate and optimize state regulation, and combine divergent policies to focus on clear and measurable goals. Taking into account the various forms of domestic industrial policy, it is useful to highlight certain patterns and features.

The industrial policy of Russia in the 2000s was aimed primarily at avoiding negative structural changes and offsetting the losses of domestic producers. The direction of this policy was largely shaped by attempts to use Soviet science and technology capacity. It was only recently that the signs of a proactive agenda started to emerge: industrial policy was re-oriented towards supporting progressive changes in the structure of the economy, the development of new sectors, and the dissemination of advanced skills and knowledge. Innovation policy was also shifted in favour of more active development of new skills and fields of knowledge.

The predominantly latent nature of the industrial policy conducted by the state often led to a discrepancy between the declared and real objectives, a reinforcement of the revenue-oriented behaviour of stakeholders and secret lobbying for the interests of certain businesses and owners. The superior lobbying abilities of traditional groups make it possible to implement a vertical industrial policy model, which is hard to predict and fragmented. The system of industrial policy priorities is being continuously transformed: the range of priorities expanded to such an extent that they have been stripped of their main role of consolidating the efforts of the state and business to work on certain breakthrough developmental areas. As a general rule, priorities are chosen and changed without a broad dialogue between society, the state and business.

The implementation of an effective industrial policy in Russia, both vertical and horizontal, is also hampered by the poor quality of state institutions, the lack of or ineffective feedback channels, and the shift in the competencies of state officials from a technocratic profile (sectoral, science and technology) towards a predominantly economic (financial, managerial, or institutional) background. In addition, restrictions in priority setting due to the dominance of existing interest groups and ineffective agreements are further obstacles.

Russian industrial policy traditionally opted for the distribution of financial resources, while regulatory instruments were seen as ineffective. The key directions of industrial policy were stimulating domestic demand (including through public procurement) and establishing quotas and preferences for certain groups of producers. No system to assess the outcomes of domestic industrial policy was actually developed. An evaluation procedure only came about using non-transparent rules based on aggregate assessments by potential beneficiaries. Under these conditions, the identification and dissemination of best practices was kept to a minimum.

We now set out several lessons that could optimize the new industrial policy in Russia.

First. Global experience shows that the requirements for industrial policy, its instruments, and other opportunities change significantly with time. Adapting to

changing conditions requires a continuous review of previous approaches to industrial policy and the implementation of new ideas and solutions. It is extremely difficult to transfer successful experience and replicate the successes of other countries.

Retrospective (*ex post*) assessments of industrial policy are valuable not just for their ability to identify the necessary (correct) content and direction of the policy, but also to formulate principles to develop, implement, monitor and review it. Methods to formulate and implement politics alongside quality state management play a decisive role in this area.

Second. It is widely recognized that a central element of industrial policy is the system of sectoral and technology priorities, which has not yet been formed in Russia in any clear and valid way. At the same time, every new round of interest in industrial policy in Russia started with a discussion of priorities. Unfortunately, these broad-based discussions were typically limited by this topic.

Setting limits on the number of priorities is a complex political task, requiring the state to refuse to support a given sector despite lobbying efforts by that sector's representatives. Evidence shows that the transition from sectoral priorities to technology priorities does not radically change the situation: traditional priorities still exist in the science and technology sphere.

Third. Countries that have achieved relative success in the implementation of industrial policy gambled on an orientation towards the global market, guaranteeing global competitiveness and attracting foreign investors. Today, an effective industrial policy is impossible without transparent and sufficiently free entry and exit conditions for major players, without the involvement of foreign partners (financial or technological). Otherwise, such a policy devolves into imitation (or worse still, simulation) of successes, giving rise to strong information asymmetry and contradictory images of what is actually happening in the economy in the eyes of society and the public authorities. Globalization requires consistent formation of global value chains, the transfer and broadening of current skills, the selection of strategic partners and the creation of international technology alliances.

Fourth. The problem of correctly assessing scientific and technological potential and areas where this potential can be used is of great importance for implementing technology industrial policy. Numerous assessments appear to be overestimates as they are based on 20–30 year old ideas, in particular with regard to the structure of demand for technology in business and the economy as a whole. The dependence on the legacy of past decades is sometimes politically motivated and often blocks new approaches and the development of international technology cooperation.

Fifth. The analysis of certain examples of industrial policy implemented in Russia showed that the stability of the changes is critically dependent on the rapid formation of new interest groups (re-orientation of a portion of existing groups towards modernization goals). Consolidation of new interest groups is more probable in emerging sectors where traditional networks are not yet strong, in order to fully monopolize industrial policy instruments. At the same time, the emergence and consolidation of such groups is often unwittingly hindered by the state, pushing its best individuals into public service.

Sixth. A negative attitude towards particular policies and the activity of the state in certain areas should not impose a taboo against studying the related issues. The long-term lack of an official industrial policy in Russia has led to the low quality of its formation and implementation as well as of the culture surrounding its research.

The categorical nature and ideological bias of discussions surrounding industrial policy and the lack of pragmatism and substantiation are all hindering a rationalization of industrial policy. The range of opportunities and risks in terms of developing and implementing industrial policy in the modern world are only multiplying. Therefore, of crucial importance is the exchange of reasoned and verified opinions on the forms of industrial policy, the forecast results, and, above all, on the undesirable or directly destructive measures. F

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Knowledge Intensive Business Services: The Russian Experience

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Knowledge-Intensive Business Services (KIBS) are seen to be a core sector of the so-called 'knowledge economy', and already play an important role in developed economies. The KIBS providers are both innovate themselves and provide their clients with knowledge and learning opportunities.

This paper examines the status of KIBS in Russia, and explores some key issues in their role in innovation using data from surveys of KIBS firms and their clients.

Russia as a Service Economy

The global economy is shifting from agriculture and manufacturing to services, as measured by the percentage of the workforce employed in each sector and the value created by the different sectors. The International Labour Organization reported that for the first time in 2006, more people worked in the service sector worldwide than in either the manufacturing or agricultural sectors [*Spohrer, Maglio*, 2008]. Industrial economies have largely become service economies in these terms. By 2006, the service sector was responsible for over 70% of US and European Union-15 (EU-15) value-added, and just under 70% of Japan's. The share of employment in services was 81.4% in the US, 72.6% in EU-15 and 68.5% in Japan [*European Commission*, 2011].

Russia has been moving in a similar direction, especially since market reforms were introduced in recent decades. In the Soviet era, while manufacturing activities were given numerous privileges and released from hard budget constraints, the service sectors were treated as 'unproductive' and played a minor role in economic and social development. In 1989, the share of services in the USSR's GDP was between 30%–40% [IMF, 1991]. There was an almost complete lack of policies for a service economy .

The situation changed when market reforms started in the early 1990s. Economic liberalization led to domestic producers facing international competition; domestic prices for inputs such as energy have gradually approached world market levels. Many industrial enterprises went bankrupt. The services sector, however, absorbed some of the displaced labour and idle resources, It also provided job opportunities for new labour market entrants, and mobilized additional resources. Importantly, although many service jobs are fairly low skilled, the sector overall absorbed relatively skilled labour and created new incentives for skill formation [*Langhammer*, 2008]. Service industries are very diverse, and feature both low and high-skilled jobs in large numbers.

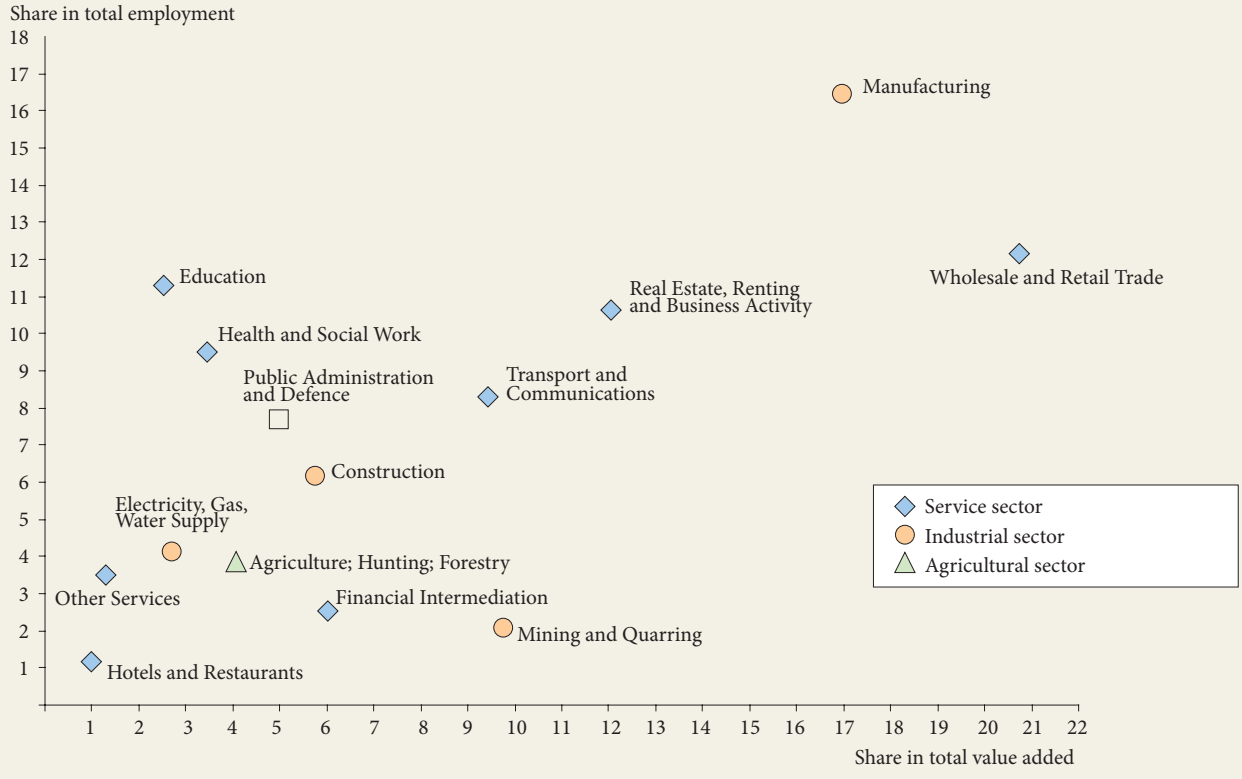
At the dawn of market reforms, Russia suffered from a severe deficiency in a competitive supply of services, especially those service industries supporting businesses. The sharp rise in demand together with a large stock of available resources (primarily human resources) enabled quick growth of the service sector in Russia. Its contribution to the national economy has almost doubled according to recent World Bank data, and now embraces 60% of GDP and 63% of employment. Figure 1 shows that while the manufacturing sector contributes more employment and output than any of the individual kinds of services, market services combined easily outweigh manufacturing. Public services exceed manufacturing in terms of employment, but (due to the statistical calculation methods) appear to lag in terms of value-added.

The KIBS Phenomenon

Business services, as well as the service sector on the whole, have shown substantial growth in the last 50 years, during which time they have become increasingly important elements of most Western economies. We use the term 'business services' in a broad way, understanding that some service sector firms may provide their outputs to consumers as well as to businesses and other organizations that support diverse business processes by providing similar services (for example, telecommunications, transport and financial services). Others may only offer services to organizations. For this reason, we distinguish between 'business-related services' (BRS) — services of all sorts that businesses and other organizations may purchase to support their business processes – and 'business services' (BS) — which are supplied predominantly to support business processes, and are relatively rarely acquired by consumers.

Statistical classifications have adjusted considerably to accommodate the growing importance of BS. In the long-standing *International Standard Industrial Classification* (ISIC) (most) BS were included under Division *K* — Real estate, renting and business activities, which with successive revisions of the ISIC was increasingly treated as a separate category from the 'Major Division' of services (Financing, insurance, real estate and business services). Towards the end of the 20th century, new and more elaborate classification frameworks were introduced, such as NAICS in North America and NACE in Europe. These too have

Figure 1. **The structure of the Russian economy by main economic sectors: 2013** (%)



Source: Federal State Statistics Service (FSSS) database, 2013.

undergone successive revisions. The most recent of revision of NACE (NACE rev. 2, adopted in 2008) provides useful insights on the structure of BS.

NACE rev. 2 divides the economy into 21 'sections'; two of these are particularly relevant to BS: ***M* — Professional, scientific and technical activities**, and ***N* — Administrative and support service activities**. Section *M* has seven divisions — division 69 [Legal and accounting activities]; 70 [Activities of head offices; management consultancy activities]; 71 [Architectural and engineering activities; technical testing and analysis]; 72 [Scientific research and development, R&D]; 73 [Advertising and market research]; 74 [Other professional, scientific and technical activities]; 75 [Veterinary activities]. The last sub-division of section *M* (75) is something of an anomaly. Section *N* covers six divisions, whose activities range from office support through security services and renting and leasing — some of these activities (like travel agencies) might better be considered as BRS, since they often serve consumers. We should point out that Section J — dealing with Information and Communication activities — includes several divisions that mainly support business processes, such as division 62 [Computer programming, consultancy and related activities].

An important feature of the activities in Section *N* (and division 62) is that these are typically activities that require a great deal of professionalism and specialized knowledge. For this reason, they are labeled KIBS (Knowledge Intensive Business Services). Within this category, researchers commonly differentiate between **P-KIBS** (traditional professional services such as accountancy and law, requiring specialized knowledge of organizational structures and regulations), and **T-KIBS** (technology-related services such as computer services and engineering services, requiring specialized scientific and technical knowledge). Recently, there have been suggestions that a third category — C-KIBS ('creative' business services) should be used to capture the distinctive features of activities such as advertising, industrial design, architecture, and a few other KIBS that require aesthetic and creative capabilities, and associated, specialized knowledge.

Most KIBS industries in many Western countries displayed substantially higher rates of growth compared to other market services and the economy as a whole (Table 1). The recent economic crisis has had uneven effects on different KIBS; they are rebounding in countries that have managed to weather the crisis.

Miles [2005] reviewed the major features of KIBS, including the undeniable fact that they tend to employ an unusually high share of graduates. The specialized knowledge that KIBS rely on may not always be acquired in higher education, but many KIBS firms insist employees have a higher education degree. KIBS sectors feature a higher share of small and medium-sized firms than manufacturing sectors: many of which are highly specialized and/or localized because of the need for personal contact and trust between KIBS suppliers and clients). However, most of these sectors also feature a few large, transnational companies which often provide services to transnational clients. Furthermore, KIBS often have higher shares of women in the workforce than the economy as a whole.

KIBS are problem-solvers, dealing with issues arising in different types of business processes, where the client seeks external specialized knowledge. It is often preferable to acquire these services externally, rather than in-house because of cost reasons, rapid changes in the sorts of knowledge required, and the benefits of getting external points of view, etc. The sorts of problems and knowledge involved include:

Table 1. **Share of KIBS in leading economies (%)***

		1975	1985	1995	2005	2006	2007
Value added	EU-15	4.7	6.7	8.7	11.5	11.7	12.0
	USA	…	7.2	9.4	12.9	13.0	13.3
	Japan	2.3	4.3	6.1	7.7	7.8	…
Employment	EU-15	4.0	5.6	8.6	11.9	12.2	12.6
	USA	…	8.2	11.0	13.2	13.4	13.5
	Japan	2.9	4.9	7.1	10.6	10.9	…

* Due to difficulties in comparing regions, KIBS here includes rental services (NACE rev. 1.1 71) alongside NACE rev. 1.1 categories of computer and related activities (72), research and development (73) and other business activities (74).

Source: Table 2.1 in[European Commission, 2011].

- administrative rules and regulations (legal and accountancy services);
- markets, branding and public relations (marketing, advertising, various consultancy services);
- movement, location and storage of goods, equipment and materials (supply chain management, logistics services, repair and maintenance);
- design, safety, effectiveness and related issues of aesthetics and regulation of built environments and infrastructure, goods and services (architectural and engineering services, design services, etc.);
- measurement and adaptation of properties of materials, chemicals, and devices (testing services);
- development of useful knowledge about problems associated with natural or social science and engineering issues (R&D services);
- configuration, integration, maintenance and application of information-processing hardware and software for business processes;
- gaps in skills, human relations, and organizational design (consultancy, counselling, education and training services, etc.).

The use of KIBS reflects several distinct trends. Social, economic and environmental challenges confront organizations of all sorts at some point, both directly and through the need to adapt to regulatory responses to the problems. New technologies also emerge, presenting problems and opportunities. In such cases, organizations may find that they lack sufficient knowledge internally and cannot acquire them rapidly enough. The problems may arise only occasionally or change so rapidly that the most efficient solution is to acquire highly specialized knowledge from external sources. Sometimes KIBS are used because regulatory requirements, informal norms or internal conflicts require disinterested third parties to be brought in. Finally, *outsourcing* is meant to cover the use of BS to focus on core capabilities and reduce the costs of in-house provision of non-core services.

Problem-solving may involve applying specialized skills and knowledge to a client who does not possess such knowledge, or generating new knowledge to address new problems. The view of KIBS as problem-solvers is reflected in arguments that this sector constitutes a 'second knowledge infrastructure', alongside the familiar knowledge infrastructure of universities and government laboratories [*den Hertog*, 2000]. Innovation is often a matter of overcoming problems, providing better solutions to problems, or using existing knowledge to develop new opportunities that lead to the recognition of 'latent' demands. KIBS act to support organizations that are confronting problems in their routine business processes, or are trying to turn a new idea into a commercial or socially useful application which attract attention from innovation practitioners, policy makers, and researchers. R&D services (and some engineering and testing services) are intimately related to innovation; they generate knowledge for their clients. T-KIBS in general often diffuse new techniques and systems to their clients, and are thus significant actors in innovation systems. Even P-KIBS — who can be important for organizational innovation — can play roles in technological innovation. Some KIBS acquire and apply strong competencies that can inform their clients' technology strategies (e.g. accounting and management firms providing IT services for clients, as well as regulatory and market advice for innovation). The point is not just that KIBS know or can create knowledge about solving problems. They are also able to involve their clients by sharing knowledge with them, or actually creating knowledge jointly with them. Thus, we note the presence of learning processes, potentially for both KIBS *and* clients.

The KIBS customer thus enters the equation in an important way. There can be difficulties in terms of service quality when the client has not chosen the most appropriate service supplier, or where they have not even specified their problem adequately. However, there may also be problems arising from a failure to recognize the necessity of engaging substantially with the KIBS supplier and thus to effectively co-produce the service. While it is difficult to estimate how extensive and costly such mismatches between client expectations and the performance of KIBS are, there is much evidence that they occur fairly often.[1] Thus innovation policy makers and educators should not only recognize the importance of KIBS in innovation systems, but should also be aware that improving the contribution of KIBS to national (and regional and local) economies may

[1] For a recent review, see [*Miles*, 2012]; for a perspective on how KIBS firms can manage their clients, see [*Bettencourt et al.*, 2002].

involve more than just promoting the KIBS sectors, their attractiveness as employers, the skills available for their use, and so on. It is also a matter of helping to ensure that potential clients of KIBS are well-informed about the potential opportunities arising from the use of KIBS, and what they need to do to realize these opportunities.

KIBS in Russia

Within the Russian services sector, business services are becoming increasingly visible. In the Soviet period, the majority of BS did not exist while the few that were present did not provide tradable outputs on a market. Some services — like audit, marketing, and logistics — were deemed unnecessary in a planned economy. Others, like legal services, banking, and insurance existed although with a narrower range of operations than now; their quantities and prices were however centrally established to avoid risks and competition. Technology-related services like IT, telecommunication and engineering services lagged behind international counterparts, in part because they were provided within centrally planned value-added chains (when they were not internal functions performed by special departments of manufacturing enterprises).

With market reforms, BS have become important inputs for all Russian businesses. Their contribution to leading economic sectors is comparable with that of traditional factors of production in Russia and Europe (see Table 2). The share of employees in KIBS as a proportion of total employment in the economy has increased from almost zero in the late 1980s to 3.3% in 2013.[2] The figure itself may not seem impressive as it is substantially lower than the EU average (approximately 12%). However, in Europe the landscape is uneven: Western European countries tend to have high shares of BS, while Central and Eastern European countries have substantially lower proportions, often quite comparable with those of Russia [European Commission, 2014, p. 66].

While business services on the whole are measured by both national and international bodies (see, for example, Table 2), KIBS are barely accounted for in Russian statistical publications. The Russian Classification of Economic Activities reserves separate groups and classes for a few, such as auditing (74.12), engineering (74.3 and partially 74.2), advertising (74.4) and recruiting (74.5). Other codes either combine business and consumer services (for example, design: 74.87.4), IT-related activities (72), legal services (74.11) and real estate

Table 2. **Structure of firms' total production costs (%)***

Articles of expenditure	Russia				EU-25			
	Overall	Agriculture	Manufac-turing	Services	Overall	Agriculture	Manufac-turing	Services
Land	0.6	13.0	0.0	0.0	0.1	6.5	0.0	0.0
Unskilled labour	11.3	30.7	8.7	13.7	14.3	32.2	14.2	16.1
Skilled labour	5.3	0.5	1.7	9.6	10.4	2.2	6.0	14.5
Capital	21.4	8.0	16.4	30.9	17.7	14.2	11.1	23.9
Natural resources	2.7	1.4	6.8	0.0	0.1	1.6	0.3	0.0
Agricultural goods	2.8	19.9	3.9	0.8	1.4	11.1	3.3	0.3
Manufacturing goods	28.8	13.4	38.2	22.3	23.7	18.4	44.8	12.1
Services	27.1	13.2	24.3	22.8	32.4	13.8	20.4	33.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

* Share of services indicates the median from **seven agricultural products** (cereals, vegetables and fruit, oil seeds and plants, meat and fish, milk and dairy products, vegetable oils and fat, sugar); **15** manufacturing industries (beverages and tobacco; food products n.e.c. (not elsewhere classified); forestry and wood products; paper products; publishing; mineral products; textiles; leather products; chemical, rubber and plastic products; base metals and metal n.e.c; motor vehicles and parts; transport equipment n.e.c; electronic equipment; machinery and equipment; and manufacturered products n.e.c.) and **nine service industries** (electricity, trade, sea transport, air transport, communication, financial services n.e.c, business services, insurance, other services).

Source: calculated from Global Trade Analysis Project database, March 2012. Available at: https://www.gtap.agecon.purdue.edu, last accessed: 17.07.2012.

[2] Calculated from the FSSS database using the Eurostat's definition of business services. Business services statistics are classified according to the NACE Rev.1 classification. Until 2001, the business services data covered NACE Rev.1 classes 72.10-72.60, 74.12, 74.13, 74.14, 74.20 and 74.40. From 2003, the data also cover the classes 74.11, 74.30, 74.50 and 80.42. For a discussion of KIBS in NACE, see [*Schnabl, Zenker*, 2013].

services (70.3), or they are partially included in other relevant economic activities (e.g. by reducing marketing services in market research and public opinion polling, 74.13). Thus, current statistics on KIBS are fragmented and present a distorted picture. Alternative estimates of their activities can only be found in a few studies, which are mostly in Russian and use surveys to collect empirical evidence. For example, [*Doroshenko et al.*, 2010] estimated the share of KIBS in Russia's GDP at 3-5% in 2007.

The data used here derive from specialized annual surveys carried out between 2007 and 2010 in Russia. The surveys reached 600–800 producers of KIBS annually.[3] While the surveys were fundamentally similar, some questions were only asked in particular years. Thus, when we report on KIBS characteristics below, we use data from various years according to availability. 55 to 65 market-leading Russian-based KIBS producers (big and medium sized companies)[4] were surveyed each year for each of the observed KIBS sectors. Executives answered questions about their own company and more general market developments. All surveys are anonymous and some firms took part in several surveys (not necessarily successive), but that does not negatively affect the generalisability of the results. The KIBS sectors surveyed are: advertising, marketing, audit, IT services, recruitment, engineering, financial advice, legal advice, property development services, and business design. This list includes most of the industries described as KIBS in the existing literature.

The study is unusual in that we had the opportunity to draw on data about KIBS users as well as suppliers (although we cannot match specific users and suppliers). In 2007 and 2011, a parallel survey covered over 700 business consumers of KIBS (firms that used none of the KIBS in our survey were excluded). Each of the business consumers were asked about their experiences with all KIBS from different sectors, resulting in over 2000 observations by customers about their experiences with KIBS sectors. Each respondent answered questions about all KIBS used by the company. In 2007, the average company used 4.7 services, and in 2011 — 4.2 services. This provided about 3300 answers from the KIBS' clients. The design and analysis of these surveys were also informed by structured interviews, conducted on an annual basis with at least six experts from each KIBS sector. These are drawn from the top executives of the leading provider companies from each sector; their interviews were used to preliminarily discuss research hypotheses, to scale the quantitative answers to be used in the mass surveys, and to inform our interpretations more generally.

Our study confirmed that before the recent crisis, the KIBS sector was growing at 20–25% annually, well above the average economic growth rate.[5]

The severe market crash in 2009 contracted the markets for KIBS, as businesses sought to reduce their costs. Perhaps KIBS inputs were still regarded as something of a novel luxury. The contraction of Russia's KIBS sector is estimated to have been 13% in 2009, and since then recovery has been uneven and uncertain (see Table 3).

Clients, Co-production and Innovation

Tether et al. [2001], using German survey data, discuss variations across service firms and sectors (including KIBS industries) in terms of the extent to which they standardize or particularize (or customize or specialize)[6] their services. The basic idea underlying standardization is to produce a large amount of almost

[3] The surveys were designed by the Institute for Statistical Studies and Economics of Knowledge, National Research University 'Higher School of Economics' (HSE ISSEK) and were conducted by ROMIR Monitoring, using original topic guides and questionnaires developed specially for this research.

[4] Our 2007 survey established that KIBS production in Russia is strongly concentrated, roughly following the Pareto principle: 20% of the companies accounted for 80% of the market. Respondents for the survey in each segment are recruited from the top 200 companies (measured by their turnover). While some of the same companies are surveyed in more than one year, the study was not designed as a panel survey. Indeed, data are provided to us anonymously, so we cannot examine the effect of such multiple representations. Foreign-owned companies are excluded from the study as the large multinationals who do supply Russian markets are believed to provide highly standardized services — this was confirmed by our expert interviewees. Russian companies compete with these multinational firms, in part, through providing more customized services; they would generally fail to compete in the standardized services market on the basis of economies of scale.

[5] GDP in 2000–2008 increased by only 7% per year, according to FSSS data (available at: http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/accounts/#, last accessed: 30.10.2014).

[6] While it is possible to draw useful distinctions between different approaches here — see the discussion of customization later in this paper — there is little consistency in the usage of these terms in the literature.

Table 3. **Annual growth rate of Russian KIBS sectors after the 2009 crisis (aggregated responses, %)**

Question: 'Please estimate the growth rate of your market in the last year'

KIBS Sectors Used	2009	2010	2011	2012	2013	2008 to 2013
Overall	−12.5	3.2	4.3	1.4	3.1	−1.6
Advertising	−17.2	0.0	1.1	−2.3	6.3	−13.1
Marketing services	−15.2	2.6	−0.3	−0.5	3.3	−10.9
Audit	−12.8	−0.6	−2.4	4.3	−2.3	−13.8
Information Technology services	−9.3	9.0	20.5	−1.0	6.0	25.0
Recruitment services	−14.3	4.3	−4.2	4.0	2.4	−8.8
Engineering services	−19.8	−3.9	11.0	−1.1	0.7	−14.7
Financial Advice services	−5.2	12.7	16.8	0.9	1.1	27.3
Legal Advice services	0.1	9.4	−1.6	7.7	7.0	24.2
Development services	−17.8	−2.3	1.2	8.4	3.4	−8.9
Business Design	−14.3	−0.3	6.2	2.3	1.3	−5.9
Annual GDP growth rate (2008 prices)*	−7.8	4.5	4.3	3.4	1.3	5.3

* GDP data from FSSS database (available at: http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/accounts/#, last accessed 30.10.2014).

Source: successive HSE ISSEK — ROMIR surveys of KIBS providing companies.

identical services, and to benefit from economies of scale achieved through routinized service production. Yet standard services are not suitable when the service is providing a solution to a problem that has many particularities and/or a few very critical ones).[7] Such a problem may call for some considerable effort on the part of the KIBS supplier. It may be that the understanding of the problem's root causes by the client, as well as by the KIBS firm, is shifted in the course of this 'diagnosis' phase of the problem. The service, as a solution, is individually tailored and tuned to the needs of the particular customer. This tuning is a knowledge-intensive process, which cannot readily be decomposed into a sequence of predetermined operations.[8] This kind of service production needs highly qualified, creative human resources. These knowledge intensive services are heterogeneous by nature, and highly relevant for a study of the innovative potential of KIBS. Tether et al. [2001], for example, found that in some (but not all) service sectors, high levels of standardization went along with lower levels of reported innovation (including process as well as service innovations).

The Russian survey data of KIBS firms addressed this issue in 2011 with a question asking providers about their experience in replicating service innovations (see Table 4). Surprisingly, over 40% of services were reported as **never** replicated to other customers. Another 24% reportedly were **rarely** replicated in

Table 4. **Replication of innovations (share of responses selecting each answer out of the total surveyed, %)**

Question: 'How often do you manage to supply service innovations to a customer which you co-created with another customer?'

KIBS Sectors Used	Response options			
	often	sometimes	rarely	never
Overall	9.3	25.6	23.6	41.5
Advertising	10.4	23.4	22.1	44.2
Marketing services	18.0	23.0	27.9	31.1
Audit	4.8	30.6	24.2	40.3
Information Technology services	3.3	43.3	18.3	35.0
Recruitment services	6.8	16.9	30.5	45.8
Engineering services	5.8	32.7	38.5	23.1
Financial Advice services	13.0	20.4	22.2	44.4
Legal Advice services	11.7	11.7	15.0	61.7
Development services	10.9	29.1	12.7	47.3
Business Design	8.1	25.8	25.8	40.3

Source: HSE ISSEK — ROMIR survey of KIBS firms, 2011.

[7] In the case of customization, it may simply be a matter of adapting an existing service design to a specific client's requirements, as in the case of many adaptations of standard data base systems to specific customers' requirements that differ from each other only in detail. In the case of particularized services, a more distinctive solution is created that fits the particular problem presented by the client.

[8] Yet KIBS providers may well use project management tools and best practice handbooks to guide them through the stages of problem diagnosis, and service design and delivery.

Table 5. **Distribution of KIBS in Russia by degree of standardization (share of responses selecting each answer out of the total surveyed, %)***

Question: 'What share of your total sales value in 2010 falls into each of these categories of standardization, where 1 = completely standardized, and 3 = fully customized?'

KIBS Sectors Used	Degree of services' standartization		
	Standard	Standard 'nucleus' with a personalized 'shell'	Customized
Overall	36.1 (32.6)	39.2 (31.1)	24.5 (29.6)
Advertising	30.5 (30.9)	43.6 (31.6)	25.3 (28.1)
Marketing services	42.0 (32.5)	43.5 (31.2)	14.4 (19.5)
Audit	45.2 (32.9)	33.4 (29.0)	22.5 (27.6)
Information Technology services	43.8 (28.6)	39.0 (26.0)	17.6 (18.0)
Recruitment services	38.7 (30.2)	44.4 (26.8)	18.2 (19.7)
Engineering services	34.8 (38.5)	30.6 (32.5)	35.0 (39.0)
Financial Advice services	34.5 (31.2)	51.0 (33.6)	14.6 (23.6)
Legal Advice services	32.9 (35.5)	28.5 (30.9)	38.2 (39.1)
Development services	33.5 (35.5)	41.9 (36.0)	21.6 (27.8)
Business Design	25.4 (26.1)	36.2 (28.0)	38.2 (33.1)

*Mean shares shown; standard deviations in brackets.

Source: HSE ISSEK — ROMIR survey, 2010.

this way. Only 10% were reported to be **often replicated**. Due to the non-random nature of our samples, we shall not analyse sectoral variations in detail. However, it is notable that the proportion of KIBS firms that said services were 'often' replicated varied dramatically by sector — from a low of around 3% to a high of around 18%. Those that 'never' replicated services varied from 23% to more than 47%. Moreover, we noted that very different sectors were found at the two extremes of these indicators. This reminds us that KIBS are themselves very heterogeneous, both across and within sectors.

In the previous year (2010) KIBS producers were asked to indicate the share of total sales value of services that services with different levels of standardization contributed. Three levels of standardization were proposed — services that were customized, essentially customized service variants around a standard 'nucleus', or completely standardized. Table 5 demonstrates that, overall, KIBS firms reported more than a quarter of their output, in terms of quantity of services, to be **completely** customized. All of the sectors feature some firms reporting extremely high or low levels of standardization. While in some sectors the great majority of firms report very little output coming from standardization, in others the focus of activity appears to be much more widely distributed, with some firms undertaking considerable degrees of standardization of their product. Interestingly, some of the more technology-oriented KIBS firms in this sample — notably IT services — quite frequently report high levels of standardization. Engineering, legal advice and business design services display less complete standardization, and substantially engage in personalization of a standard product.[9] Customization is much rarer in services like marketing and financial advice.

Generally, high degrees of standardization are uncommon while particularization is common in the Russian KIBS sector, at least among the leading providers that we sampled (we could expect small and very local firms to be providing more routine and elementary services). It follows that the majority of services that they supply can be seen as innovations, in the sense that they are new products during particular supplier-client interactions. In addition, at least a quarter of their output in value terms consists of services that are neither standardized products, nor customized products built around a standard nucleus.

The particularization of a service almost inevitably requires some degree of co-production: the client should at least supply relevant information about the business processes where there are problems that the KIBS firm is helping to address. Quite often, the client is engaged in much more substantial and prolonged dialogue with the KIBS firm, concerning the nature of its problem and the 'fit' of possible solutions (these may be discussed in an abstract way or applied in practice by developing prototypes or testing different options).

[9] Interestingly, we found a prominent number of legal advice firms reporting completely standardized services, alongside their non-standardized peers.

The term 'co-production' refers to the role of the customer in generating services, including many traditional services as well as KIBS. The basic point is that the customers and users of services often have to contribute greater or lesser amounts of effort to the service production process. Sometimes physical presence is enough, but often the client is required to input information and to interact more intensively with the service provider (and sometimes with other clients). Among other things, this can make assessment of service productivity challenging — should we include a customer's labour inputs alongside those of service workers? How do we assess innovations that shift the division of labour between service supplier and user? In the case of business services, the client organization is typically required to provide information to the service provider for the service to be produced; often there will be extensive interchange, as the service is defined and tailored to customer requirements. Information can flow in both directions, with both partners learning from the experience [*Doroshenko*, 2012; *Miles*, 2012].

Co-production can be more or less effective. When co-production works well, the quality of rendered services is high, and customers typically have a positive experience. We can expect that customers learn more, and thus that their innovative potential will increase; because they have learned through the interaction, we can expect them to demand more KIBS in the future since they have come to realize the value of specialized external knowledge. When co-production works poorly, the services that are provided will often be less appropriate to a client's requirements. A negative experience of acquiring low quality services might lead a customer to blame the specific KIBS firm, or indeed seeing that class of KIBS in general as not really up to the job. Alternatively, such an experience could be an incentive mechanism (where the client concludes that better co-production would improve results), which would contribute to improving the level of co-production of these customers in the future.

Poor co-production could result from numerous causes, for example loss of key staff at critical moments, unanticipated organizational crises, poor management procedures, etc. However, we anticipate that ineffective co-production will be most common among inexperienced customers, who have less understanding of the nature of KIBS service. They erroneously see KIBS as homogeneous (standardized) since the service offered to them looks identical to those that they have seen supplied to others in the market (we call this an 'opaque glass' effect: objects and differences between them become less recognizable when seen through an opaque glass). As a result, customers fail to appreciate that customization is feasible and requires co-production.

The Russian surveys allow us to examine the experience of co-production. Thus, KIBS providers were asked to estimate the level of customers' involvement in service production on a scale ranging from 1 (minimum participation, no inputs provided except the terms of reference for the service contract) to 10 (maximum participation i.e. joint project implementation). Table 6 presents data from the 2007 and 2011 surveys: the score for co-production in most sectors exceeds 6 out of 10, indicating that customers do often participate quite substantially in co-production of their services. Moreover, 30% of KIBS firms report scores of between 8 and 10 in both years. Overall, there is mostly very little change over the four year period. Individual sectors move in different directions, but generally in a very limited way, despite the economic downturn.[10] It may be that some KIBS firms are pushed towards more light-touch service provision, while others seek more co-production as a result of market contraction.

The survey also asked about the quality of co-production and the factors explaining why this is sometimes low. Less than half (46.5%) of Russian KIBS producers in 2011 thought that they received *excellent* co-production from their clients. Most respondents who said that co-production was imperfect explained that this was because clients were either unwilling or unable to co-produce, and not so much because they misunderstood the need for co-production (see Table 7).

It is not uncommon to find that clients do not understand the importance of co-production, although this can benefit them. Bettencourt et al. [2002] go so far as to advise KIBS firms about how to better mobilise their clients. We find support

[10] Since we do not have panel data, we cannot test the possibility that there is more volatility at the firm level. However, we think this unlikely.

Table 6. **Co-production of KIBS in Russia* (scoring)***

Question: 'Please estimate on a scale of 1 to 10 the degree to which yourcustomers are on average involved in the production of services, where 1 = provided the terms of reference for the service contract but otherwise minimum participation until we presented our final report, and 10 = full participation, close work in working groups, customer did some of the work themselves'

KIBS Sectors Used	2007	2011
Overall	6.1 (2.4)	6.3 (2.4)
Advertising	5.2 (2.4)	5.9 (2.2)
Marketing services	6.1 (2.1)	6.0 (2.3)
Audit	5.6 (1.8)	7.3 (2.6)
Information Technology services	6.4 (2.4)	6.2 (2.6)
Recruitment services	5.7 (3.1)	6.2 (2.2)
Engineering services	6.2 (2.4)	6.2 (2.1)
Financial Advice services	7.0 (1.7)	6.5 (2.5)
Legal Advice services	5.6 (2.5)	6.0 (2.6)
Development services	6.3 (2.7)	6.4 (2.6)
Business Design	6.5 (2.6)	6.2 (2.4)

*Mean scores shown; standard deviations in brackets.

Source: HSE ISSEK — ROMIR surveys of KIBS firms, 2007 and 2011.

for our 'opaque glass' hypothesis that explains customers' inability to appreciate customization and hence the importance of co-production. Our Russian survey data suggest there is a mismatch of perceptions between suppliers and customers, a feature first noticed in the 2007 survey. Providers and customers differ in their views on the extent to which KIBS services are customized (Table 8). For all KIBS sectors, KIBS producers considered a smaller share of services to be standardized on average compared to consumers.

The most striking result is that, in all KIBS sectors, consumers underestimate the degree of individualization of services compared to the providers' view (the latter's understanding should in theory be based on superior knowledge of how the services actually address customers' specific needs). This *asymmetry in perceptions* differs from the usual notion of asymmetric information as applied to services. The usual argument is that because the service product is not visible before it is produced, the customer will know less about the likely service quality than the supplier.[11] The key difference between the usual notion of asymmetric information and the idea of asymmetric perception introduced here is that the former is isolated from the market — it simply refers to the asymmetry in information between the two parties involved in a single transaction.[12] In contrast, the concept of asymmetric perceptions refers to other services (and goods) of

Table 7. **Reasons for imperfect co-production** (share of responses selecting each answer out of the total surveyed, %)

Question: 'Why have you been unable to achieve the required level and quality of coproduction?'

Response options \ KIBS Sectors Used	Overall	Advertising	Marketing services	Audit	Information Technology services	Recruitment services	Engineering services	Financial Advice services	Legal Advice services	Development services	Business Design
The customers follow the principle 'We pay — you work'	31.9	28.1	34.5	33.3	32.3	22.6	17.4	28.6	28.6	42.3	45.7
Insufficient competencies of customers make them poor co-producers	30.8	28.1	34.5	25.0	32.3	16.1	56.5	33.3	52.4	23.1	20.0
The customers are unwilling to co-produce as they want to save their employees' work time	18.7	15.6	10.3	20.8	16.1	25.8	13.0	33.3	9.5	15.4	25.7
The customers fail to understand why we need co-production	9.9	25.0	6.9	12.5	12.9	16.1	8.7	0.0	4.8	3.8	2.9
The customers do not want to share confidential information on their businesses	8.8	3.1	13.8	8.3	6.5	19.4	4.3	4.8	4.8	15.4	5.7

Source: HSE ISSEK — ROMIR survey of KIBS firms, 2011.

[11] Service marketing often uses the related concept of services that 'lack demonstrability.'

[12] There can be differences in the definition of the information that the parties view asymmetrically: efforts, technology, quality etc. In all cases, though, it is the information available to one party and not to the other party in the same contract or transaction.

Table 8. **Standard services in Russia as seen by service providers and consumers***

Question: 'What was the share of standard services in the total volume of services provided/ordered by your company?'

KIBS Sectors Used	Providers		Customers	
	Share (%)	*N*	Share (%)	*N*
Overall	47.0 (32.2)	612	54.6 (23.0)	2422
Advertising	45.8 (28.6)	68	52.8 (22.8)	515
Marketing services	36.5 (29.2)	59	54.8 (22.2)	187
Audit	60.4 (28.4)	62	59.6 (22.0)	256
Information Technology services	59.7 (29.0)	63	59.3 (22.5)	283
Recruitment services	40.5 (34.9)	53	56.1 (23.6)	236
Engineering services	47.0 (27.6)	60	52.8 (21.2)	196
Financial Advice services	59.2 (29.9)	63	61.1 (23.5)	139
Legal Advice services	50.1 (32.9)	53	52.5 (25.8)	210
Development services	48.4 (33.4)	63	53.1 (21.7)	164
Business Design	23.5 (29.8)	68	46.6 (21.8)	236

* Standard deviations shown in brackets. *N* differs for providers (here it is the number of firms, which equals the number of answers) and for customers (the number of valid answers, which exceeds the number of firms). In 2007, customers used on average 4.2 services.

Source: HSE ISSEK — ROMIR survey of KIBS firms and KIBS customers, 2007.

a similar nature that are provided to other consumers in the market. A customer may be fully informed about the service that has been rendered, but is still liable to consider it identical to the services provided to other consumers (of which they know little). As a result, customers of a tailored service may believe that they have purchased a standard service.

The asymmetry of perception stems from different degrees of awareness of the service process (rather than of the service product). From the viewpoint of the KIBS suppliers, clients frequently underestimate the particularization involved in this process. The producers of services know the technology of the service production thoroughly. They judge the degrees of individualization and innovativeness of the service based on knowledge of how the service was produced. In contrast, consumers will not be fully aware of the technology, work organization and activities involved in service production, although they may be very aware of the characteristics of the service rendered. In estimating the degree of standardization, consumers subjectively compare the service they received with their ideas of similar services supplied to other consumers ('services of the same name'). A comparison of this sort has an *'opaque glass'* effect. When one looks through an opaque glass, similar objects may seem — superficially — identical. Likewise, consumers of KIBS see a vague image of services provided and are unable to differentiate between services to see their individualized features. The 'opaque glass' effect prevents customers from distinguishing between a knowledge-intensive service innovation and a replication.

It is worth noting that asymmetric information and asymmetric perception can co-exist in these cases. To assess a product's particularization, a customer ultimately needs to be able to compare with other products (is there a product in the market that would better suit this particular consumer's needs?). However, such a comparison is not usually feasible. The consumer is not able to compare the service product in advance with other products to know if there is another product on the market that would better suit their particular needs; thus it is not feasible for the customer to assess a service product's particularization. The consumer can neither compare the service with other products, nor observe the process and judge on particularization (as the process is opaque). Making the process more transparent (removing asymmetric information between the two parties) contributes to a better understanding of particularization. It reduces but not entirely eliminates asymmetric perceptions because asymmetry is generated by the limited availability of information about the whole range of (potential) services on the market. We thus expect that if there is knowledge and information transfer during co-production, asymmetric information will be reduced (in the future and possibly during the transaction itself), which will also help to lessen asymmetric perceptions.[13]

[13] The opaque glass does not disappear completely but consumers become more confident that the service provided to them is particularized and thus unlikely to be a replica of other services on the market.

Customers with prior experience in consumption of KIBS should thus have a better understanding of the specifics of particularized services and thus a better appreciation of the role of co-production as a signalling device about the level of particularization. To analyse the effect of experience, we divided KIBS consumers into two groups:

- '*Experienced customers*' — defined as those who had used more than the average number of different services in the last three years (58.1% of the sample);
- '*Inexperienced customers*' — those who had purchased fewer services than average (the remaining 41.9% of the sample).

On average, inexperienced customers as defined above estimate the level of particularization of services to be 10% lower than experienced customers. The perceived particularization of services by consumers strongly correlates with the number of services purchased earlier (the Pearson correlation coefficient is 0.61). This supports our hypothesis that diverse experience with services overcomes the 'opaque glass' effect: the more types of services consumers use, the better they recognize service differentiation. On the contrary, 61% of inexperienced consumers believe services of the same name are standardized.

Co-production should ensure that the service is tuned to the needs of customers and that customers appreciate the usefulness of the service.[14] In order to identify the impact of experience, we asked those providers and consumers of KIBS who had reported incomplete absorption of services (26.5% of service providers and 24.5% of consumers on average across all sectors) why it was that full absorption failed (Table 9). The majority of the respondents (over 50% of service providers and over 60% of consumers) indicated that either the service did not match the customer's needs or that they felt the customer did not really need the service.[15] Both accounts suggest failures in co-production. On average, over 40% of all KIBS consumers reported that they paid for services that did not match their needs. The range across sectors is huge, from as low as 10% for design to as high as 80% for engineering.

Table 9. **Main reasons for imperfect service absorption (share of responses selecting each answer out of the total surveyed, %)***

Question: 'Why were the rendered services not fully absorbed? Choose ONE answer.'

Response options \ KIBS Sectors Used		Overall	Advertising	Marketing services	Audit	Information Technology services	Recruitment services	Engineering services	Financial Advice services	Legal Advice services	Development services	Business Design
Poor quality of the service	P	—	—	—	—	—	—	—	—	—	—	—
	C	11.1	10.0	8.1	0.0	0.0	9.1	0.0	0.0	8.3	50.0	20.0
Service does not match the needs of the customer	P	19.4	16.7	21.1	0.0	20.0	25.0	23.1	41.7	20.0	9.1	10.0
	C	40.5	45.0	56.8	61.5	42.9	36.4	80.0	25.0	33.3	16.7	10.0
The service was not actually needed	P	35.8	33.3	31.6	9.1	40.0	20.0	38.5	41.7	60.0	72.7	40.0
	C	22.8	15.0	10.8	0.0	57.1	27.3	0.0	37.5	25.0	33.3	20.0
Customer unable to implement (absorb) service	P	19.4	27.8	21.1	27.3	20.0	25.0	23.1	8.3	0.0	9.1	10.0
	C	15.7	20.0	18.9	23.1	0.0	27.3	0.0	25.0	16.7	0.0	30.0
The management of the customer company did not care whether or not the service was absorbed	P	17.2	5.6	15.8	54.5	13.3	25.0	7.7	8.3	20.0	0.0	30.0
	C	9.8	10.0	5.4	15.4	0.0	0.0	20.0	12.5	16.7	0.0	20.0
Other	P	8.2	16.7	10.5	9.1	6.7	5.0	7.7	0.0	0.0	9.1	10.0
	C	—	—	—	—	—	—	—	—	—	—	—

* For each suggested answer the table shows the percentage of respondents in the form x/y where upper figure (x) represents the answers of service providers, lower figure (y) represents the answers of the consumers; '—' = option not offered as a possible answer.

Source: HSE ISSEK — ROMIR survey of KIBS firms and KIBS customers, 2010.

[14] Although poor co-production need not necessarily imply poor absorption (a customer can still appreciate and absorb the service even if co-production is poor), the opposite does not hold. Poor absorption suggests failures in co-production. There are usually exceptions to such a rule of course, and here we might cite cases such as those when key members of staff in the customer firm depart, meaning that the co-production effort is poorly reflected in the experience of new staff.

[15] The exact wording for the service providers was 'the service was not needed (ordered for future needs, just in case)', while for consumers the wording was 'the service was not needed / useful.'

If co-production is required to fine tune a service, this unsatisfactory experience should act both as a strong signalling device (indicating insufficient co-production) and as an incentive mechanism (sending the message that it will be beneficial to co-produce in future). Only one of the four factors behind poor co-production mentioned in Table 7 seems to be irreparable: this is the competencies of the customer, which accounts for about 30% of poor co-production. The remaining factors account for about 70% of co-production failures — unwillingness to engage in co-production, customer's desire not to spend own human and time resources on the process, and not to share confidential information on their businesses. All these reasons can be overcome by the customer. We might therefore expect that even customers with unsatisfactory experiences in the past may achieve better experiences in the future.

KIBS as Enablers of Innovation

The topics of co-production and customization are inherently interesting, but also have broader implications for the very important topic of innovation. As we have seen, KIBS have often been identified as critical players in innovation systems, though this has not often been noted in the Russian context.

KIBS' clients can gain knowledge about their own business through interacting with the service providers. The interviews indicate that KIBS suppliers believe their customers often do not know exactly what they need at the outset. The clients have only general and fairly nebulous ideas about the service they require, e.g. 'I need your marketing efforts to promote my new product', or 'We need somebody for the post of project manager.' When the demand is fairly unspecified, it is obviously difficult to produce a tailored service. The KIBS suppliers make efforts to specify particular service parameters; this clarifying process may well last into the later stages of the relationship.

Four opportunities to improve customers' knowledge about their core activities can be identified:

a) Reflecting upon KIBS providers' questions and requests can lead the customers to articulate a more comprehensive understanding of their needs, and the state of their business (One KIBS provider told us that at the beginning of co-operation, a typical client's answer to any question is 'We've never thought about that before').

b) In the process of co-operation, consumers acquire general knowledge about their business environment from information supplied by KIBS suppliers (such as lawyers, financial and marketing consultants, recruiting agencies, etc.).

c) Communication with service providers reveals new opportunities that customers did not know about before or failed to appreciate. For example, recruiting agencies not only find candidates for existing vacancies, but also propose alternative forms of employment; real estate agencies organize 3D virtual tours inside and outside office buildings, etc.

d) Customers may improve their expertise in problem setting. For example, they may find that their initial ideas are unrealistic. Their first approaches may be illegal, liable to face huge opposition, or they may be technically unachievable. They can learn to avoid time-wasting by making more realistic demands from the outset.

Co-production can therefore upgrade KIBS customers' skills. They can learn more about their business and acquire new knowledge beyond their principal activities. Furthermore, they can jointly create innovative services, especially in the case of bespoke production. In this sense, customers acquire additional expertise in knowledge-intensive performance and thus improve their own innovative potential. This argument is supported by survey results. Table 10 summarizes customers' answers about the external effects of using KIBS. They indicate that their general propensity to innovate improves as a result of KIBS use.

Two thirds of consumer respondents reported improvement of their general propensity to innovate due to their experience with KIBS consumption and co-production. The most powerful influences appear to come from marketing consultants, who stimulate positive shifts in readiness to innovate in 80%

Table 10. **Effects of using various KIBS on customers' propensity to innovate** (share of responses selecting each answer out of the total surveyed, %)

Question: 'Please estimate the impact of KIBS consumption on your own company's propensity to innovate'

KIBS Sectors Used	Response options		
	Positive effect	Negative effect	No effect
Overall	65.8	0.8	33.4
Advertising	73.4	0.7	25.9
Marketing services	81.9	0.9	17.2
Audit	56.1	1.5	42.4
Information Technology services	73.7	0.0	26.3
Recruitment services	63.4	0.0	36.6
Engineering services	61.2	0.0	38.8
Financial Advice services	64.6	0.0	35.4
Legal Advice services	47.7	2.5	49.8
Development services	47.1	1.5	51.4
Business Design	72.0	0.0	28.0

Source: HSE ISSEK — ROMIR survey of KIBS company users, 2011.

of customer firms, according to their customers. Consultants in the spheres of business design, IT and advertising reported influencing over 70% of their consumers. Legal services demonstrate a less frequent effect, with just under half of their customers reporting positive effects. Strikingly, a negative impact was reported by less than 1% of respondents — and none at all for several KIBS.

Table 11 presents data for the 66% of the sample who reported that the use of KIBS had improved their innovativeness. They were asked about the intensity of the impact, answering on an ordinal scale ranging from 1 (weak effects) to 3 (radical effects). More than half of these customers reported substantial shifts in their innovation behaviour after obtaining experience with KIBS. The overall average positive impact of experience with KIBS reaches 2.5 (out of a possible 3) points in terms of strength of impact. The most radical improvements appear in the case of business design, legal and IT services.[16]

This evidence suggests that the KIBS sector generates strong external incentives for its clients to innovate. These incentives are likely to originate from new knowledge and skills acquired during service co-production in their principal activities. We would expect that the degree of generality will vary across various kinds of acquired expertise.

Table 11. **Degree of impact of KIBS experience, as seen by customers reporting positive effects of KIBS**

Question: 'Please estimate using a 3-point scale the degree of positive impact of KIBS consumption on your company's propensity to innovate after using marketing services, where 1 = weak impact, and 3 = radical impact'

KIBS Sectors Used	**Estimation of degree of impact** (*share of responses selecting each answer out of the total surveyed, %*)			**Mean grade** (*scores*)
	1	2	3	
Overall	9.3	33.0	57.7	2.5
Advertising	8.4	33.7	57.9	2.5
Marketing services	11.4	38.6	50.0	2.4
Audit	9.6	44.7	45.7	2.4
Information Technology services	11.0	26.4	62.6	2.5
Recruitment services	7.7	38.5	53.8	2.5
Engineering services	17.1	22.9	60.0	2.4
Financial Advice services	12.2	22.0	65.8	2.5
Legal Advice services	1.9	26.4	71.7	2.7
Development services	18.5	33.3	48.2	2.3
Business Design	4.5	28.8	66.7	2.6

Source: HSE ISSEK — ROMIR survey of KIBS company users, 2011.

[16] These answers come from firms reporting positive effects in the previous question. While legal services have the least frequent positive effect among all KIBS, it is one of the strongest effects when the effect is positive. A plausible interpretation of this result is that if legal services support new business start-ups then they are highly relevant for innovations; however if the services refer to more general legal issues, as they presumably do much more often, then there is generally no link to innovation activities.

Accordingly, we asked KIBS customers to estimate the extent of impact upon different types of innovations. The types of innovations are from the *Indicators of Innovation Activities* [HSE, 2010], enabling comparisons with other Russian industries. Their answers are quantified by the same ordinal variables as in Table 11 (from 1 = weak impact, to 3 = radical impact). The results are summarized in Table 12. We see a tendency to report stronger, rather than weaker, impacts in **all** five categories of innovation. The set of innovations where we see a low impact is marketing innovations, despite the fact that the use of marketing KIBS is seen as influential. Indeed, there seems to be a general link between the types of KIBS and the types of innovation.

Conclusions

The evidence from this study on Russia confirms and extends the thesis advanced mainly from studies in Western European countries: that the KIBS sector possesses a high innovative potential. KIBS sectors can generate service innovation of two types: commoditization and personalization of services. In Russia, the KIBS sector's share of innovative outputs is comparable with the most advanced industrial sectors. Importantly, KIBS also supports innovation among its users, and this support is a self-sustaining mechanism. The sector deserves more attention in statistical reporting and studies, and more consideration from policymakers and other potentially interested stakeholders, including management training schools and industry associations. KIBS can be significant sources of export earning and — according to our analyses — make a significant contribution to innovation in the economy as a whole.

Our study explores the issue of asymmetric perceptions of standardized / customized KIBS by providers and consumers, which partly explains the insufficient engagement in co-production by inexperienced customers. As if looking through an opaque glass, inexperienced clients see all services as essentially similar and do not see the benefits of co-production. A lack of co-production, due to customers' failure to understand why it is needed, means that services are not always fully absorbed by the customers. They may be inadequately tuned to the needs of the customer, or customers may be under-equipped to absorb them; both problems can be addressed through meaningful co-production of KIBS. The results of our study support the idea that customers with prior experience in KIBS consumption better understand why they need KIBS and the benefits from co-production. This could be an issue to address in awareness-raising initiatives for KIBS firms as well as other organizations.

Table 12. **Degree of impact of KIBS experience on different service innovations** (share of responses selecting each answer out of the total surveyed, % of responses)*

Question: 'Please estimate the degree of positive impact of KIBS consumption on your propensity for different types of innovations, on a scale of 1 to 3, where 1 = no impact, and 3 = strong impact'

KIBS Sectors Used / Types of Innovation	Overall	Advertising	Marketing services	Audit	Information Technology services	Recruitment services	Engineering services	Financial Advice services	Legal Advice services	Development services	Business Design
Communication	2.39	2.38 (0.7)	2.30 (0.7)	2.15 (0.7)	2.59 (0.6)	2.27 (0.7)	2.44 (0.7)	2.45 (0.7)	2.47 (0.6)	2.52 (0.8)	2.48 (0.7)
Product	2.37	2.37 (0.7)	2.46 (0.7)	2.30 (0.7)	2.43 (0.7)	2.28 (0.8)	2.51 (0.7)	2.18 (0.7)	2.36 (0.7)	2.00 (1.0)	2.60 (0.6)
Technological	2.36	2.25 (0.8)	2.49 (0.7)	2.41 (0.7)	2.42 (0.8)	2.17 (0.8)	2.61 (0.6)	2.19 (0.8)	2.25 (0.8)	2.35 (0.8)	2.59 (0.6)
Organizational	2.34	2.33 (0.7)	2.43 (0.7)	2.31 (0.7)	2.21 (0.8)	2.25 (0.7)	2.08 (0.7)	2.41 (0.7)	2.62 (0.6)	2.44 (0.8)	2.37 (0.7)
Marketing	2.14	2.26 (0.7)	2.41 (0.6)	2.06 (0.7)	1.88 (0.8)	1.94 (0.7)	1.91 (0.8)	2.27 (0.7)	2.22 (0.8)	1.63 (0.7)	2.27 (0.8)

*Mean grades; standard deviations in brackets.

Sources: HSE ISSEK — ROMIR survey of KIBS company users, 2011.

The survey data also supported the point that KIBS use can affect propensity to innovate and finds that when it does, the effect tends to be positive and strong. Increased innovativeness is reported to directly contribute to intentions to consume KIBS further, thus creating a virtuous circle. Conceptually, these effects are linked to knowledge transfer during co-production: customers acquire both specialized and general knowledge, improving their skills and abilities and increasing their innovation potential. This makes them better understand their own needs, and incentivizes them to demand more customized KIBS in the future. Thus KIBS are important players in innovation systems, and policymakers may consider stimulating innovation through support for the KIBS sector.

In the past, it has often been assumed that the public knowledge infrastructure should supply KIBS like services. This assumption, however, runs the risk of diverting universities and laboratories away from their core missions, while failing to provide sufficient quality of services. It is doubtful that such strategies of 'enforcing' or subsidizing provision of KIBS by public bodies contributes to the development of the sector as a whole in many cases. Alternatively, policy could target KIBS consumers, creating incentives for them to make use of KIBS suppliers and actively engage in co-production. Our observations show that a lack of experience (or, possibly, an interruption in experience with KIBS) can be an obstacle for effective co-production, and hence for improving the innovation potential of the KIBS sector.

The public sector can be a significant consumer of KIBS (to support its own business processes). Another step towards the exogenous creation of KIBS experiences could involve outsourcing some public services to KIBS providers (e-Government is one possible example). The policy mix for public-private partnerships in the KIBS sector could be diversified. This will require changes in public procurement procedures, since they tend to emphasize price when selecting service providers. In contrast, the firms studied in this paper are those where price is less important than knowledge intensity and the quality of the outsourced services when selecting KIBS providers. Simply applying competitive, price-based selection procedures in the KIBS sector is rarely possible, and thus procurement policies face a strong challenge here [*Edler, Georghiou,* 2007; *Satzger et al.,* 2009].

Finally, public authorities could support KIBS production and absorption through policies on training and skills development, and through strengthening service quality control (for example, by promoting standards and professional self-regulation although there is a risk that professionals create entry barriers to defend their interests rather than the more general welfare of society). Another key policy area relevant for KIBS is the development of educational and professional standards in this sector. F

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Civil Society as an Environment for Production and Diffusion of Social Innovation

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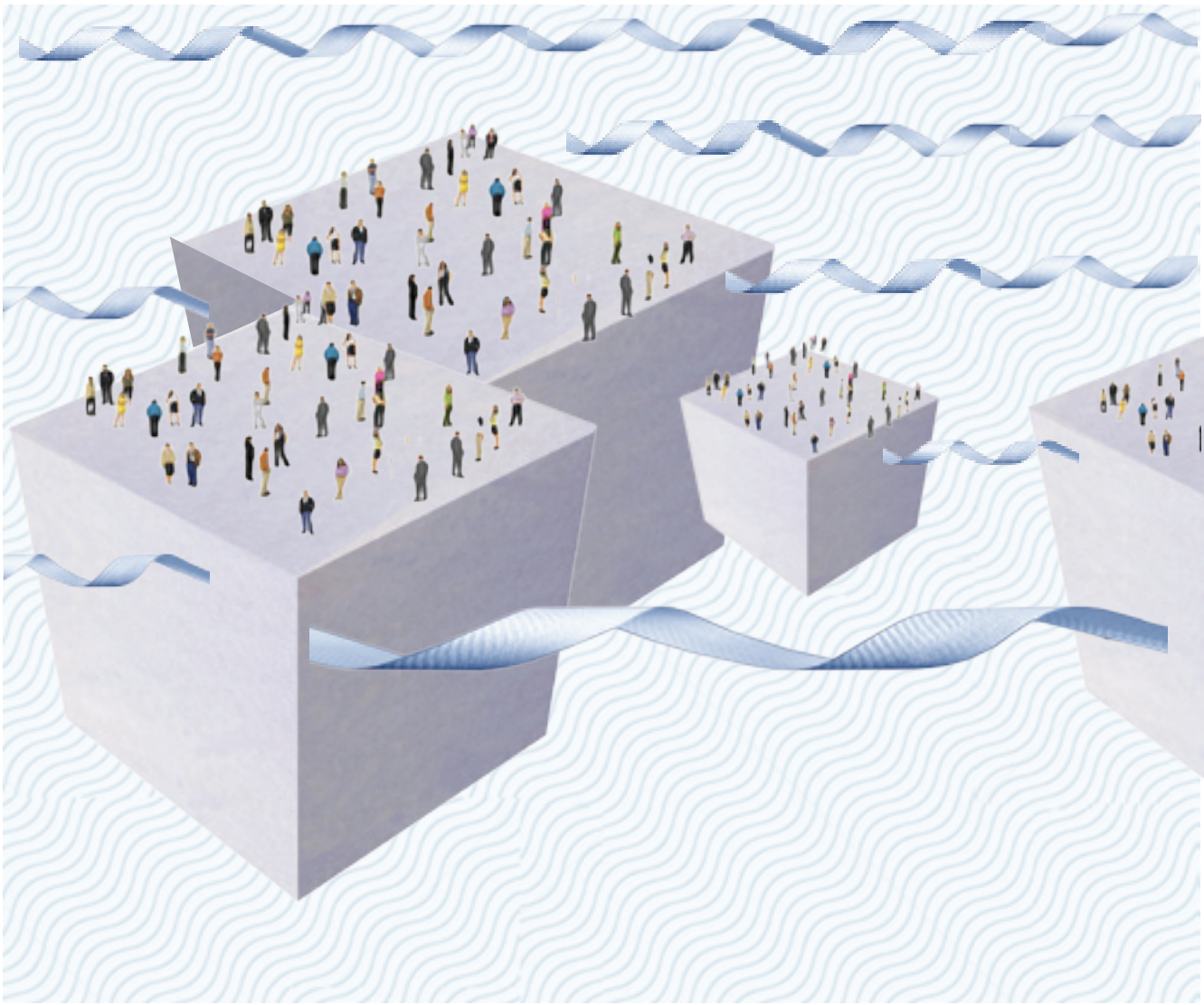

Social innovations could potentially serve as a means for society to play a role in solving social problems. Such innovations stem from an active population and non-state non-profit organizations (NPO). As a new model for civil society's collaboration with the state, social innovations enable the population to better self-organize and act.

This article examines the potential and contribution of Russian NPOs to the development of social innovations.

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The most effective method of forecasting changes in civil society is to combine normative performance with an impartial analysis of objective trends, which is the traditional methodology approached for Foresight studies [*Loveridge*, 2009; *Schwartz*, 1996]. The notion of civil society can be interpreted in diverse ways [John Hopkins University, 2004; *Edwards*, 2011, p. 7], However, almost all these interpretations are united in their focus on how voluntary collaboration between different people creates a public good.

Some authors view the concepts of 'civil society' and 'group of non-state non-profit organizations' as practically synonyms [John Hopkins University, 2004], while others see them, at least in part, as contrasting terms [*Dekker*, 2009]. We proceed from the understanding of civil society as the sphere of human activity outside the family, state and market, which is formed through individual and collective action, norms, values and social relations [*Mersiyanova*, 2013, pp. 173–174].

In the future, civil society may be viewed from a different perspective. Nevertheless, we consider such a judgement worthwhile in terms of functionality, grounding its role in the Russian modernization process [*Yasin*, 2007, p. 19]. This quality is shaped by both the external environment and internal factors. A study has shown that while the state plays a primary role in the development of civil society, without social support its existence is inconceivable [Ministry of Economic Development, 2012; Civil Fund, 2013; HSE, 2008; *Zadorin et al.*, 2009; *Volkov*, 2011].

We consider the main parameters shaping the possible developmental scenarios for civil society in Russia to be the strength or weakness of the state's policy in this area, which is dependent on the extent of its influence over relevant institutes, and the level of social activity. These parameters can be combined into a two-dimensional matrix, giving rise to four scenarios with reference to Russian conditions (Table 1).

The development of civil society under the most preferable scenario of responsible subjectivity is not only dependent on the successful institutionalization of its structures and state support, but also on the extent to which the population is directly involved in overcoming social problems. Accordingly, we view social innovations as one of the most promising potential instruments for civic involvement and inter-sectoral partnership in solving social problems. These innovations generally refer to new developments (products, services, models, processes, etc.) which satisfy social demands more effectively compared with existing developments and contribute to the development of inter-sectoral relations and rational use of resources [European Commission, 2012a]. As a new model for collaboration between the state and civil society, social innovations enable civil society to better self-organize and act.

The article analyses the potential and real contribution of Russian NPOs (also referred to as the tertiary sector) to the development of social innovations by providing the necessary conditions in civil society to satisfy the logic of the preferred Russian scenario of responsible subjectivity. It considers the essence of social innovations and how they differ from market or technological innovations. The critical role of civil society and the tertiary sector as a favourable

Table 1. **Development scenarios for civil society in Russia**

Social activity	State policy supporting the development of civil society institutions	
	Weak	Active
Low	Deep freeze	Greenhouse effect
High	Explosive pocket	**Responsible subjectivity***

* Desired scenario.

Source: compiled by the authors.

environment for social innovations will be highlighted. Data will be presented on the state of NPOs in Russia and citizens' involvement in their activities.

Social innovations: The essence and some specifics

In the last decade, social innovations have become one of the main focal points in the economic development strategies of the US and EU countries. In particular, they have been noted for their positive contribution to achieving a high level of employment, social security, and gender equality, to the reinforcement of economic and social unity, and the integration of territories into the EU [European Commission, 2011, 2012a]. The Social Innovation Fund has been supported by the US Presidential Administration since 2009 and, with the assistance of various civil society organizations, contributes to inter-sectoral collaboration and uses entrepreneurial approaches to implement programmes in healthcare, youth support and the creation of economic opportunities.

However, a theoretical understanding of social innovations, despite their political and research 'popularity', is extremely vague. Virtually all research publications are based on weak theoretical groundings, and therefore the practical use of the notion is ambiguous. The existing literature on the subject is sometimes seen as 'grey' as, for the most part, it comprises reports, memoranda and recommendations [*Voorberg et al.*, 2013].

Social innovations are often viewed as a unique remedy to overcome all social challenges. Politicians and academics constantly search for new approaches to solve problems such as youth unemployment, migrant adaptation, the territorial integrity of regions, etc. For instance, Eva Bund and her colleagues identified over 15 different indices which all, to varying degrees, reflected the state and development of social innovations at a country level and in comparison with other countries [*Bund et al.*, 2013]. All of these indices are based on corresponding theoretical assumptions and measure specific forms of social innovations in a given context. On this basis, it is scarcely possible to formulate a unified approach to conceptualizing social innovations.

In Russian literature, social innovations have not yet received any visible attention. They are considered one of the functional forms of innovation alongside technological, organizational and administrative, and information innovations [*Kolosnitsyna, Kiseleva,* 2008]. Exceptions to this include a number of articles on user innovations, where consumers modify products to adapt them as best as possible to their own needs [*Zaytseva, Shuvalova*, 2011]. But user initiatives are predominantly viewed from a commercial perspective, analysing the potential economic effects. Several studies have focused on the effect of the population's involvement in innovation processes on raising the quality of products and services, as well as on the emergence of new and expansion of traditional markets [*Ibid.*]. Some authors address the topic of open innovations, which, in essence, reflect the principles on which social innovations are based. Jean Guinet and Dirk Meissner analyse the role of the state in open innovation processes in entrepreneurial and public sector sciences and collaboration with innovators based on principles such as decentralization and network cooperation [*Guinet, Meissner*, 2012].

In view of the identified limitations, we consider the notion of social innovations as analogous to these foreign notions, paying special attention to their potential in the social sphere. 'Social inventions' were first mentioned in the works of Max Weber [*Moulaert et al.*, 2005, p. 1969] in which he attempted to interpret the social changes caused by technological and economic transformations. In the 1930s, Joseph Schumpeter introduced the concept of 'social innovations' as an element of organizational theory [*Ibid.*]. He interpreted innovations as a process of creative destruction [*Schumpeter*, 1942] leading to the emergence of new

combinations of existing resources in politics, business, the arts, the sciences, etc. In this sense they cannot be separated from enterprise, which is aimed at changing or modifying existing social and economic agreements that are unable to satisfy primary needs [*Bekkers et al.*, 2013, p. 37]. In other words, innovations, according to early theorists, were based on action and led to evolutionary changes in society [*Kattel et al.*, 2012, p. 3]. Thereafter, they started to view innovation as a source of economic growth [*Crepaldi et al.*, 2012].

Technological developments and the results of commercializing developments started to be studied actively from the 1980s. Today, the majority of indicators for the development of social innovations include innovation activity indicators for the entrepreneurial sector [OECD, 2002; OECD, Eurostat, 2005].

The role of innovations in economic development has close ties to the local social and cultural context. It is generally accepted that intangible variables — values and culture — have a significant impact on innovation activity and the output of the sciences and economic institutes [*Rubalcaba*, 2011, p. 3].

Contemporary researchers offer varying definitions of social innovations, each of which reflects their specific functions or properties. It has been argued that they satisfy society's needs, respond to social challenges, offer new or significantly improved products, processes, marketing methods or organizational models which satisfy social needs more effectively than existing options, and help to develop social collaboration and form alliances (the project 'Social Entrepreneurs as "Lead Users" for Service Innovation', SELUSI) [*Stephan*, 2010].

Some approaches focus on the contribution of civil society to the development of innovations (the project 'SPREAD: Sustainable Lifestyles 2050') [*Rijnhout, Lorek*, 2011]. Other variants look at social innovations from the opposite angle. Here, social innovations refer to a sub-group of innovations that are not based on technological inventions and where profit-making is not the priority for their creators. Innovations are aimed at transforming social relations and creating new opportunities. The main outcome of their use is a change in social practices, but economic effects are also not ruled out [*Hochgerner*, 2011, p. 2]. What is meant here is the production and dissemination of public goods and services, the transformation of financing and material production methods for socially important goods and services, institutional changes to forms of administration, and new methods to involve consumers of services in their production [*Grimma et al.*, 2013, p. 7]. Having analysed the various approaches to define social innovations, Bund and colleagues suggested the most fitting, in our view, definition of social innovations, where the role of civil society is taken into account. Social innovations are new solutions that respond to social needs and simultaneously create new or improved systems for collaboration, contribute to an effective use of resources and broaden social opportunities [*Bund et al.*, 2013]. In other words, they have a positive effect on society and, at the same time, raise its potential for action [*Davies et al.*, 2012].

Technological and other market innovations, as a general rule, also respond to social needs and are aimed at improving existing collaborative efforts; nonetheless, social innovations have a number of principal differences. Certain criteria can be used to identify them [*Alcock, Kendall*, 2014]. First, the 'social' characteristic in relation to innovations is often interpreted from the position of membership of society as a whole and of any social collaborations, which of course leads to confusion. In actual fact, this definition should be viewed in the context of social services. The remaining criteria are the existence of a social need, the high degree of importance accorded to the need, its urgency and social legitimacy. It is only when all these criteria have been satisfied that we can speak of social innovations.

The difference between social and market innovations can be observed visually in the example of a washing machine, which is a market innovation that satis-

fies the need for cleaning. However, it cannot be classified as a social innovation that responds to demands perceived as legitimate i.e. providing basic civil rights and free by definition public goods. Washing machines do not have to be provided free of charge unlike, for example, access to drinking water, health care or freedom of movement. In other words, besides the fact that market innovations contribute to raising the standard of living, they are not specifically geared towards satisfying basic civil rights and liberties.

It is generally accepted that social innovations can be broken down into four groups. Similar classifications can be found in the majority of studies [*Bekkers et al.*, 2011]. These classify them as: service innovations, innovative forms of production for goods and services, innovative administration solutions and the right of consumers to independently define and assess the importance of a producible social good.

The characteristics and examples of each of these groups are given below.

1. Service innovations. These offer new or improved services to satisfy existing social needs. Here, the focus is placed on joint activity between interested parties to solve a particular problem and on new methods for such collaboration. At the same time, it is perceived to be a personified approach (the proposed developments are specific to a certain territory and/or group of users) and one where new professional competencies are formed in the social services sphere [*Osbourne, Brown*, 2011; *Ewert, Evers,* 2012; *Crepaldi et al.*, 2012]. An example is creating new labour market opportunities to reduce youth unemployment or offering employment to people with limited capabilities.

2. Innovative production methods. These refer to hybrid forms of organizations — social enterprise, corporate social responsibility, etc. They imply active involvement of organizations and resources from various different industries [*Crepaldi et al.*, 2012]. This group includes social technological innovations (*civic tech innovations*), which emerge as a result of using technologies to provide new types of services, such as telemedicine. Developments that guarantee and simplify communities' activities occupy an important position among social technologies: public crowdfunding, organizing local social action and initiatives, collecting and disseminating information, etc. [*Patel et al.*, 2013].

3. Innovative forms of administration. These are predominantly linked to reorganizing a decision-making process that previously either did not take into account the interests of all groups or was unbalanced in nature [*Moulaert et al.*, 2005, p. 1975]. The innovation lies in delegating a certain proportion of authority, for instance, from the state to new actors, including members of civil society [*Moore, Harley,* 2008, p.18].

4. The right of consumers to independently define and assess the importance of a producible social good [*Grimma et al.*, 2013, p.17]. Joint decision-making, attracting new sources of funding and expanding the group of participants are all encouraged. Thus, conceptual innovations offer new paradigms of solutions to social challenges, in particular changing the approach to social work by including people with limited capabilities in the work process. The innovation lies in the fact that the collaboration takes place not in terms of an activity that a person cannot do, but in terms of his or her principal work capabilities and the duties he or she is able to carry out. In other words, the focus of attention is not their limited capabilities but rather the work potential.

Existing projects to study social innovations more often than not fall under several research fields (Table 2). Above all, they touch on questions of social integration, as well as innovations in public administration. Moreover, the focus of the study often turns out to be societal changes, social infrastructure, education and health care, and the labour market for young people and citizens with limited capabilities. In some cases, some attention is paid to network organizational

Table 2. **Examples of international initiatives to measure innovation**

Study focus	Name of initiative	Literature
International comparison of states' innovation potential	Innovation Union Scoreboard	[European Commission, 2014]
	Global Innovation Index	[INSEAD, 2012]
	Nordic Innovation Monitor	[Nordic Council of Ministers, 2009]
Innovations in the public sector	European Public Sector Innovation Scoreboard	[*Bloch*, 2010]
	Australian Public Sector Innovation Indicators	[DIISR, 2011]
	Measure Public Innovation in the Nordic Countries; Innovation in Public Sector Organisations	[*Hughes et al.*, 2011]
Economic innovations	Global Entrepreneurship Monitor	[*Kelley et al.*, 2012]
	OECD Science, Technology and Industry Scoreboard	[OECD, 2011]
	Measuring sectoral innovation capability in nine areas of the UK economy	[*Roper et al.*, 2009]

Source: compiled by the authors.

structure, communications, social involvement and enterprise. At the same time, social activity and social capital is hardly ever encountered in studies of social innovations.

We will now outline the basic theoretical elements of the concept of social innovations, upon which specialists have reached relative agreement. First, social innovations offer new and long-term solutions geared towards the current needs of the population [*Kattel et al.*, 2012]. In terms of their effects, they can surpass technological innovations, satisfying legitimate public and social needs and establishing new values that are perceived to be important by society.

In this sense, social innovations are an element of institutional development and one of the factors behind changes in society [Eurofound, 2013, p. 6]. They offer more effective solutions than traditional variants [European Commission, 2012b, p.18]. For instance, one-stop shops or multifunctional centres have clear advantages over a decentralized model for municipal services by various institutions. Such innovations lead to significant and at times unexpected redistributions of existing models for collaboration between stakeholders to solve social problems [*Osborne, Brown*, 2005]. As it is an open process, they encourage representatives of interested parties to get involved in exchanging experience, knowledge, skills and resources during the production of an in-demand product [*Bekkers et al.*, 2013].

In this context, we often speak of co-production of social or user-driven innovations through the joint efforts of network participants [*Verschuere et al.*, 2012, p. 1084]. This process is based on collaboration between state, volunteer and non-profit organizations, local public associations or certain individuals with the aim of improving the quality of social services. Officials of state organizations, private individuals or groups of citizens all play a role in this process voluntarily. Their involvement is dictated by demand to create new services or to raise the quality of existing services. The difference from 'traditional' volunteering in this case lies in the provision of personalized good, the end consumers of which are the volunteers themselves [*Verschuere et al.*, 2012, p. 1085].

Social innovations are for the most part produced and disseminated in the service sector and in organizational and administrative activity (*governance*). The latter is extremely important, as the existence of 'free space' for structures capable of producing social innovations to operate is dependent on the nature of state governance, especially in the social sphere. From a theoretical perspective, the innovations are a hybrid concept [*Dekker*, 2009] proposing, as mentioned above, collaboration between the state, civil society and the market to satisfy current and legitimate social needs.

Finally, the potential for civic involvement in the co-production of social services is often referred to as the foundation of social innovations [*Moore, Harley*,

2008, p. 8, 10]. As they are engaged in the current interests of the population, civil society organizations are the sole environment for the production of such innovations. We will now examine this thesis in more detail.

The tertiary sector as a favourable environment for the development of social innovations

Current theories pit the tertiary sector against the market and the state, stressing its compensatory role in plugging the gaps left by the latter two. It is widely recognized that NPOs are more sensitive to signals from citizens:

'Non-profit organizations are the priority mechanism for representing the diverse values of social groups and voicing religious, ideological, political, cultural, social, and other views' [*Anheier*, 2005, p. 174].

NPOs take on special significance as a tool to amass and represent the interests of a part of the population experiencing difficult living conditions and whose needs are barely being catered to by the state or businesses.

The structural characteristics and features of tertiary sector organizations give them an advantage over the authorities or commercial entities in terms of establishing a more favourable environment for innovative solutions [*Vedres, Stark,* 2010; *Rogers*, 2003; *Archibugi, Iammarino*, 2002]. These characteristics include:

1. Bringing stakeholders together: NPOs can establish complex networks of lateral connections and involve representatives of various different social groups that have not previously collaborated with one another or communicated with one another in a hierarchical manner.

2. The activity of NPOs responds to the values and aspirations of a specific local community and, in this context, can be more relevant to the local population than the activity of 'external' state or commercial organizations. As a result, the involvement of citizens and feedback from citizens on such structures can be expected to intensify.

3. The diversification of resources, including financial, information and human (the latter predominantly through volunteering), makes it possible to achieve stability. Volunteers play a key role in the creation of social innovations, as they serve as a further binding link between NPOs and society, its values, problems and needs in their capacity as 'think tanks' and carriers of knowledge and skills [*Brandsen et al.*, 2010]. It is through these 'links' in the local community that the validity of the work done by NPOs is maintained and increased.

Table 3 sets out the prospects of social innovations depending on the intensity of civic involvement and the size of the tertiary sector. The table shows the contribution of the tertiary sector to the advancement of social innovations by creating opportunities to develop and later disseminate new ideas and approaches initiated by citizens. It is not true that these citizens are implicitly oriented towards innovation activity or that they are prepared to independently realize innovative ideas to improve the social situation in society as a whole or locally. If we were to draw a parallel with the proportion of citizens who are potential entrepreneurs (aged 18 to 64 years, and have not yet started their own business but positively

Table 3. **Possible options for the development of social innovation**

Maturity (size) of the tertiary sector	Civic involvement	
	Weak	Active
Small	Weak development	Moderate development
Sizeable	Moderate development	Intensive development

Source: [*Anheier et al.*, 2014].

evaluate their own entrepreneurial skills and the current economic situation), then the number of such citizens would be low in Russia. In 2012, only 3% of Russians could be considered potential entrepreneurs [*Verkhovskaya, Dorokhina*, 2012]. Although no specific data have been gathered, it is reasonable to assume that the proportion of real 'social innovators' is even lower still. It is less that they share specific intentions to open their own business, but rather their assessment of their own abilities to produce new, in-demand ideas or products.

Non-profit organizations act as guides for new ideas in the social sphere. By making the corresponding organizational, expert, and at times even financial resources available, they test out the effectiveness of solutions proposed by the population and contribute to their further dissemination.

We will now analyse the population's involvement in civil society. Furthermore, we will examine the current state and potential of the Russian tertiary sector as the optimal environment to support and produce social innovations.

Sources

The empirical basis for our analysis was the results of a study on NPOs (2012) as well as a Russia-wide survey of the population carried out across Russia within the context of monitoring the state of civil society, carried out by the Centre for Studies of Civil Society and the Non-profit Sector, NRU HSE.

The information on NPOs was collected by MarketUp LLC through individual surveys of the directors of these organizations using a semi-structured questionnaire. Respondents were selected on the basis of regional registers of NPOs and public associations using representative quotas based on their legal form of organization and year of registration. 1,005 organizations from 33 regions across Russia were selected based on their classification in the following indices:

- urbanization index;
- level of development of the non-profit sector (in quantitative terms);
- economic development indicator, assessed according to the gross regional product per capita compared with average figures for Russia as a whole.

Respondents were selected mechanically. No more than two thirds of the total number of organizations in each region was surveyed in the region's administrative centre (excluding Moscow and St. Petersburg).

The population survey (2011–2013) was carried out by the 'Public Opinion' Fund through a structured individual interview at participants' homes. The sample covered 2,000 respondents selected according to how representative they were of socio-demographic characteristics: age, sex, type of settlement and proportional representation according to education and social and professional group. The statistical margin of error of the data received did not exceed 3.4%.

The tertiary sector as the driving force behind the development of social innovations in Russia

The tertiary sector comprises informal volunteer associations and NPOs that all feature certain characteristics: they have to be formal self-regulating structures, act on a voluntary basis, be independent from state administration bodies and not distribute profit between members and founders [*Salamon, Anheier*, 1997; John Hopkins University, 2004].

Uncovering the potential of NPOs as a favourable environment to produce and introduce innovations in the social sphere is possible using empirical data obtained through the study carried out by NRU HSE to monitor the state of civil society. This study assessed the number of non-profit organizations, their stability, ability to mobilize volunteering, as well as the variants stated by individuals describing their involvement in the work of these structures.

We lack reliable data on numbers of informal associations. Official statistics point to roughly 434,000 NPOs, but the problem of determining the actual number is pervasive. According to the results of the national study carried out by the Centre for Studies of Civil Society and the Non-profit Sector, NRU HSE in 2007, the proportion of NPOs actually operating as a percentage of those officially registered was no more than 38% [*Mersiyanova, Yakobson*, 2007].

The subjective role of these and other voluntary alliances implies that they have certain properties. In particular, three signs of a collective subject have been identified [*Zhuravlev*, 2002, pp. 64–70]:

- inter-connectivity between members;
- joint activity;
- group self-reflexivity reflecting the aims and ideas underpinning the group's existence, its values, ideals and prohibitions, the history of how it came into being, its achievements and failings, and its potential opportunities and challenges.

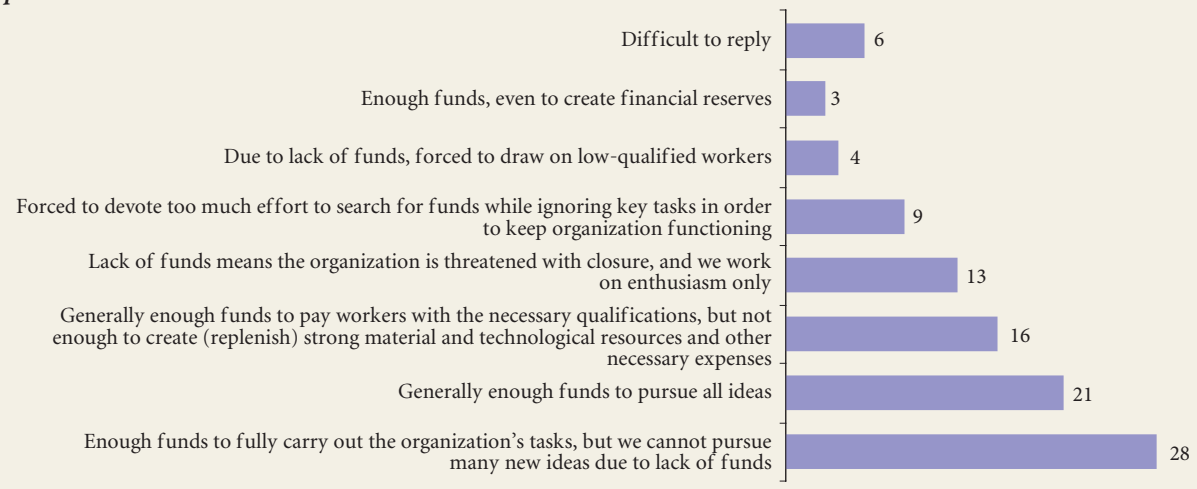
However, the subjective role of such organizations and groups can be weakened by unfavourable external and internal factors. We will now provide several empirical examples.

Data from the Russian study carried out in 2012 suggests that NPOs, on the whole, are economically weak and are often on the brink of folding. More than one third of them (37%) have no full-time workers. The proportion of NPOs that have to manage with the bare minimum of regular staff (from one to five workers) is 31%, of which 14% have one to two permanent employees. When it comes to attracting volunteers the situation is no better: only 41% of organizations have 10 or more volunteers, and 31% do not enlist any. Figure 1 shows that only one fifth of NPOs overall have the necessary resources to fulfil their plans, while almost the same proportion are teetering on the brink of folding, acting merely on enthusiasm, with the majority experiencing varying degrees of shortfalls in resources.

The ability of NPOs to act as formal channels to mobilize social activity is still minor. Only 3% of Russians reported working as a volunteer (0.42% of the economically active population expressed as full employment) and only 1–2% indicated that they volunteer with certain organizations as intermediaries for charitable activities. The majority actually prefer to make direct monetary donations or give hand-outs [HSE, 2010, p. 233].

Figure 1. **Distribution of responses to the question on the current economic state of non-profit organizations** (as a percentage of total surveyed, n = 1005)

The question to directors of non-profit organizations was: 'How would you rate the economic state of your organization at the present time?'



Source: authors' calculations.

It is worth noting that the level of civic awareness of the activities of public and other non-state NPOs in their home town is relatively high. Only 24% of respondents confessed to not knowing anything about them, and 3% found it 'difficult to reply'. Despite the relatively widespread lack of information, the involvement of Russians in the work of NPOs remains low: only 16% of those surveyed are involved with a public association. The results of the CHAID analysis[1] show that this figure differs considerably from the average in various social and demographic groups. It is more frequently the following categories of people who are involved with NPOs:

- non-working pensioners with a higher education (20%);
- non-working pensioners with a secondary specialist education living in Russian cities with a population of over one million (25%);
- hired workers with a higher education (26%), mostly aged 46 years or above (32%) or between 31 and 45 (26%);
- students and hired workers with secondary education or lower and who live in cities with a population of between 500,000 and one million (23%).

Expectations in terms of the prospects of citizens getting involved with NPOs to solve their own problems, help other people, and control the activity of the authorities are average. 40% of those surveyed were convinced that Russians would not look to become involved in such activity and 31% indicated that by 2020 the majority would work in public, religious, charitable and other non-state non-profit organizations.

Based on data from the two surveys reflecting attitudes towards NPOs[2], and specifically recognizing the need for involvement in their work, as well as the forecasts for the population's involvement, it is possible to construct a social typology of the population. Successive groups are situated logically on the main diagonal — social optimists and opportunists. On the second diagonal, we place groups with more popular conceptions of obligation and prospects – loyal opportunists and moralizers (Figure 2).

Social optimists, who are not only in favour of involvement in non-profit organizations, but also forecast active growth in involvement to reach the majority

Figure 2. **Social typology of the population based on normative attitudes and expectations of actual involvement in non-profit organizations by 2020** (as a percentage of total surveyed)

Source: authors' calculations.

[1] This method of analysis is described in more detail in the study [*Mersiyanova, Korneeva*, 2011, p.22].

[2] The first question was on *proper* and *civilly justified* conduct: 'In developed countries the majority of citizens are involved in the work of public, religious, charitable and other non-state non-profit organizations to work together to solve their problems and help other people, as well as to control the activities of the authorities. In your opinion, should the situation in Russia in this regard mirror that of developed countries?' The second was on notions of *actual* involvement in the tertiary sector: 'In your opinion, by 2020 will the majority of Russians be involved in the work of public, religious, charitable and other non-state non-profit organizations to solve their problems and help other people, as well as to control the activity of the authorities?'

of the population by 2020, make up one quarter of those surveyed. They can be considered the real target group for the tertiary sector and the potential core of the civil society's social base.

One third of the population falls under the 'social opportunists' category. This group considers involvement in such activity in general and their own participation unnecessary or inadvisable. We cannot really expect any support from them for the development of civil society in the near future.

Little more than one third of those surveyed (35%) falls under the most inert category of moralizers who agree that there is a need to be involved with nonprofit organizations, but deny the possibility of this involvement growing in the next six years. While technically supporting the proposed initiatives, they do not see any potential for them to be fulfilled. Thus, the dual structure of social consciousness observed long ago by sociologists is repeating itself, leading to a clear difference between what people say and do. This category, even with the utmost loyalty to the reformative rhetoric, poses the greatest danger to any transformation as a descent into a 'spiral of silence' [*Noel-Noiman*, 1996] establishes the foundations for the reproduction of a passive, civilly inert majority.

Loyal opportunists, accounting for only 7% of respondents, do not see any motive for involvement with NPOs yet believe that by 2020 such participation will become more widespread. The discrepancy in actual and expected conduct could lead to formal declarations of civil positions amid complete nihilism towards social and democratic values.

As such, assessments of civil society organizations' opportunities to influence the achievement of the country's strategic development goals up to 2020 are poor. With the awareness of the supreme authority of state structures, the separate tertiary sector will rather be seen as incompetent and incapable in terms of solving strategic problems. Therefore, the development of positive policies linked to involving civil society in social practices and the widespread dissemination of its values are becoming the most important conditions for including the public in the production of social innovations.

At present, the proportion of adults who have not been involved in public affairs is slightly higher than those who have (53% and 42% respectively). Overall, involvement in voluntary clean-up work and measures to improve apartment entrances and courtyards, and cities (towns, villages) was reported by 28% of respondents. The second most popular variant — taking part in meetings of tenants in a particular building or those who share an entrance (18%) — can also be classified as involvement in self-organization based on residence. The remaining forms of activity were mentioned much less frequently: 4–7% publicly expressed their opinion on the Internet, organized groups to resolve a personal or external problem, or helped those in a difficult situation. The rarest of activity reported by respondents was gatherings at peaceful demonstrations, acts of protest, meetings, picket lines, and public hearings (2–3%). The most socially passive were the elderly and people with a low level of education and income, as well as Muscovites and villagers.

Trust, association and mutual assistance, among other things, all have an impact on the involvement of Russians in publicly beneficial forms of activity. Thus, those who believe they can trust people are almost five times fewer than those who think it is important to be cautious when dealing with others (17% and 80% respectively). Despite the fact that members of certain social and demographic groups are more open, caution when dealing with outsiders tends to dominate all groups.

Our studies corroborate a well-known pattern: the shorter the social distance the greater the trust. Citizens prefer to trust their personal entourage far more frequently than other people (58% compared with 17%). Highly resourceful

groups (those with a higher education and financial security, specialists, and residents of large cities) are more inclined to trust others, as are those who are publicly active and are confident about the future. More often it is members of marginal, deprived groups who show the greatest distrust, for instance, those who do not feel that they are citizens of the country, those living below the poverty line, the unemployed, or those waiting for improvements in their personal and social life. Those who believe that disagreement and disassociation dominate in society are four and a half times greater in number than those convinced that agreement and solidarity are more common (77% and 17% respectively). The latter group tends to include the younger generations, while the elderly are more inclined to mention disagreement.

Regarding solidarity, we observe the same pattern as that revealed by the analysis of issues relating to trust: reducing social distance increases the proportion of those who report agreement and solidarity by more than three times (58% for the question on the respondents' entourage compared with 17% in relation to society as a whole).

The closest ties are forged by younger people and members of society's upper classes who have resources and social status, for instance, directors and specialists.

It is striking that believers who are involved in the life of the church community and active users of the Internet most supported the predominance of agreement and solidarity among those in their personal entourage. It was often the elderly, the poor, the unemployed or people with very low levels of education who mentioned disagreement and disassociation in their close surroundings.

Opinions on preparedness for mutual assistance are split. The view that mutual assistance is rare is more widespread (52%). Slightly less in number (42%) are those who believe that mutual assistance is a widespread phenomenon. The difference in these assessments is shaped by the same set of factors as described above. It is important to note the interrelationships between trust, agreement, and preparedness to help, especially when talking about respondents' groups of immediate contacts. Those who are trusting in people more frequently note their willingness to help one another, while those respondents who consider mutual assistance to be widespread tend to also report agreement and solidarity. Willingness to unite with others was expressed by two thirds of adult Russians (63%), while the opposite was reported by roughly one quarter (24%). Young people showed a greater tendency for unity, while the elderly, on the other hand, had no desire to unite with anybody. Frequently, members of contrasting social groups expressed the least and greatest inclination for unity. This is related not only to age, but also education, financial position, membership of certain social classes, and views on life prospects. Moscow residents expressed significantly less willingness to associate with one another than residents of other cities with populations of over one million (54% and 70% respectively).

In view of the weak institutional structure of civil society and the informal nature of Russians' involvement in its practices, it is critical that we grasp the development opportunities of social innovations in the context of the responsible subjectivity scenario [HSE, 2010].

Conclusion

By their very nature, social innovations are worthy of rapt attention as a new tool in the development of civil society and the realization of the desired scenario of responsible subjectivity. At the same time, the strong parties involved in social innovations limit the opportunities for their practical application in Russia. The tertiary sector cannot yet be described as institutionally mature or ready for the production and dissemination of social innovations.

Our analysis enables us to identify the weak parties in this sphere, its infrastructure and existing tools to involve citizens in the production of innovative social solutions. Despite the numerous examples of innovative initiatives in the social sphere initiated and developed both by individual citizens and by non-profit organizations [Non-profit Foundation, 2013; Agency for Social Information, 2011], they are by nature rather isolated. To raise their viability and spread, further efforts are needed. In this regard, one cannot deny the desire of Russian tertiary sector organizations to solve social problems together with the state. The overwhelming majority of NPO directors (86%) believe, to varying degrees, that their organizations should be involved in overcoming existing problems in education, health care and culture. The hope is that tertiary sector organizations will make a positive contribution to help effectively solve existing social issues. The perception of these structures as suppliers of social services is gradually intensifying: 79% of the population expressed the need for NPOs to be involved in active social activity in 2012 survey.

Russia's tertiary sector lags far behind both Europe and the US in terms of its ability to produce social innovations. However, the sector's development and supportive state policies, while contradictory, are on the whole showing positive signs. The challenge for the state is to create favourable conditions for NPOs and, at the same time, strengthen their role as a driving force of innovative changes in the social sphere. F

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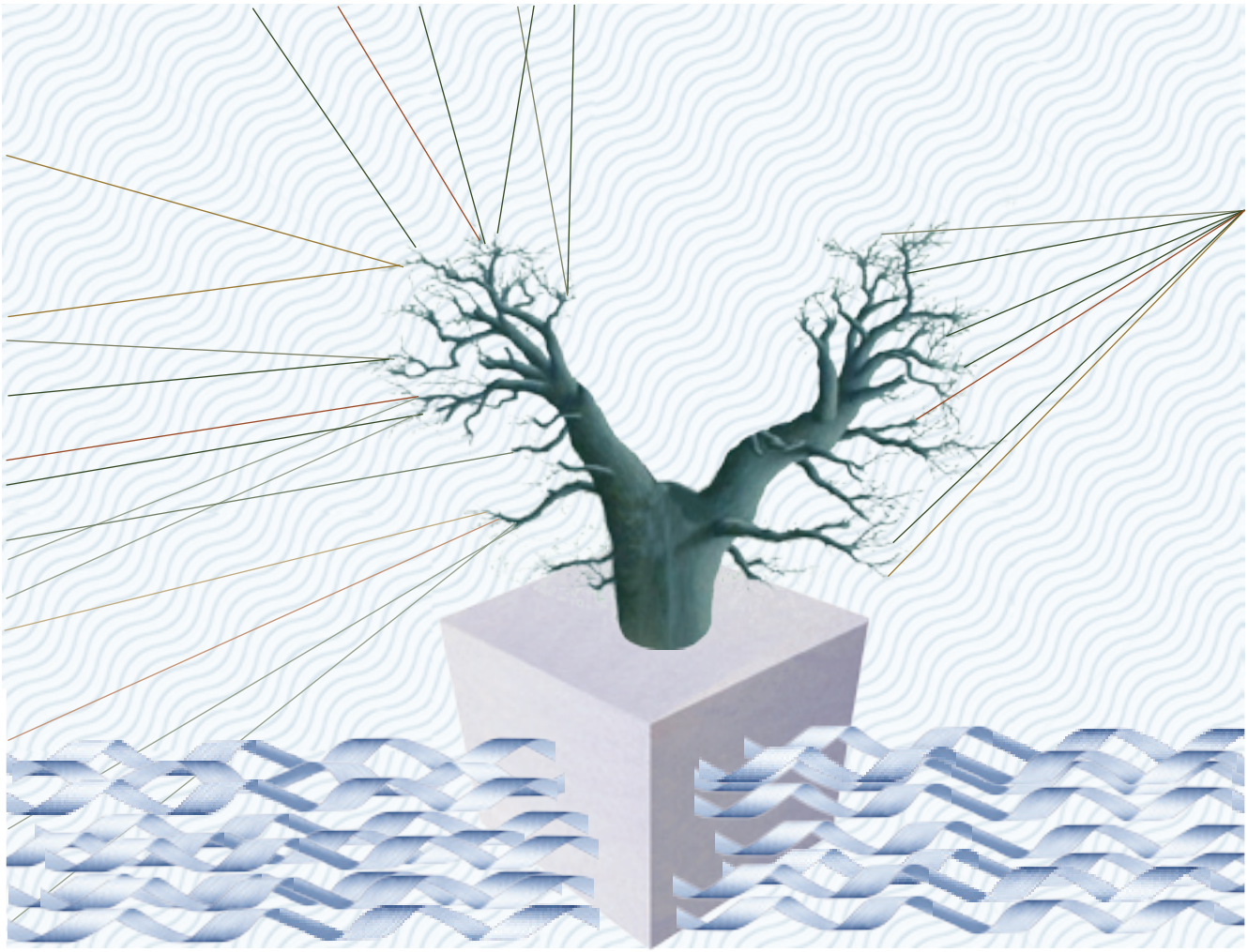
Can Basic Research Prevent Economic Stagnation?

Andreas Schibany, Christian Reiner



Decreasing performance in innovation may lead to re-enforcement of economic stagnation in developed countries. Well-balanced development of projects aimed at finding answers to the 'grand challenges', in parallel to curiosity-driven research, could make notable contribution in preventing such a negative trend.

Evidence from Austria shows the contradictions intrinsic to well-established innovation systems. The authors recommend re-adjusting mechanisms that foster career development in academia and creating organizations with sufficient administrative capacities and autonomy to attract qualified staff and funding.

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Stagnation Theory and Innovation Deficits

Recently, the debate surrounding technological progress has adopted an unusually pessimistic tone, as shown by US economist Tyler Cowen in his much talked-about book 'The Great Stagnation' [*Cowen*, 2011a]. This was supported pictorially by *The Economist* in 2013 with the headline picture of Rodin's *Thinker* shown sitting on a plinth made of a toilet complete with cistern [The Economist, 2013]. This illustration can be understood through the ideas of one of the well-known pessimistic economists, Robert Gordon [*Gordon*, 2012], who proposed the so-called 'toilet test' to assess the significance of innovations arising in different historical periods. He identified declining innovation performance in the Western world's most recent past and predicted that this trend would continue for the foreseeable future. According to the 'toilet test', let us assume you are offered the choice of the following options:

- Option A: You may use all innovations which were invented *up to* 2002, including PCs, running water and indoor flushing toilets;
- Option B: You may use all innovations, notably those invented *since* 2002 (e.g. Twitter, Facebook) but you must do without running water and indoor flushing toilets.

If you picked A, you are with the majority of all previous participants who have done the toilet test for innovation performance. Clearly, inventions from the 19th century are considerably more useful and more fundamental than all the innovative electronic gadgets which we seemingly benefit so much from using.

The essence of these arguments is that advanced, modern economies have reached a technological plateau. In contrast to previous eras, the capacity for technological modernization in the recent past appears to be nowhere near that of the 1960s. This is in spite of unprecedented volumes of human resources, financial investment and competition in research. As Cowen vividly argued, we have already harvested all the '*low hanging fruits*' [*Cowen*, 2011a] which makes it increasingly difficult to generate new impulses for growth from today's plateau.[1] Even the achievements to date of the digital age do not reflect on better labour productivity, as shown by the example of the US from 1891 to 2012 (Figure 1).

Andreas Schibany (1966–2014)

This article (in English and Russian) is a reprint of a working paper in German by the Austrian Institute for Advanced Studies [*Schibany, Reiner*, 2013]. It commemorates one of its co-authors, Andreas Schibany (1966-2014).

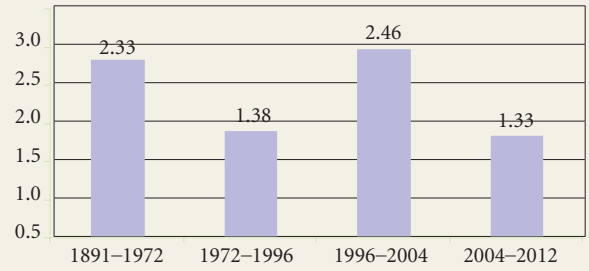
Andreas was born in 1966 and grew up in Vienna, Austria. His intellectual interests and inquisitive mind covered a broad variety of subjects and found expression in his successive studies at Vienna University, first of philosophy and sociology, and later of economics.

Andreas worked at the Austrian Research Centre Seibersdorf (in the Austrian Institute of Technology), the Institute for Technology and Regional Policy of the Joanneum Research Centre, and then at the Institute of Advanced Studies in Vienna. Andreas was a well-known and widely respected authority on a wide range of questions related to science, technology, and innovation policies, the internationalization of R&D, higher education, evaluations and comparative studies of national innovation systems, and the interactions between research and industry.

His academic and research output includes well over a hundred research papers, reports, book chapters and policy briefs. For many years, Andreas was the main author and coordinator of the annual Austrian Research and Technology Report. Andreas was a frequent speaker at public events and a frequent commentator in the media. He was a much respected for his razor-sharp logical thinking, his ability to review and discuss issues in their wider historical and societal context, and his constructively-critical approach to analyse current political, economic and social affairs. After a protracted illness, Andreas Schibany died in June 2014 at the age of 48. He is much missed by all those who knew him.

[1] 'Undoubtedly, high technology gadgets such as personal computers and smartphones have triggered massive changes. The quality of many goods and services has increased and their range has expanded. But if you go with what my grandmother says, the most important used objects have remained the same.' [*Cowen*, 2011b].

Figure 1. **Labour productivity growth in the USA** (as a percentage per year)



Source: [*Gordon*, 2012].

The computer-driven third industrial revolution began in the 1960s and could not prevent the considerable reduction in productivity growth in the ensuing decades (1972–1996). The famous quotation from Robert Solow came from this period: '*We can see computers everywhere except in the productivity statistics.*' [*Solow*, 1987]. Certainly, a considerable increase in productivity of 2.46% on average occurred shortly afterwards in the period from 1996 to 2004. The ICT sector and the new economy seemed to fulfill their expectations. However, in truth, the benefit of hindsight allows us to understand that it was just a relatively breathless growth spurt, which was replaced in the years to follow by a new drastic reduction in productivity growth. Admittedly, some remain optimistic and argue that this gloomy scenario is because the full productivity benefits of computer technology will not be fully realized for a long time (as shown already by a plurality of new technological uses of computer technology, such as 3D printers). Despite this, on a realistic medium-term development path economic stagnation remains possible as the reason for fewer basic innovations which would increase productivity growth over time. If one considers the burdens of an ageing population and rising debt levels which have arisen as a result of the great recession, this scenario looks ever more likely [*Krugman*, 2013].

Science policy must address how to overcome this negative economic scenario. There are many lively discussions about growth policy and innovation policy instruments [*Keuschnigg et al.*, 2013]. This article concentrates on the role of basic research systems in growth processes and its recent dynamics. Ultimately, science is an important catalyst for innovation, which is, in turn, the most important driver of economic development: '*Fundamental R&D, mostly undertaken and funded by governments, provides the foundation for future innovation*', as the OECD states in its innovation strategy [OECD, 2010]. However, a more rigorous analysis of the basic research system highlights several problems and organizational deficits in basic research which restrict its potential stimuli effects on innovation and growth.

Basic Research versus Applied Research

The official definition of basic research has remained mostly unchanged since 1963, when it was stated as follows by the OECD's Frascati Manual:

'*Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view.*' [OECD, 1994].

Before the 1963 OECD definition appeared, there was much debate in the USA about how to appropriately classify research. The results of this process were the establishment of the National Science Foundation (NSF), and creation of a statistical database, which led to greater understanding of atricky and all-encompassing concept. To date, it has not been possible to clearly distinguish between *basic* and *applied* research. For this reason, debate continued about suitable definitions of the terms. New definitions of free, basic research that were generated

include: *'pure, strategic, curiosity- driven'*. It was suggested that the differences between '*basic pure*' and '*basic-oriented*' research be highlighted.

Benoît Godin has a provocative theory as to why such a *fuzzy concept* could endure so long despite much criticism:

'*The concept of basic research has existed for so long because society defines itself according to it and significant resources and actions (science policy) are attached to the idea. Above all else, the concept is a category; and categories very often acquire social and political existence through numbers.*' [*Godin*, 2000, pp. 2–3].

The definition of basic research does not just have a semantic nature, but also determines financing streams and obligations. In providing financial resources, the state — represented by various institutions or agencies — starts from a self-definition. The definition of *basic research* remains, however, illogical. In the literal sense, it means that a research project is applied when the researcher knows the purpose of the research, and basic when this is not the case. Today there is a complementary, not diverging, relationship between basic and applied research. Distinguishing between the two types of research is harder and we witness a continuum of research where both types complement each other and partially overlap. This can be best observed in universities.

According to the latest Austrian R&D surveys published by Statistics Austria (*Statistik Austria*), 54% of university-based R&D projects is basic research and 46% is applied research. This explains why it makes more sense to talk about 'academic research' as this can be more freely defined, rather than divide research into specific types as the latter is increasingly becoming irrelevant and meaningless.

Even the integral criterion of excellence is of little use for spelling out what basic research means. The scientific community (or the *science lobby,* according to [*Arnold, Giarracca*, 2012, p. 4] and businesses interpret R&D excellence in different ways. For if the excellence criterion alone determines the selection and funding of research projects, the other criteria for allocating funding reduce the relevance of the single 'excellence' criterion. It is clear that the significance and originality of research results and social and/or economic relevance do not always contradict each other. If nearly half of Austria's research carried out in the higher education sector is applied, then the state cannot exclusively fund 'free and curiosity-driven research.' Greater competition for funding only has a limited effect as the excellence criteria differ so much across scientific disciplines and even research projects, which it makes it hard to compare.

Finally, even when all the elements come together — competition, excellence criteria, and the *peer review* process — the science sector is still suffering a crisis of quality. This is explicitly supported by a quote from a recent issue of *The Economist*:

'*Professional pressure, competition and ambition push scientists to publish more quickly than would be wise. A career structure which lays great stress on publishing many articles exacerbates all these problems. This means that the majority of the 'discoveries' in academia are the result of negligent experiments or superficial analysis.*' [The Economist, 2013].

The American Age and the 'Mark II' Innovation Model

Technical sciences proved their military utility during the Second World War, and could finally establish themselves at American universities in the succeeding years. These developments enabled the distinction between '*applied*' and '*basic research*' to become sharper. Basic research was aided by the way American universities self-identified as the protectors of true and pure science, as only their representatives fully possessed academic impartiality: hence universities saw themselves as the source of scientific progress.

Basic research was understood as servicing this hierarchy of values. Robert Merton declared, as early as the start of the 1940s, that the research university was the only institutional home of science [*Merton*, 1942]. The surprising point is that Merton's ideology of the 'ivory tower' found support from a source he would have least expected it: from the management of large commercial laboratories [*Hirschi,* 2013]. Thus, Kenneth Mees, head of the Eastman Kodak Research Library for many decades, stressed the optimal organizational advantages of a university in particular and attempted to reconstruct this commercially. Industrial academics should be able to research as freely and independently as possible, and to do this they need as little interference from outside as possible and flat hierarchies internally. Like Merton, Mees did not believe that scientific researchers' capabilities were the deciding factor for the success of research, but rather the academic culture and university structure. In Merton's and Mees' time, the issue of making research more efficient was not as pressing as it is today. The prevailing view was that it was necessary to invest however much resources (personnel, ideas, money and time) as was required. Mees saw *basic research* as the most important source of innovation and the starting point for all further technological development [*Ibid.*].

A similar 'linear model' was championed by physicist Mervin Kelly, who between 1934 and 1959 led the Bell Labs within the AT&T company. He named Bell Labs an '*Institute of Creative Technology*' [*Gertner*, 2012] and directed his focus particularly towards establishing communication structures between the 5700 scientists, engineers and technicians in order to achieve the knowledge exchange and necessary integration which was necessary for the production of commercial goods. The monopoly of AT&T was ultimately broken up by regulatory and judicial interventions between 1974 and 1984. It is noteworthy that the Bell Labs of AT&T was not the only firm to combine innovative basic research with a monopoly position on the market. Until the 1960s, several research-intensive monopolies, including Eastman Kodak and IBM, developed transformative innovations. These innovations arose not because of competition but because of the companies' monopolistic status that allowed the market leaders to invest significant financial resources, personnel and time in basic research. This innovation process is called the 'Mark II' model in economics and comes from the theory proposed by Joseph Schumpeter in his later work. While Schumpeter's earlier ideas argued that the main drivers of innovation were the dynamic, small and medium companies ('Mark I' model) [*Schumpeter*, 1934], he later argued that the main determinants of innovation were established monopoly companies [*Schumpeter*, 1942].

This American dream ended on October 4, 1957. On this day, the Soviet Union sent its first satellite into orbit and the USA fell into a state of shock, perceiving that its technological advantage was threatened. Politicians felt the need to intervene by significantly increasing state R&D expenditure. The National Science Foundation (NSF) was founded at the start of the 1950s; its annual budget increased from USD34m in 1959 to USD134m, and USD500m in 1968.

The status of research establishments also changed at this time. The existing policy up to the late 1950s had been to allow basic research complete freedom for ten years without imposing any guarantees of success, as Mees had demanded; after 1957, this appeared a luxury which could not be afforded in the face of the technological threat of the Soviet Union. With the rapid growth of state R&D support, a battle over the distribution of the funding between diverse research establishments broke out and certain rules were needed to regulate funding distribution. The research sector first saw the introduction of something resembling competition as a selection mechanism, which signaled the beginning of the 'age of marketing and self-representation in science.' Every publication, however unimportant, served as a signal and every small innovation was trumpeted as an immense breakthrough in an attempt to acquire funding.

Thus not only did the nature of industrial research change, but so too did the relationship between industry and universities. The corporate industrial giants withdrew from costly lab work and turned instead to co-operation with universities and state scientific institutions. Greater division of labour between industry and universities began. At the same time, new research areas were developed which attracted the interest of basic research. The most prominent example is the biotechnology sphere, where thanks to developments in the technological base the boundaries between basic research and industry have begun to erode [*Pisano*, 2006].

This brief historical perspective helps us to better understand what forms of interactions between science and industry are possible and the value of basic research for companies. In this context, we often hear critiques about the insufficient intensity of knowledge transfer from research to the commercial sector. A closer examination, however, disproves such beliefs to some extent.

The European Paradox

Many of the funding measures on a European level in the 1990s were induced by grave and hard-to-correct problems which dominated much of European innovation policy. Thse problems came to be known as the '*European Paradox*': the situation where Europe has great strengths in research compared to the USA but weaknesses in converting these scientific results into innovations [European Commission, 1995]. The European framework programmes were largely implemented under the influence of this paradox [*Arnold et al.*, 2011]. The problem of transforming research into innovation was seen by many European decision makers as a failure, which they proposed to overcome by emphasizing the development of networks, co-operation, and effective co-ordination of research. The belief in this paradox is still widespread today, as shown by the European Council's decisions in 2011 and 2012: '*Innovation and research are at the heart of the Europe-2020 strategy. Europe has a strong science base but is not yet capable of transforming research into new innovations targeted to market demands – an issue that needs to be addressed if the Europe-2020 strategy is to be implemented successfully.*' [European Commission, 2012, p. 1].

At the same time, many commentators also saw in this '*networking frenzy*' [*Dosi et al.*, 2006, p. 1461] one of the reasons for a less successful European innovation policy. While the US remains the leader[2] for the quality of research, '*Europe is bad at innovation because it is bad at innovation; the amount and quality of European research has little to do with this.*' [*Arnold, Giarracca*, 2012, p. 46].

Table 1 shows the main indicators of research productivity in the US and EU. The most important result is in the last line, which summarizes all research areas. While the quantity of articles is higher in the EU than the US, US articles are cited significantly more frequently than EU publications. Despite problems

Table 1. **The productivity of research in the EU and US: 1998–2002***

	Share of total articles (%)		Share of total citations (%)		Normalized average number of citations	
	USA (1)	EU (2)	USA (3)	EU (4)	USA (5)=(3)/(1)	EU (6) =(4)/(2)
Social Sciences	55.90	27.60	66.90	25.50	1.20	0.92
Natural Sciences	25.20	37.40	37.90	42.00	1.50	1.12
Life Sciences	38.00	39.20	51.00	39.30	1.34	1.00
All Sciences	32.90	36.70	46.30	39.50	1.41	1.08

*Data comprise 3.6 million articles and 47 million citations.
Source: [*Albarran et al.*, 2010].

[2] 'Despite the fact that the US publishes fewer articles than EU countries, US papers overwhelmingly dominate overall compared to those from the EU …' [*Herranz, Ruiz-Castillo,* 2011, p. 12].

associated with bibliometric indicators, they are an important indicator of the high significance and quality of R&D in the US. Hence, the *'EU's* lagging behind is unlikely to be caused by weak industry — university co-operation.' [*Dosi et al.*, 2006, p. 1458].

The aforementioned problem of the 1990s no longer exists in the same form. Development of research-intensive industrial sectors (such as the chemical and pharmaceutical industries, electrical engineering, machinery construction, and the automotive industry) is impossible without inputs of new ideas from research. In addition, researchers co-operate with industry not so much to commercialize their knowledge but more to search for ideas for their research (for example, in the medical industry). Co-operation with companies gives researchers an understanding of current social and economic issues, which in turn gives momentum to their scientific research. Under an effective industry-university partnership, the dangers of reduced autonomy for university research are minimal. Today, knowledge transfers between research and industry should therefore be understood in a broader and more comprehensive way, in particular stressing the benefits for research. This knowledge transfer can work through different channels:

- research by contract and scientific-technical consultancy;
- shared use of research infrastructure;
- mobility of researchers between research and industry[3];
- founding of companies by scientists (spin-offs);
- education of highly qualified human resources (*'knowledge transfer face-to-face'*), the lack of which is a much more serious obstacle for innovation in companies than access to new technologies or finding suitable co-operation partners [FTB, 2012, p. 107].

Although the hurdles for research and industry collaboration on joint research projects have been mainly overcome, a particular '*entrepreneurial spirit*' does not yet seem to have taken root in universities. Getting a worthy research career in a university requires, first and foremost, the proven ability to attract external funding for projects and publications in high-ranking, international journals. The contemporary system of incentives in universities is biased towards the educational process and not on the transfer of new technologies to the real economy. For the situation to evolve, we need to change the image of universities and make researchers aware of companies' needs. A broad array of mechanisms is available to achieve this, including teaching entrepreneurial skills, offering researchers 'creative sabbaticals' for researchers to launch start-ups, and awards for the best university spin-off.

The fear that supporters of the 'Humboldt model' often share and voice — is that such an approach may lead to an 'economization of research', which would thus restrict free, curiosity-driven research. While such worries are not groundless, the majority of research has some immunity against such 'commercialization'. Furthermore, there is evidence of a complementary relationship between the creation of economically relevant outputs (measured by contract research, spin-offs, R&D services, patents, etc.) and the number of scientific publications [*Crespi et al.*, 2008; *Lotz et al.*, 2007; *Link et al.*, 2007) As Crespi et al. wrote:

'*Top researchers succeed [in publishing and patenting] a lot; a high patent output does not seem to [negatively affect] the publication output of the most prolific researchers.*' [*Crespi et al.,* op. cit., 2008, p. 3]. According to bibliometric analysis, research projects carried out on behalf of or in co-operation with industry are capable of producing excellent scientific results [*Arnold et al.*, 2004; *Balconi et al.*, 2006; *Lebeau et al.*, 2008; *Labory et al.*, 2008; *Abramo et al.*, 2009; *Perkmann et al.*, 2011).

[3] '*The best technology transfer is a pair of shoes*' [*Bramwell, Wolfe,* 2008].

How to provide effective support for research in Austria?

In the last 15 years, Austria has become one of the leading nations for innovation. This achievement was helped by first and foremost, joining the EU, the implementation of large structural programmes, the openness of Austrian companies to innovation and their ability to compete, the strong internationalization of academic research, and the creation of new framework conditions. The fact that Austria is frequently described as having a 'mature' innovation system does not insulate the country against different kinds of crises. Besides, as in finance where an ailing bank can ruin the financial sector, the innovation system can be damaged by an ineffective university that receives resources from the state budget for many years. Nevertheless, whether or not the social returns would increase given a stable volume of investment is a question that needs further analysis.

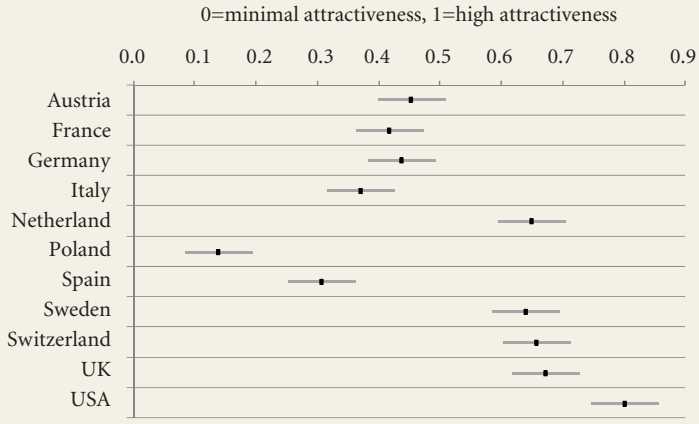
As in many policy areas, the effectiveness of research is assessed by the relationship between inputs and outputs, even though such links are quite hard to measure. However, we note that on this indicator — even taking into account the methodological difficulties — Austria is considered to have an efficient innovation system [DTS, 2012]. When an innovation system still finds itself in the catching-up process, i.e., behind the *technological frontier*, then the funding instruments for research and requirements for this process should be adapted accordingly. Thorough attention to science, technology, and innovation development and comprehensive project support customized to companies' needs indicate that Austria has not adapted the funding instruments to the new environment but simply widened the list of existing instruments.

There have been intense discussions about funding allocations for different research areas as such resources are discretionary. Moreover, Austria's priority goal has for many years been to maintain manufacturing. In connection with this goal, the government has broadened existing programmes to support companies and created new ones. There is evidence to show that the role of state financing in determining a company's choice of location for production is at times exaggerated. Industry tends to emphasize this argument about the importance of state funding [OECD, 2011; *Schibany et al.*, 2013a]. In fact, the decision about a company's production location is really determined by other factors.

Two facts are significant and worth noting. First, recent studies show that 93% of successful export-oriented innovative companies in Austria ('*frontrunner companies*') are not planning to move their production and R&D facilities to other countries [*Schibany et al.*, 2013b]. Second, mobility is key characteristic of Austria's research sector. Although universities cannot change their location, the high levels of mobility among individual researchers can seriously affect the entire university's research strategy. Figure 2 shows that for Austria, inward migration of specialists with higher education is not high enough. In particular, Austria needs to provide opportunities for stable career growth based on performance to increase the country's attractiveness.

A characteristic of innovation-leading nations is that innovations and technologies are increasingly research-intensive. Supporting long-term research enables new knowledge to be created and the country to be embedded in international networks. It is these initiatives as well as advanced technologies and global networks that are the sources of global competitiveness. Austria's science funding system is based on a mistaken idea that any given project should be limited in time and is an isolated project. Thus the whole set-up needs fundamental reform. External funding increases universities' financial autonomy which in turn allows them to overcome some of the systemic constraints, including those related to personnel. At the same time, employees hired for specific projects can find themselves in a precarious situation if the new project contracts are not authorized or adequately supported. According to Austria's 2002 University Law (*Universitätsgesetz*), universities can independently make personnel deci-

Figure 2. **Index of Academic Workplace Quality in an International Comparison**



Source: [*Janger*, 2013].

sions. However, even though this is not put into practice to the extent permitted in the Employees Law (*Angestelltengesetz*), universities still find themselves in a contradictory situation because of their legal responsibility to provide a certain number of state-funded student places and provide employees with attractive career development opportunities.

The share of R&D employees financed from external funds at Austrian universities has increased continuously since 2002 — and reached 42% in 2009.[4] Such a high proportion not only creates an environment of uncertainty for full-time staff but it also means a possible loss of competent researchers. Highly qualified specialists are rare in Austria — a fact confirmed by universities and large and small enterprises. The training of highly qualified specialists along with ensuring long-term funding for research are two of the most high priority tasks facing the Austrian state.

Conclusion

Basic research has the potential to help overcome stagnation in the economy and innovation sphere. To do this it needs long-term, constant funding and large research networks that have greater visibility and a critical mass. Research teams with international members are more effective and attractive for foreign researchers. There is no need to launch new programmes to address these challenges: the 'Initiative for Excellence in Science' programme *(Exzellenzinitiative Wissenschaft)* has been in place since 2006 and aims to create excellence clusters [FWF, 2006; RFTE, 2013]. A suitable approach would be to support different areas equally, including curiosity-driven research and research that addresses the 'grand challenges' of developed societies.

The Austrian contemporary system of basic research is highly specialized and needs long-term investment in human capital. This provides opportunities for stable career development. Thus such investments can bring the necessary social yield.

The Austrian research system has gained solid experience in research management over recent years. There is an understanding of the need for institutions that help a research-intensive innovation system to function. Examples of such institutions include the Institute of Science and Technology Austria (IST Austria) and the Research Centre for Molecular Medicine (Ce-M-M). Such research organizations possess sufficient administrative capabilities and internal autonomy to independently define their own projects and, with long-term financing, build bridges towards future innovations, which may only appear after 10 or 20 years. F

[4] These external resources include state funds (for example, the Austrian Science Fund, FWF) and private investments [FTB, 2012, p. 142].

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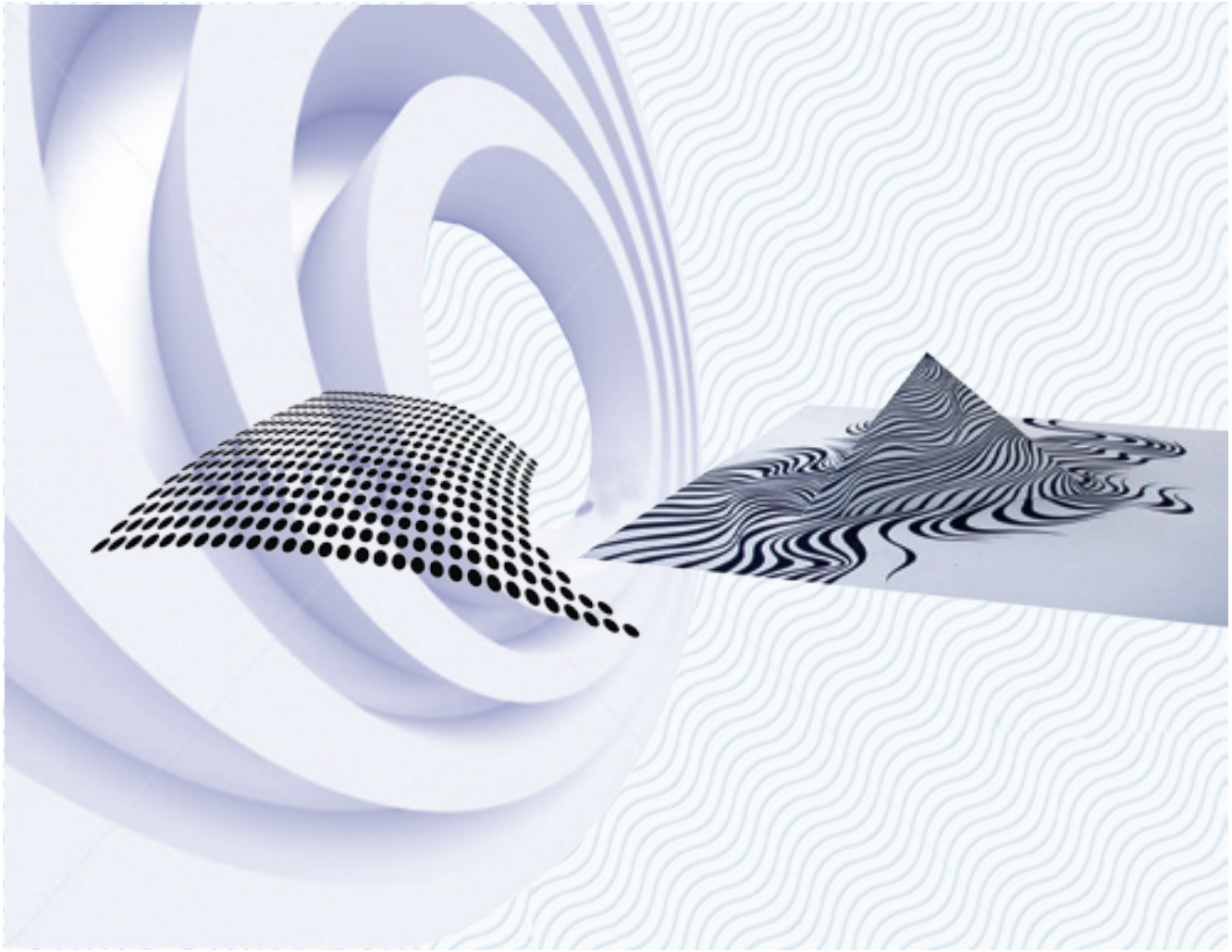
Master Class

Global Technology Trends Monitoring: Theoretical Frameworks and Best Practices*

Nadezhda Mikova, Anna Sokolova



Monitoring and accurate interpretation of the data on technological trends is a key prerequisite for the gaining competitive advantages in various economic sectors. Validation of expert assessments via quantitative methods helps to reveal inexplicit signs of technological change based on the analysis of large data sets. Synthesis of qualitative and quantitative methods enables identification of global technological trends, formalization of their criteria, and creation of automated information processing tools.

The paper presents an analytical review of international practices for monitoring global technology trends, as well as the key theoretical approaches and methods, which have been developed in this field.

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Keywords

global technology trends monitoring; technology mining; Foresight; qualitative and quantitative methods; evidence-based approach; bibliometric analysis; patent analysis; text mining; information overload; information sources; automated tools

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Alongside the accelerating pace of technological progress and the shortening of the innovation cycle, we are faced with the task of identifying and systematically monitoring trends that are capable of having a significant impact on long-term social and economic development. Systematic monitoring of prospective science and technology (S&T) trends is necessary for flexible and timely strategic decision-making in response to technological changes.

Numerous studies aimed at uncovering these technological trends interpret this very term variously and make use of associated concepts. These studies differ in the emphasis they place on varying effects, the life cycle stage of the technologies, and the scale and methods used. The expected effects are the most significant characteristic of a technological trend. Thus, the unique feature of *disruptive innovations* lies in the fact that they endow technology with fundamentally new consumer properties which are capable of fully changing the structure of markets [*Christensen*, 1997]. Where *emerging technologies* are identified, intensively developing technological directions with high potential for inventions, innovations and associated significant economic and social consequences are the focus of attention [*Gokhberg et al.*, 2013]. When analysing *technology applications*, the emphasis is on interdisciplinary technological fields that could have a major impact on social and economic development and change the lives of people around the world [*Silberglitt et al.*, 2006]. Authors often include differing notions in the concept of technological trends depending on the technology's life cycle stage. For instance, emerging technologies fall under the research and development stage, while technology applications and products may already have been partially introduced on the market. Terminological preferences can be caused by the trends' scale. Thus, *mega-trends* are viewed as stable trends on a global level that determine the future development of the global economy and society [*Singh*, 2012]. Technology trends can also differ in the way they can be identified. In particular, dynamic and high-interest areas of S&T such as *research fronts* are defined as clusters of documents sorted on the basis of co-citation analysis [*Upham, Small*, 2010].

As such, choosing how best to define the notion 'trend' primarily depends on the aim and objectives of the study, its scale, and main focus. In a general sense, a *technology trend* can be defined as a topical breakthrough and actively evolving direction of technological development, capable of having a significant impact on the economy and society in the future.

Studies aimed at identifying prospective S&T trends are carried out at national, industry, and corporate levels in many countries. The results of such research are in wide demand across a broad spectrum of stakeholders (for example, government, business, research institutes, and the general public) involved in the development and practical use of long-term forecasts. For the most part, expert methods (interviews, surveys, seminars, etc.) are used to carry out such large-scale projects. At the same time, there is a growing demand for an evidence-based approach to monitoring trends, capable of verifying expert assessments and revealing implicit signs of technological changes using large volumes of data. It is no coincidence that theoretical studies increasingly focus on improving quantitative technology monitoring methods and developing automated data processing procedures.

The aim of this paper is to present an analytical review of international practices on identifying global technology trends, as well as key related theoretical approaches and methods.

Global practice in technology trends monitoring

Many projects on identifying technology trends are now being carried out by international organizations, national research centres, universities, companies and consultancy agencies. The aims of these studies vary. Technology monitoring by international organizations is necessary for supranational regulation of the S&T sphere, the development of joint programmes within country unions, and effective integration and standardization of activities in science, technology

and innovation. Governmental institutions are faced with the task of shaping the overall state of global S&T and identifying a country's competitive advantages in key areas that are important from the perspective of national security and improving military potential (a portion of such data remains secret and inaccessible to the public). Monitoring projects by universities and research centres involve regular collection and analysis of information on new S&T directions, not only for scientific purposes, but also in the interests of businesses and drafting recommendations to governments on selecting certain national or regional priorities. Major corporations and private firms carry out their own monitoring of potential S&T breakthrough areas, which helps them to adapt to changing market conditions and guarantee global competitiveness. Consultancy and audit companies engage in such initiatives to collect information needed by businesses to define strategic priorities.

Trends monitoring covers both certain sectors and the entire range of potential directions of technological development. The forecasting horizon, as a general rule, ranges from 10 to 30 years or more (the database of the German consultancy firm Z_punkt includes assessments up to 2020, while in some cases it is up to 2040–2050). These projects make active use of qualitative methods (literature review, expert surveys, interviews, developing scenarios, etc.) alongside quantitative methods (bibliometric and patent analysis, collecting and summarizing web-data, etc.). Numerous attempts have been made to automate the processing of information on technologies (a semi-automated approach) and to use online tools to publish and discuss results online.

Figure 1 shows certain types of technology trends monitoring projects carried out by different organizations.

International organizations

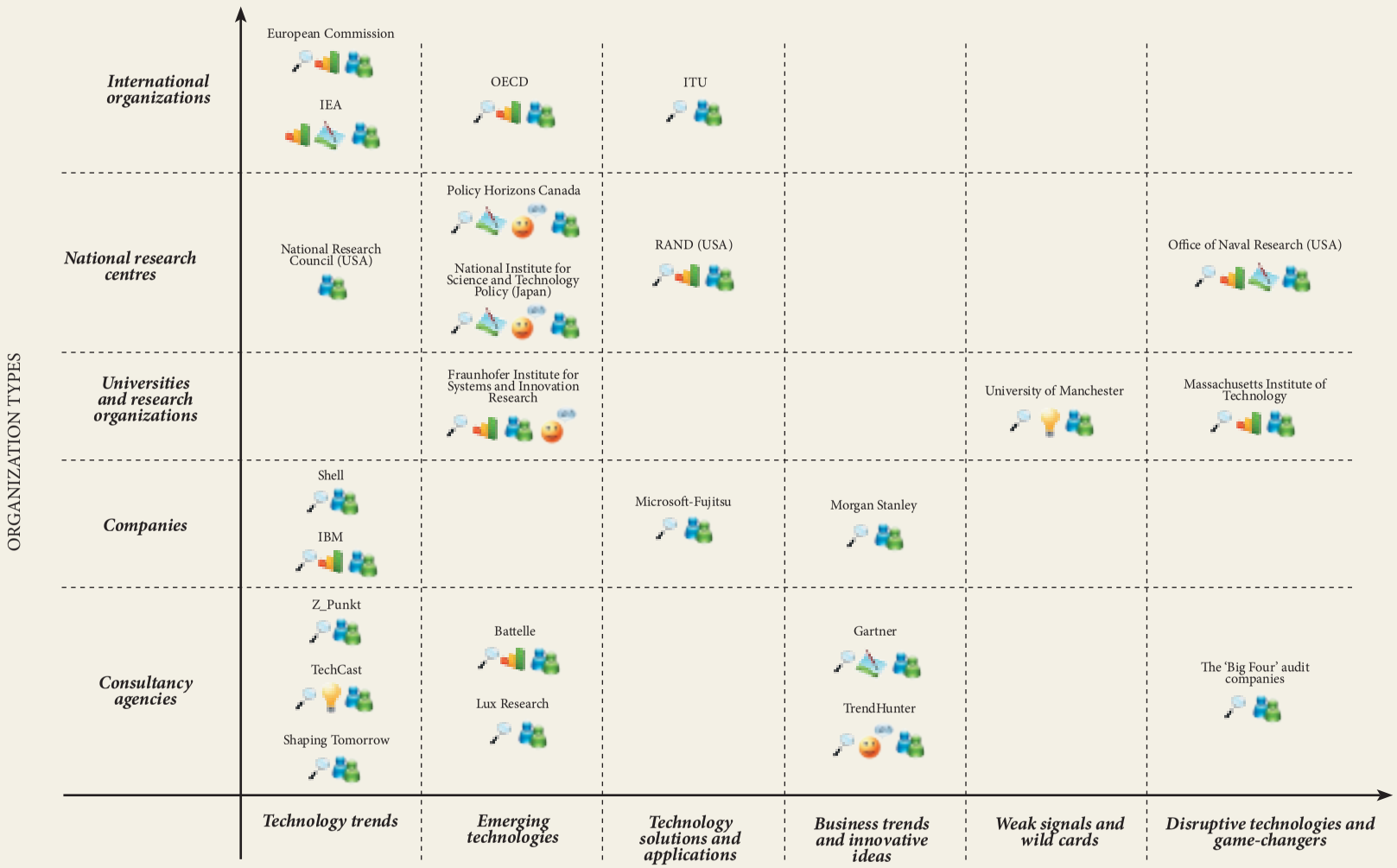
A number of international organizations carry out studies to identify prospective S&T directions and emerging technologies and to assess long-term development opportunities in certain areas. Generally, these projects result in the development of scenarios, a list of key technologies, trends and driving forces behind their development, and technological standards and policy recommendations for various countries. Examples of monitoring projects by international organizations are given in Table 1 below.

The European Commission implements various programmes to study global technology trends capable of influencing the development prospects of the economy and society and publishes summary reports with recommendations to the European Parliament on S&T policy. For example, the 'European Technology Watch' programme by the European Organization for Security [European Commission, 2009] draws together the efforts of various participants (science, business, government) with a view to furthering existing competencies and raising the potential of European countries in S&T to secure the region's leading positions in the world. This type of monitoring involves searching for potentially important technological fields and working on measures to stimulate their development in European countries.

The OECD conducts an ongoing large-scale analytical study on technology forecasting and a number of projects to monitor technology trends and drivers of growth in an extremely diverse range of fields (space, energy, bioeconomics, etc.) For instance, in 2006–2007 the OECD published a series of 'Infrastructure to 2030' reports [OECD, 2007] analysing the long-term opportunities and challenges faced by the global environment and setting out recommendations for the governments of the organization's member states. In 2014, a report revealed the key challenges and trends which could change the developmental trajectory of prospective fields such as nano-, bio-, space and information and communication technologies, and incorporated the lists of key OECD reports in these fields [OECD, 2014].

The International Telecommunication Union's (ITU) 'Technology Watch' project [ITU, 2014] looks at significant trends in information and communication technology (ICT) and proposes standards for new technological fields. The study aims to search for and study prospective S&T directions and measure

Figure 1. **Typology of organizations and technology trends monitoring projects**



Methods

- Review of information sources (international projects, media resources, reports, etc.)
- Statistical analysis (publications, patents, news, etc.)
- Analysis of 'weak signals' and 'wild cards'
- Development of scenarios and roadmaps
- Surveys of the population and community participants
- Expert procedures (surveys, seminars, interviews, etc.)

Source: compiled by the authors.

Table 1. **Examples of technology trends monitoring projects by international organizations**

Organization	Project name	Project aim	Examples of trends	Methods	Results
European Commission	European Technology Watch [European Commission, 2009]	Early identification of emerging technologies in various fields, assessing their impact on the market to stave off any security threats to EU states	Robotic assistants	Literature review (materials from joint European Commission projects – DEISA, PRACE, EGI, EMI) Collecting and summarizing expert assessments (interviews, expert panels, surveys, seminars, etc.)	Recommendations to EU state governments to guarantee security in Europe and globally
Organization for Economic Co-operation and Development	'Infrastructure to 2030: Mapping Policy for Electricity, Water and Transport' [OECD, 2007]	Identifying long-term development opportunities for infrastructure around the world, drafting recommendations to improve infrastructure for OECD member states	Intelligent transport systems	Reviewing studies by the OECD and member states of the organization Collecting and summarizing expert assessments (involving specialists from government agencies, companies, research institutes)	Report on opportunities to develop infrastructure in fields such as electricity production, water resources, rail freight transport, urban public transport, road transport List of recommendations to OECD member states to improve infrastructure in the sectors under consideration
International Telecommunication Union	'Technology Watch' [ITU, 2014]	Identifying emerging technologies to later set ICT standards in developed and developing countries	Ubiquitous sensor networks	Literature review (various ITU reports) Consultations with experts	27 reports on technology monitoring (for example, 'Trends in Video Games and Gaming', 'The Optical World', 'Standards and e-Health', etc.) TechWatch Alerts on technology development
International Energy Agency	'Energy Technology Perspectives 2012' [IEA, 2012]	Identifying technologies capable of reducing the negative effects of climate change and improving energy security	Carbon capture and storage	Statistical analysis Building roadmaps Developing scenarios Seminars with experts	Energy development scenarios and strategies up to 2050 10 technologies potentially capable of having an impact on energy development 25 energy recommendations to governments of various countries

Source: compiled by the authors.

their potential in terms of R&D standardization. The ITU reports offer an assessment of the impact of emerging technologies on the competitiveness of developed and developing economies, analyse standardization activity and trace the trajectory of ICT dynamics. As a whole, 'Technology Watch' describes the broad current and future context of global S&T development and establishes a normative framework within which to draft regulations and standards in ICT at national and international levels.

National research centres

Many national research centres have been called upon by their governments to monitor prospective directions in technology development with a view to adjusting the country's domestic and foreign policy. These projects describe technology trends, emerging technologies, prospective technology applications, driving forces and alternative technology development scenarios, as well as the most promising countries in terms of S&T collaboration. Table 2 shows several monitoring projects by national research centres.

The activities of the RAND Corporation — a strategic US research centre — focus on analytical support for science and education activity and health care and helping to strengthen national security and the stability of international relations. Certain technological trends are covered in the report 'The Global Technology Revolution' [*Silberglitt et al.*, 2006]. The report presents four main S&T directions that are capable of having a radical impact on future development: bio-, nano-, information technologies and new materials. As part of the study, researchers looked at factors underlying the technology revolution and evaluated the prospects of 16 key technology applications, including hybrid vehicles, green manufacturing, targeted drug delivery, etc., and their most important effects.

Table 2. **Examples of technology trends monitoring projects by national research centres**

Organization	Project name	Project aim	Examples of trends	Methods	Results
RAND Corporation	'Global Technology Revolution 2020' [*Silberglitt et al.*, 2006]	Identifying key technology applications and analysing their impact on global social andeconomic development	Embedded sensors and computational devices in commercial goods	Literature review (core S&T publications) Assessment of R&D and investment dynamics Interviews with experts	List and description of key technology applications
National Institute for Science and Technology Policy (Japan)	'The 9th Science and Technology Foresight' [NISTEP, 2010]	Analysing science, technology and innovation trends to increase the country's competitiveness in key S&T fields	Cloud computing	Delphi surveys Developing scenarios Population surveys	12 scenarios 120 key topics List of countries for S&T collaboration with Japan 13 areas with special importance to Japan
Office of Naval Research (USA)	'Science and Technology Text Mining' [ONR, 2014]	Analysing and mapping technology directions to plan and develop political programmes	Sensor networks	Review of information sources (reports) Statistical analysis (patents, scientific publications) Web-mining Collecting and summarizing expert assessments (roadmaps)	Global map of S&T development S&T investment plan
National Research Council (USA)	'Technology Warning' [NRC, 2014]	Identifying key technologies and innovations from a military perspective, posing a potential threat to the US national security system	Supercomputing	Review of information sources (materials from the 'Joint Vision 2020' project and others) Consultations with experts	Description of key technologies in the form of reports on: 'Technology Futures', 'Technology Watch', 'Technology Warning', 'Technology Alert' and others.

Source: compiled by the authors.

The National Institute for Science and Technology Policy (NISTEP) was set up through the Japanese government to work on S&T policy, provide companies and associated organizations with analytical materials, and assist in research activity in vital technological fields. In 2010, NISTEP published 'The 9th Science and Technology Foresight' [NISTEP, 2010], which was devoted to key directions to raise the competitiveness of the country in science, technology and innovation. The NISTEP Foresight centre publishes regular reports (Science and Technology Trends) [NISTEP, 2014] focusing on trends in technological fields (life sciences, ICT, ecology and energy, nanotechnology, etc.) which, if developed, could help to solve global and national problems. These trends are studied within expert networks made up of representatives from the sciences, business and the public sector.

Since 1998, the US Office of Naval Research (ONR) has been working on its 'Science and technology text mining' programme [ONR, 2014]. The aim of this project is to identify technology trends by processing textual data obtained from S&T databases (publications, patents, etc.) and using the results when planning and developing political initiatives. The programme looks for new interdisciplinary ways to overcome current challenges and identifies the key players and experts in specific S&T fields. In view of the importance of the programme to protect the country's national security, the results are presented to the US Navy command privately. At the same time, the authors behind the research regularly publish articles in academic journals and use their work as empirical evidence to support the accuracy of analytical conclusions [*Kostoff et al.*, 2001, 2002, 2004].

The US National Intelligence Council (NIC) prepared a series of 'Global trends' reports describing the factors and directions of technological progress that are capable of changing the trajectory of global development. Thus, the technology section of the report 'Global Trends 2030: Alternative Worlds' [NIC, 2012] outlines the impact of new technologies on global development in fields such

Table 3. **Examples of technology trends monitoring projects by universities and research organizations**

Organization	Project name	Project aim	Examples of trends	Methods	Results
Manchester Institute of Innovation Research	iKNOW database [Manchester IIR, 2013]	Identifying, classifying and analysing 'weak signals' and 'wild cards'	Production of artificial organs	Review of information sources (publications, blogs, news articles, EU technology monitoring projects) Delphi surveys and interviews (panels involving scientists and research organizations) Analysing 'weak signals' and 'wild cards'	List of 'weak signals' and 'wild cards' according to the themes of the EU Seventh Framework Programme
Fraunhofer Institute for Systems and Innovation Research	'Emerging technologies' [Fraunhofer ISI, 2014]	Identifying technology trends in S&T fields and analysing the potential to introduce innovative technology applications into industry	Lithium-ion batteries	Review of information sources Monitoring R&D activity Developing scenarios Seminars with experts Population surveys	Reports on emerging technologies in various fields (bioeconomy and life sciences, health system, ICT and others)
Massachusetts Institute of Technology [MIT, 2013]	'MIT Technology Review' [MIT, 2013]	Analysing prospective technology fields selected at the Open Innovations Forum	Human brain modelling	Review of information sources (scientific reports, news articles, etc.) Statistical analysis Surveys and consultations with experts	List of key technology trends

Source: compiled by the authors.

as ICT, automation and manufacturing, resource and health technologies, and others. The document was drawn up on the basis of surveys carried out among company employees, members of academic institutes, governmental and non-governmental experts from the USA and other countries around the world. The study proposed four alternative global development scenarios, indicating the drivers, barriers and disruptive factors for them.

Universities and research organizations

Academic institutions, including non-governmental, make a significant contribution to technology trends monitoring. The emphasis here is placed on new technologies, 'weak signals' and 'wild cards'[1] that could have a major impact on global socio-economic development in future. Studies such as these are carried out with the backing of national and international grants or as part of consultancy activity using vast information databases. They tend to develop databases (of trends, emerging technologies, 'weak signals', 'wild cards', etc.) that are widely accessible. Table 3 shows certain monitoring projects of this type.

The iKNOW project by the Manchester Institute of Innovation Research [Manchester IIR, 2013] is carried out with the support of the European Commission jointly with a number of international organizations and aims to identify 'weak signals' and 'wild cards'. iKNOW operates within an expert network bringing together decision-makers, researchers and participants in scientific and innovation activity. Every member of the community has access to a specialized database and can add information on existing or new technology trends. This project serves as an effective monitoring and long-term planning tool and is based on carefully studied conceptual and methodological principles to search for, classify and analyse 'weak signals' and 'wild cards' which have proven effective when assessing the potential impact of the latter on S&T development in Europe and the rest of the world.

A specialized division operates within the Fraunhofer Institute for Systems and Innovation Research (ISI) called the Competence Center for Emerging Technologies [Fraunhofer ISI, 2014]. Employees at this centre analyse develop-

[1] 'Weak signals' are indicators of possible, but not obvious, changes in the future. 'Wild cards' are less likely, but potentially highly important events that could bring about radical negative (e.g. terrorist attacks or natural disasters) or positive (e.g. the discovery of penicillin) consequences [Manchester IIR, 2013].

Table 4. **Examples of technology trends monitoring projects by large companies**

Organization	Project name	Project aim	Examples of trends	Methods	Results
Shell	'Shell Energy Scenarios to 2050' [Shell, 2009]	Analysing factors affecting the business environment, development of global energy scenarios	Biofuels	Review of information sources Interviews with experts	Trends in the energy industry Alternative global energy scenarios
IBM	'Next Five in Five' [IBM, 2014]	Identifying technologies that have potential to change people's lives in future	Personalised medicine based on DNA technologies	Collecting and analysing information on cutting-edge technologies developed at IBM laboratories Analysing markets and social trends	Regular reports describing five promising innovations over the next five years in fields such as education, retail trade, healthcare, security, urban development
Microsoft-Fujitsu	'Insights Quarterly' [Microsoft-Fujitsu, 2011]	Identifying the most important challenges and technological solutions in ICT	Tablet computing	Review of information sources Surveys of ICT company representatives	Quarterly reports on challenges and technology trends in ICT
Morgan Stanley	'Morgan Stanley Blue Papers' [Morgan Stanley, 2014]	Analysing technological changes that could have a significant impact on the development of the global economy and business	Mobile commerce	Review of information sources Consultations with experts (analysts, economists, strategic management specialists)	Reports on technology trends

Source: compiled by the authors.

ments in fields such as bioeconomy and life sciences, health system, data processing and communications, etc. Using a wide range of data, they study the developmental trajectories of emerging technologies and their impact on one another and they carry out assessments of the economic, ecological and social effects of S&T progress. The institute involves economists, politicians and representatives of various scientific industries in its interdisciplinary projects, and its final recommendations are used in decision making on science, technology and innovation policy.

The 'Technology Review' project [MIT, 2013] by the Massachusetts Institute of Technology (MIT) aims to identify prospective trends, business models and innovative solutions, as well as the directions of global development. In the report on the project for 2013, information was presented on biomedicine and pharma, medical devices and digital health, the digital economy and mobile world, the new global energy map, advanced manufacturing, nanotechnology and new materials, 'smart' cities, and the mass market. These fields had a short description, a list of key trends and game changers, leading countries and forecast assessments of the future development of the technologies. In addition, the report contained an analysis of mega-trends relevant to a wide range of sectors (nanotechnology and new materials, the power of the consumer, the automation of work, hyper-connectivity). As part of its 'Technology Review' project, the Massachusetts Institute of Technology publishes annual reports on 'Ten Breakthrough Technologies' [MIT, 2014] that are giving renewed momentum to many S&T fields.

Companies

Large private companies carry out technology trends monitoring projects in the core sectors of their activity and associated fields. Such studies allow them to detect innovation breakthrough areas at an early stage, thereby enabling them to improve the flexibility of their business and their market competitiveness. These projects result in alternative scenarios and lists of trends (innovative solutions) in the technological fields selected for study. Table 4 gives some examples of monitoring projects implemented by companies.

The goal of IBM's 'Next Five in Five' monitoring project [IBM, 2014] lies in analysing key marketing and social trends that are capable of changing people's

lives, as well as the new prospective technologies underlying these trends, over the next five years. In 2013, innovative trends were identified in five key fields: education, retail trade, healthcare, security and urban development. IBM uses the results when drafting strategic priorities and publishes them on its website for use by any interested parties. There is demand for this type of data from private firms, investors, research collectives, the media, etc.

A global alliance was signed between Microsoft and Fujitsu with a view to search for and apply innovative approaches to guaranteeing reliable long-term relationships with clients, involving consultancy services, business hardware, and software solutions. In 2011, the alliance launched the 'Insights Quarterly' research project aimed at identifying challenges and trends in ICT and searching for technological solutions that companies can rely on amid restrictions on budgets and high administrative risks. The 'Key ICT Trends and Priorities' report [Microsoft-Fujitsu, 2011] gives a short review of technological trends in fields such as tablet computing, cloud computing, business intelligence and communications and also gives assessments of the significance of and trust in these technologies from the perspective of representatives of leading ICT companies.

Consultancy agencies

Consultancy companies offer an extremely broad range of technology monitoring services, although they are often highly specialized in nature and adapted to the needs of specific clients. Consultancy services tend to focus on business trends and emerging and breakthrough technologies in fields that are most attractive to their clients (Table 5).

The consultancy company Z_Punkt provides services to work on the development strategies of its client companies, including identifying technology trends in the corresponding fields. The 'Z_Punkt Trend Radar 2020' database [Z_Punkt, 2014] covers technological development directions such as ICT, materials, life sciences, nanotechnology, robotics and artificial intelligence, transport and mobility, medicine, the environment, energy and others. It allows users to carry out a complex analysis of significant medium- and long-term social, cultural, economic, technological, political, and ecological events. The database includes approximately 240 trends with detailed descriptions of their time horizon, global development level, potential impact, etc.

Gartner carries out regular studies on the ICT market, offering consultancy services to developers, investors and software suppliers. An important strand of Gartner's studies is its forecasts of technology trends capable of affecting prospective market dynamics. The aim of the 'Top 10 Strategic Technology Trends' project [Gartner, 2014] is to search for and analyse strategic technologies that could have significant impacts for businesses in the coming three years. The potential of the technologies, investment demand and the risks caused by late implementation are all factors that affect their impact. Both existing and new directions in ICT that open up unique opportunities or have high disruptive potential for companies over the next few years are all considered strategic.

Deloitte's expert network brings together roughly 200,000 financial, audit and risk management specialists from around the world. Deloitte publishes annual reports on technology trends that will have the greatest impact on the activities of ICT companies in the future. After a round-up of a wide range of potential technologies, the analysis moves on to private surveys of clients, suppliers, researchers and analysts. In the final report, technology trends are classified into two categories: disruptors (causing stable positive changes in the ICT sector) and enablers (their development gives rise to new practices in the field). In particular, the 'Tech Trends 2012: Elevate IT for digital business' report [Deloitte, 2012] describes five disruptive trends ('Social Business', 'Gamification', 'Enterprise Mobility Unleashed', 'User Empowerment' and 'Hyper-hybrid Cloud') and five enabling trends ('Big Data Goes to Work', 'Geospatial Visualization', 'Digital Identities', 'Measured Innovation' and 'Outside-in Architecture').

Trend Hunter is the largest global trends monitoring community covering various fields (fashion, technology, culture, design, social media, business, ecology, and others) [Trend Hunter, 2014]. The TrendHunter.com global network brings

Table 5. **Examples of technology trends monitoring projects by consultancy companies**

Organization	Project name	Project aim	Examples of trends	Methods	Results
Battelle	*Battelle.org* [Battelle, 2014]	Identifying innovations and technology trends in various S&T fields	Membrane technology	Review of information sources (reports, standards) Statistical analysis Collecting and summarizing expert assessments Laboratory experiments	Emerging technologies in various fields (industry, energy and environment, healthcare, national security, pharmaceutical and medical devices, and others)
Z-Punkt	*TrendRadar* database [Z_Punkt, 2014]	Identifying and describing key technology trends in the medium and long term	Social networks and collective intelligence	Review of information sources Web-data collection and analysis Interviews with experts	Database of technology trends in fields such as ICT, materials, life sciences, nanotechnology, robotics and artificial intelligence, transport and mobility, medicine, environment, energy, nutrition
Lux Research	*Luxresearchinc.com* [Lux Research, 2014]	Identifying and describing emerging technologies for clients to select key technology directions to finance	Metamaterials	Review of information sources (marketing surveys, company profiles, publications, etc.) Interviews with company managers, clients, partners and external experts in more than 20 countries	Database of discoveries and technology trends in various fields (advanced materials, agro innovation, alternative fuels, bioelectronics, water, and others)
Gartner	'Top 10 Strategic Technology Trends' [Gartner, 2014]	Identifying technology trends capable of affecting the activities of ICT companies in the next three years	Smart cars	Review of information sources Web-mining Developing scenarios Expert surveys	Ten strategic technology trends in ICT
Deloitte	'Tech Trends' [Deloitte, 2012]	Identifying disruptive technologies, as well as technologies that contribute to S&T development in ICT	Gamification	Review of information sources Collecting and summarizing expert assessments by science and industry representatives Crowdsourcing of ideas* (global expert network)	Annual reports on technology trends: five disruptors and five enablers
TechCast	*Techcastglobal.org* [TechCast, 2014]	Analysing topical technology trends for use in business planning and developing company policy	The Internet of Things	Review of information sources (S&T literature, web-data,the media, etc.) Interviews with experts	Summary map of technologies, published annually 60 emerging technologies and 30 'wild cards' in various fields Technology forecasts by direction (energy and environment, information technology, digital economy, manufacturing and robotics, medicine and biogenetics, transportation, space, and others)
Shaping Tomorrow	*Shapingtomorrow.com* [Shaping Tomorrow, 2014]	Monitoring key trends, events and news in science and technology	Augmented reality	Review of information sources (news feeds, materials from analytical centres, international reports, etc.) Collecting and summarizing expert assessments (in the form of interviews, expert panels, surveys, seminars, etc.)	Reports on trends in various fields Trend alerts Information bulletins
Trend Hunter	*TrendHunter.com* [Trend Hunter, 2014]	Collecting information on innovations and cutting-edge technologies for start-up businesses and large-scale companies	Wearable fitness trackers	Crowdsourcing and polling among community members Collecting and summarizing expert assessments	250,000 microtrends 2,000 technology clusters Summary reports on trends

* In crowdsourcing, a solution to a problem is sourced from a large distributed group of community members, which helps to reduce spending on searching for and processing information.

Source: compiled by the authors.

together more than 150,000 participants and serves as an important source of information on technologies and innovative ideas for start-up enterprises and large companies. Within this network, a methodology has been developed making it possible to codify information on emerging technologies, added by service users and to exchange opinions on their relevance using polls on the site. At present, the Trend Hunter database has thousands of reports on trends, technology clusters and new innovative ideas which private companies can use when developing their marketing and product strategies.

Quantitative approaches to technology trends monitoring

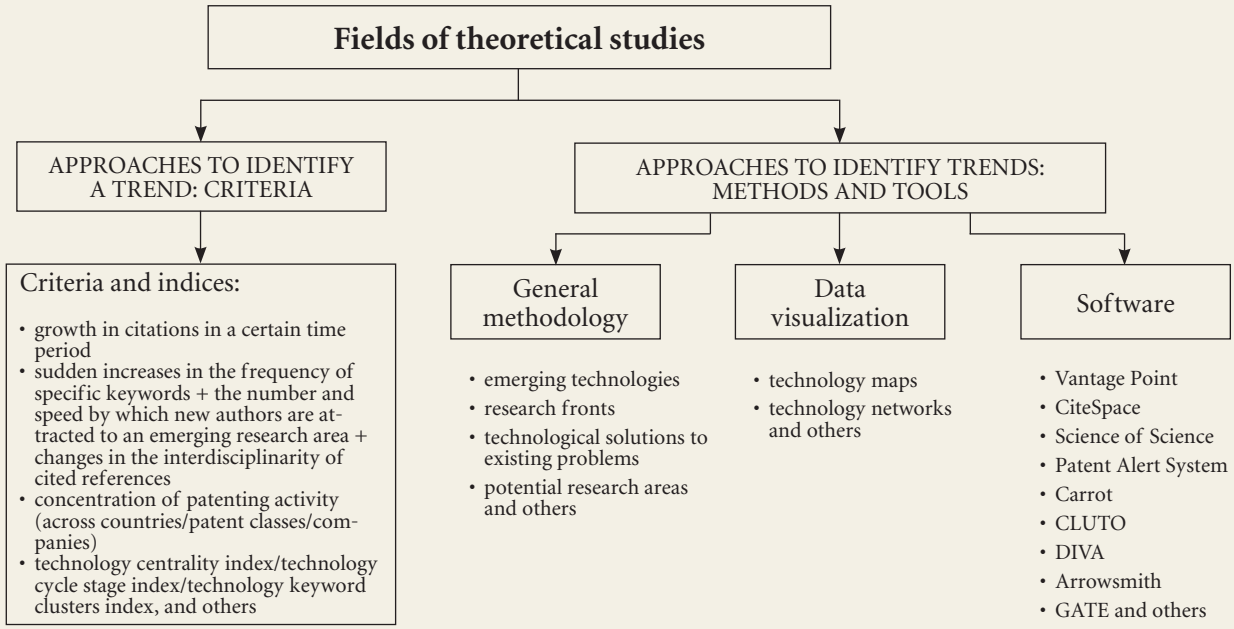
Contemporary approaches to technology monitoring propose a synthesis of qualitative and quantitative methods with the latter taking on an ever-growing role. Amid the current information overload, researchers are developing new toolkits to detect 'hidden' knowledge using effective processing and interpreting methods for data collected from a broad spectrum of sources.

The main theoretical studies devoted to identifying and revealing technology trends are shown in diagram form in Figure 2 below.

Several studies are devoted to classifying trends and developing criteria to identify them. Trends are grouped according to various parameters: growth in the number of highly cited publications on the topic [*Upham, Small*, 2010], keywords use statistics [*Guo et al.*, 2011], etc. One study [*Upham, Small*, 2010] analysed the change in the number of publications in research fronts[2] over a specified period of time, identifying the following types of research fronts:

- **Emerging** — fronts in the current dataset that contain no papers from the previous dataset;
- **Growing** — those that have more papers in the current period than the sum of all their contributing fronts in the previous period of analysis;
- **Stable** — those for which the sum of all contributing fronts yields the same number of papers;
- **Shrinking** — those that are smaller than the sum of all their contributing fronts in the previous time period;

Figure 2. **Main fields of theoretical studies on technology monitoring**



Source: compiled by the authors.

[2] Research fronts represent the most dynamic areas of S&T and the areas that attract the most scientific interest.

- **Exiting** — fronts that existed in the previous period of analysis but have no papers in any front in the current period analysed.

The authors of the study [*Guo et al.*, 2011] propose a mixed model to describe and forecast emerging technologies involving three key indicators:

- Sudden increases in the frequency of specific words indicating the emergence of new directions in scientific research;
- The number and speed by which new authors are attracted to an emerging research area;
- Changes in the interdisciplinarity of cited references.

The authors note a correlation between these three factors: first, authors show up in emerging fields, then the number of interdisciplinary publications and citation levels starts to grow, which in turn gives rise to a spike in keywords use statistics [*Ibid.*]. Besides, various technology trends indices are being developed. In particular, one study [*Cobo et al.*, 2011] proposes using parameters such as centrality and density[3] to divide scientific subjects into the following types: highly developed and isolated; emerging or declining; motor; basic and transversal. Another study [*Corrocher et al.*, 2003] analyses emerging technology trends on the basis of concentration of patenting activity across countries, International Patent Classification (IPC) classes and companies.[4] The suggestion is that the newer the technology, the narrower the range of countries and companies that have access to it, and information on technology in the early stages of development is only provided for key patent classes.

Monitoring stages

The most important research task is developing the overall methodology to monitor technology trends. Methodologies can include methods to identify emerging technologies [*Porter, Cunningham*, 2005], technological solutions to existing problems [*Kostoff et al.*, 2008; *Kim et al.*, 2009], research fronts [*Upham, Small,* 2010], potential research fields [*Lee et al.*, 2009] and other trend types. On the whole, irrespective of the chosen focus and the tools used, the monitoring can be broken down into five main stages (Table 6).

Porter and Cunningham [2005] introduce the notion of *tech mining* to refer to the step-by-step process of technology monitoring. At the stage of setting the objectives, the aim of the study is set and relevant data sources are selected. At the second stage, certain queries are formulated and data are collected from the selected sources. The next step — data processing — involves a basic (refining and filtering) and advanced (in-depth) analysis of the information gathered. The monitoring closes with the stage where the results are presented, interpreted and summarized.

Table 6. **Main stages of technology trends monitoring**

No.	Stage	Content
1	Setting objectives	Establishing the research objectives, selecting the subject area and methodology
2	Data collection	Selecting data sources for analysis and the search strategy determined by the research objectives; collecting materials
3	Data processing	Selecting the units of analysis (documents, keywords, authors, etc.) and methods (text mining, clusterization, network analysis, citation analysis, etc.)
4	Drafting a preliminary list of trends	Defining candidate trends (integrating the results from the data processing)
5	Validation and interpretation	Validation of candidate trends (ensuring that the candidate trends meet the criteria of a trend)

Source: compiled by the authors.

[3] 'Centrality' describes the strength of the external links between the scientific subjects under consideration and other subjects. 'Density' defines the strength of the internal links between keywords describing a particular scientific subject.

[4] The basis of the patenting activity concentration across countries lies in the hypothesis that the development of innovative products and applications takes place in a limited number of countries, the number of which gradually grows after standardization of the technologies. The analogous concentration across patent classes stems from the hypothesis that in the early stages of development, emerging technologies are concentrated in certain IPC classes, and then information on these technologies spreads to other patent classes. The concentration across companies is based on the hypothesis that the development of emerging technologies is initially carried out by a narrow, albeit expanding over time, group of companies.

The methodology of creating patent maps [*Lee et al.*, 2009] to identify new prospective research fields is also packed into the presented technology monitoring outline. Based on the objectives, a collection of patents is formed, and the data processing stage involves the creation of a patent map to identify and describe candidate trends. The final stage of the monitoring is devoted to analysing, validating and interpreting the results obtained.

Differences in the technology monitoring process are caused not only by the objectives set, but also the sources of data and methods of analysis used. Figure 3 shows the possible choices at each stage of technology trends monitoring.

As Figure 3 shows, the monitoring process is dependent on the chosen trend type (emerging technologies, research fronts, technological solutions, potential research fields, etc.), the sources of information (databases of publications, patents, news, etc.), the data extraction methods (broad thematic inquiry such as 'nanotechnology', list of keywords or a certain feature), the units of analysis (a certain document, structured or unstructured data), and the methods used to process and validate the trends identified (quantitative, qualitative or mixed).

Data sources

The selection of database is one of the most important stages of technology monitoring. The majority of authors give preference to bibliometric sources (either general e.g. Web of Science or Scopus; or specialized e.g. Medline, etc.) to monitor research fronts and emerging technologies or patent databases (e.g. the United States Patent and Trademark Office (USPTO), European Patent Office (EPO), Japan Patent Office (JPO) to search for information on technology solutions and applications in a particular subject area. Other data sources for technology monitoring might include: the news [*Daim et al.*, 2006], business resources (in particular, the LexisNexis database) [*Porter, Cunningham*, 2005], and reports on activity by venture capital funds, start-ups, etc. [*Cozzens et al.*, 2010]), conference materials [*Porter, Cunningham*, 2005] and others.

Collecting information from the sources selected is a separate task, solved by drawing up a list of keywords delineating the scope of the study. The specific tools used in the search include: one or more keywords combinations describing the subject field, a list of keywords selected on the basis of expert opinions [*Lee et al.*, 2009; *Morris et al.*, 2002] or from key documents [*Kim et al.*, 2008], or combinations of these approaches [*Kim et al.*, 2008; *Porter, Cunningham*, 2005]. An alternative search strategy is to draw up a list of publications or patents based on a specific feature: articles from specialized journals [*Cobo et al.*, 2011; *Guo et al.*, 2011; *Kajikawa et al.*, 2008; *Kostoff et al.*, 2008], the most cited publications [*Upham, Small*, 2010], patents from corresponding IPC classes [*Corrocher et al.*, 2003; *Lee et al.*, 2011], patents in certain countries [*Tseng et al.*, 2007] etc.

The data obtained forms collections[5] (of scientific publications, patents, etc.) which are then processed using certain qualitative or quantitative methods.

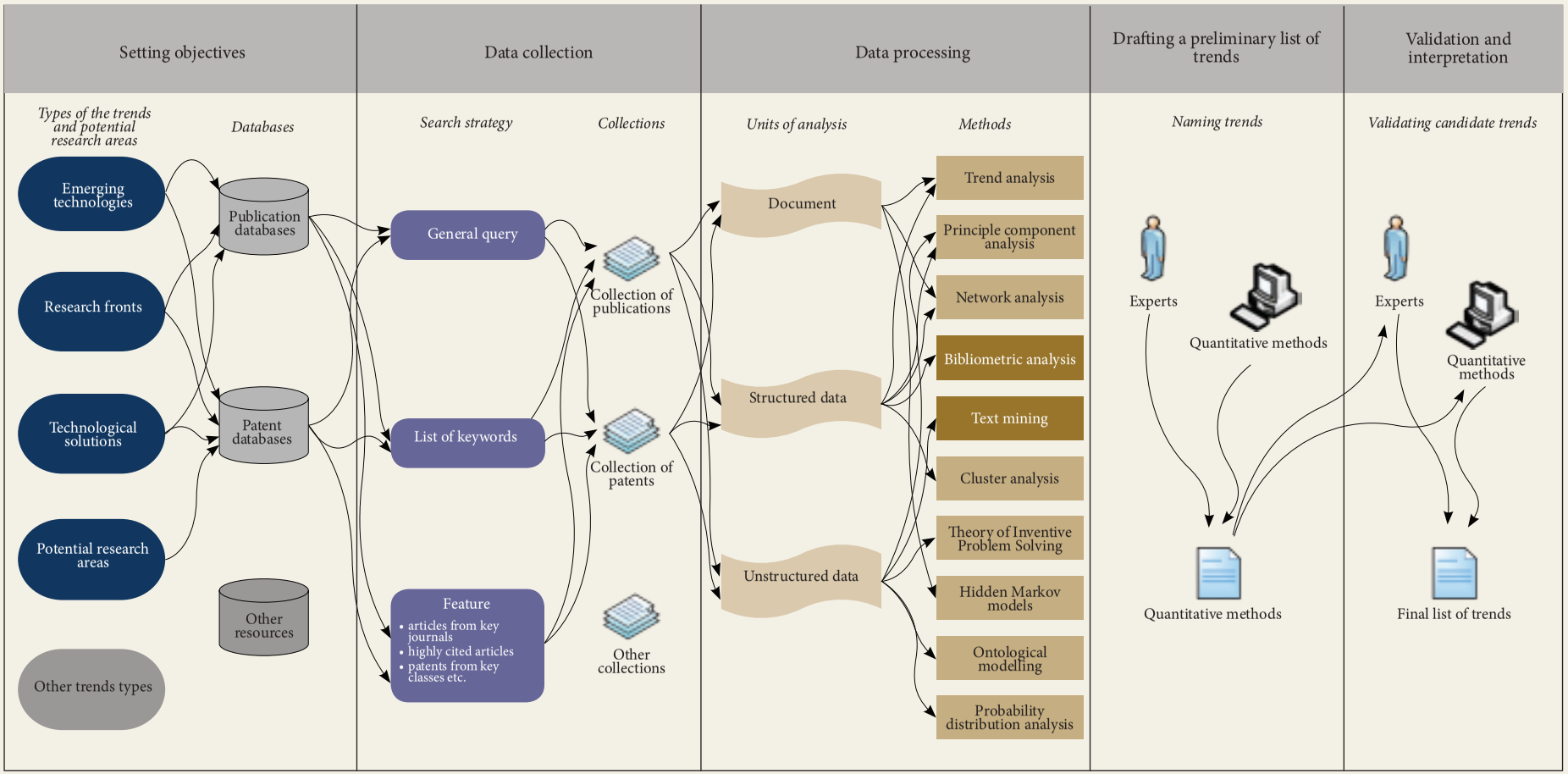
Data processing methods

Data collections may be processed in one of three ways. The first involves taking a certain document as the unit of analysis and examining their quantitative dynamics within a set time interval [*Campbell*, 1983; *Daim et al.*, 2006; *Dereli, Durmusoglu*, 2009; *Lee et al.*, 2011] to assess publication activity in a specific subject area — a sufficiently narrow and potentially breakthrough direction. The second way is working with structured data from each text: the classification code determining which subject area the document falls under, keywords chosen by the author, citation statistics, etc. The third method uses unstructured information, i.e. analysing a full text after preliminary processing — removing duplicate documents, excluding stop words without individual meaning (prepositions, conjunctions, pronouns, etc.), stemming[6], etc.

[5] A collection is an array of structured or unstructured data obtained from a specific source (database of publications, patents, news, dissertations, etc.).

[6] Many words have the same lexical root but perform various syntactical functions, for instance *computation* and *computing* [*Wang et al.*, 2010]. During stemming, researchers look for the common lexical root of similar-sounding words for further normalization of a text.

Figure 3. **Stages of technology trends monitoring**



Source: compiled by the authors.

The selection of the unit of analysis predetermines the methods that will be used during the technology monitoring. The main methods used to process the data under consideration involve citation analysis and text mining, which in many studies are combined with supporting methods such as network analysis, clusterization, trend analysis and others. Figure 4 shows the methods used to identify technology trends. It goes without saying that their scope and the diverse ways in which they can be combined are not covered exhaustively in this diagram and can be supplemented by other methods, the use of which depends on the objectives set, the types of technology trends identified, and other factors.

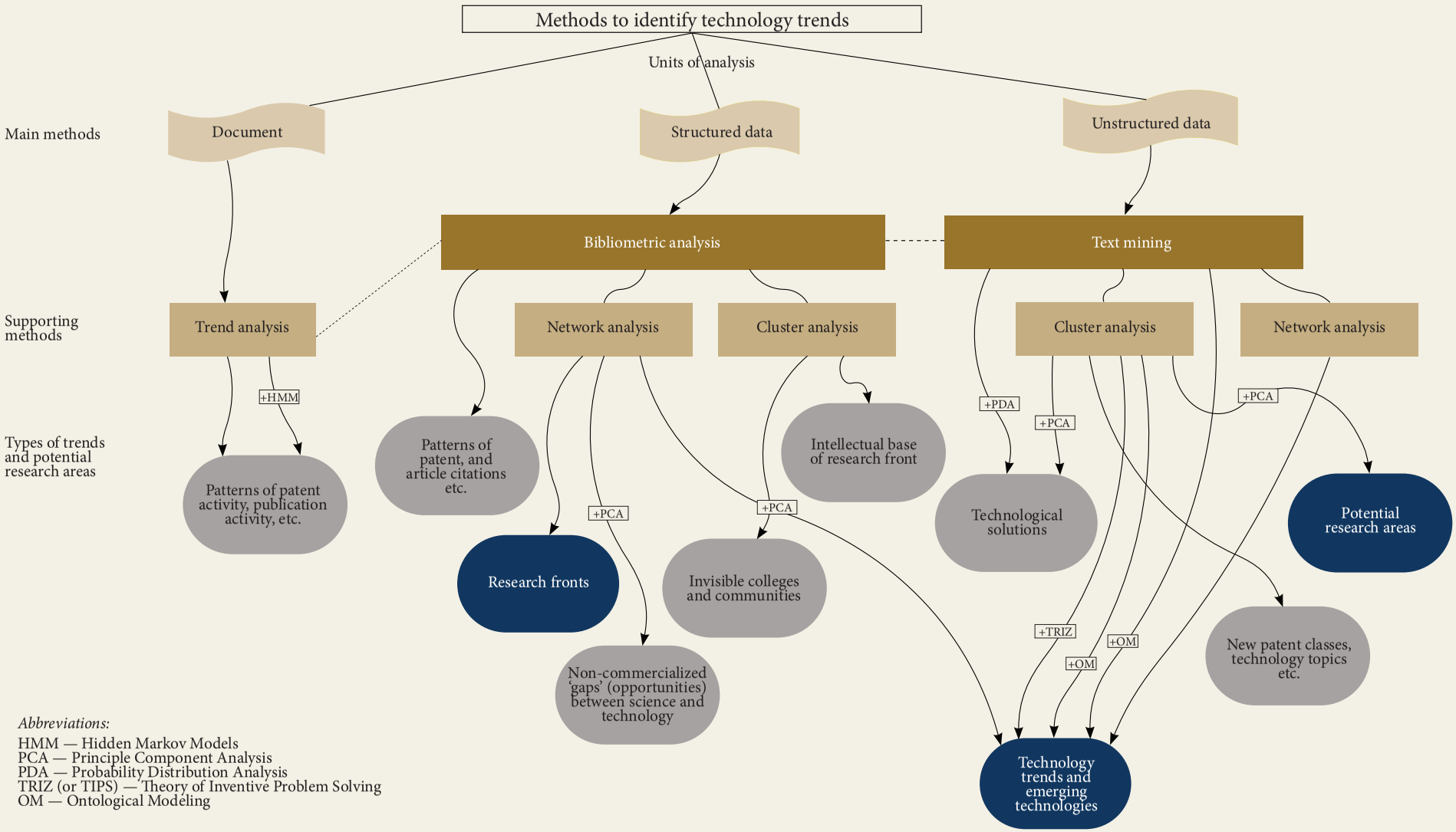
Citation analysis as a bibliometric method is widely used to process structured data. The citation level of documents (publications, patents, etc.) can point to the emergence of research fields (fronts), opening up new directions for technological development [*Igami, Saka*, 2007; *Kim et al.*, 2008; *Morris et al.*, 2002; *Upham, Small*, 2010; *Chen*, 2006; *Shibata et al.*, 2008; *Kajikawa et al.*, 2008; *Noma*, 1984]. In addition to citations when monitoring technology trends, structured data from bibliometric descriptions of documents can also be analysed: keywords [*Kim et al.*, 2008; *Cobo et al.*, 2011; *Guo et al.*, 2011], the name of the organization, author, title, and abstract [*Morris et al.*, 2002], and classification category [*Spasser*, 1997], among others.

One of the most widespread methods used to work with unstructured information is *text mining*.[7] Use of this method requires the structure of the document to be taken into account [*Tseng et al.*, 2007] so that word combinations selected from the most relevant segments of the text can serve as data for clustering. Therefore, sentences or paragraphs in a text that include keywords, parts of headings or associated words selected by experts (for instance, *goal, important, needed, problem*, etc.) can have maximum weight. Some methods propose an analysis of keyphrase distribution throughout a text. Some authors work on the basis that keywords repeated throughout the entire document with a certain regularity can contain information on the nature of a technological problem in the subject field and can be used to search for solutions using linguistic analysis [*Kim et al.*, 2009]. The focus of the analysis might be the most [*Lee et al.*, 2009; *Corrocher et al.*, 2003] or least frequent but potentially significant word combinations [*Wang et al.*, 2010; *Li et al.*, 2009] to identify emerging technologies and promising research areas. Some works offer a mechanism to create automated annotations of documents [*Trappey et al.*, 2006]. For example, text mining of a patent generates a short abstract containing the most frequent keywords and parts of headings, phrases specific to the subject field, etc. In the future, this lexical material could serve to improve the speed and efficiency of patent analysis.

As mentioned above, text mining is based on large volumes of data. Many theoretical studies have been devoted to creating and using automated software to process data, including linguistic and statistical analysis and visualization tools [for example: *Chen*, 2006; *Guo et al.*, 2011; *Dereli, Durmusoglu*, 2009; *Morris et al.*, 2002; *Palomino et al.*, 2013; *Porter, Cunningham*, 2005]. The faster information processing time significantly speeds up the sorting and filtering of data, analysis of trends and statistics, and the process of visualizing results. During analysis, both online (*Carrot, PAS* and others) and offline software tools (Vantage Point [*Porter, Cunningham*, 2005], CiteSpace [*Chen*, 2006], DIVA [*Morris et al.*, 2002], Sci [*Guo et al.*, 2011], TextAnalyst [*Wang et al.*, 2010], Arrowsmith [*Smalheiser*, 2001], PackMOLE [*Fattori et al.*, 2003] and others) may be used. Many of the above tools have been developed by the authors themselves. Such applications, as a general rule, use information from electronic databases (publications, patents, news, etc.) and have a special user interface to make queries, filter and visualize the results. Some programmes — Vantage Point, CiteSpace, DIVA — offer powerful data processing and visualization tools in the form of tables, graphs, maps, clusters, etc.; others allow users to receive special alerts on changes in the developmental trajectory of technologies (for example, PAS notifies users of

[7] The aim of text mining is to extract hidden, previously unknown meaning from a large volume of unstructured data (annotations and full-texts of documents, web content, etc.) As a complex approach, text mining is a combination of statistical and computational linguistic methods of data processing. It simplifies the technology data collection process by indexing the keywords encountered in the text of the documents and makes it easier to deal with these indexes afterwards [*Yoon, Park*, 2004].

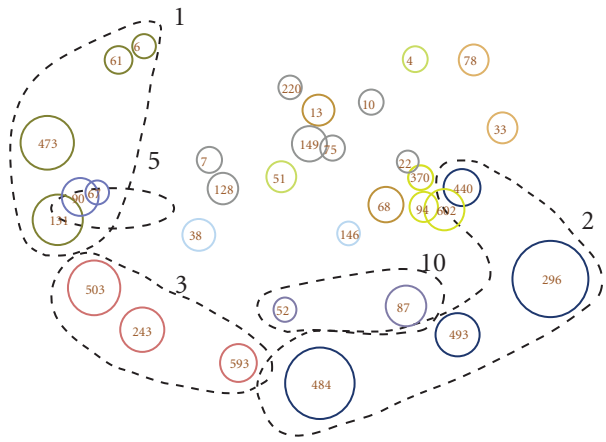
Figure 4. **Methods to identify technology trends**



Abbreviations:
HMM — Hidden Markov Models
PCA — Principle Component Analysis
PDA — Probability Distribution Analysis
TRIZ (or TIPS) — Theory of Inventive Problem Solving
OM — Ontological Modeling

Source: compiled by the authors.

Figure 5. **Example of a cluster map**



Source: [*Tseng et al.*, 2007].

a marked increase in patent activity; and DIVA help users to generate integrated reports).

Specialized tools to group and visualize data on technology development play an important role in the processing of structured or unstructured information [*Porter, Cunningham*, 2005; *Kim et al.*, 2008; *Yoon, Park*, 2004]. *Clusterization* or *network analysis* are often used for this purpose.

In the framework of technology monitoring, a *clusterization* is used to separate the prepared data (documents, keywords, thematic areas, growth curves, etc.) into groups with similar characteristics reflecting the development of the most important technological directions in the subject field. Some of the most widespread clustering methods include the k-means [*Kim et al.*, 2008; *Trappey et al.*, 2006], hierarchical [*Kostoff et al.*, 2008; *Lee et al.*, 2011; *Spasser*, 1997] and topological [*Shibata et al.*, 2008, 2010; *Kajikawa et al.*, 2008] clusterization, and the k-nearest neighbours method [*Tseng et al.*, 2007], among others. Figure 5 shows an example of data visualization in the form of a cluster map serving as evidence of developing technological directions (clusters of a similar theme are highlighted in the same colour).

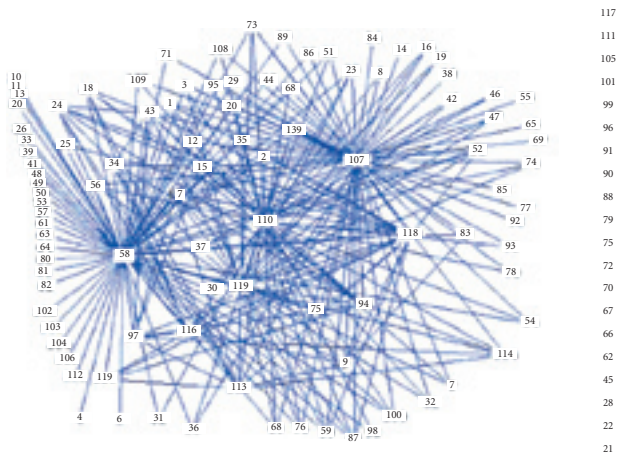
In recent years, *network analysis* has generated serious interest, allowing researchers to identify, analyse and visualize the links at the heart of various processes. This quantitative method, based on graph theory, simplifies the analysis of the links between elements (nodes) of an emerging network. Documents, authors, thematic fields, countries, keywords, etc. can constitute nodes, as sources of information on emerging technology trends. When applied to technology monitoring tasks, network analysis is actively used to forge links between documents and create citation networks [*Small*, 2006; *Shibata et al.*, 2008; *Shibata et al.*, 2010; *Kajikawa et al.*, 2008] and networks of semantically related keywords [*Yoon, Park*, 2004; *Kim et al.*, 2008]. Figure 6 gives an example of a constructed patent network based on semantic links between documents.

Depending on the aims of the technology monitoring, basic processing methods for structured (bibliometric analysis) and unstructured (text mining) data can be combined, and they can be supplemented by supporting methods (Figure 4). The latter include network analysis, clusterization, trend analysis, principle component analysis,[8] probability distribution method,[9] ontological model-

[8] The principle component analysis is most often used to supplement text mining, for example, to identify key factors (components) on a keywords map [*Porter, Cunningham*, 2005; *Lee et al.*, 2009]. It can be used in combination with citation analysis when forming citation networks [*Kajikawa et al.*, 2008; *Shibata et al.*, 2008; *Chen*, 2006], for which documents that do not have either incoming or outgoing citation links are removed from the network.

[9] An analysis of probability distributions can be used to identify keywords combinations that are encountered in documents with equal frequency i.e. they describe a certain important problem that various authors are working on in that particular technology field [*Kim et al.*, 2009].

Figure 6. **Example of a patent network**



Source: [*Yoon, Park,* 2004].

ling,[10] the theory of inventive problem solving[11] (TRIZ or TIPS), and others. Varying combinations of these methods make it possible to identify different types of trends (emerging technologies, research fronts, invisible colleges, potential research areas, citation patterns, etc.) and expand the range of information sources, relying not only on databases of scientific publications and patents but also on additional sources such as the news, information business resources, conference materials, etc.

Conclusion

Our review in this paper of the theory and practice of global technology trends monitoring shows that in a large number of studies carried out in this field different definitions and variations on this notion are used, with an emphasis on the most important effects of developing trends, life cycle stage, the scale of the trends and ways to identify them. However, the majority of authors predominantly show an interest in identifying, at the earliest possible stage, prospective technological fields with significant social and economic impacts and high potential for commercialization.

Theoretical studies and applied projects on technology trends monitoring are carried out at extremely diverse levels — global, national, industry and corporate. Interest in the results of these studies comes from international organizations, government bodies, business, research institutes and other structures involved in the process of developing and using long-term forecasts and shaping policy based on their recommendations.

Theoretical studies are focused on developing a substantiated methodology to identify emerging technologies (they also define the necessary criteria for this) and developing automated methods and software to process large volumes of data and visualize the results obtained, a critically important stage of the entire process.

Technology trends monitoring involves several stages (setting objectives, data collection, data processing, drafting a preliminary list of trends, interpreting results). The precise nature of these steps depends on the research objectives and the chosen trend type, sources of information, search strategy, units of analysis and methods used for further processing and validation. Alongside traditional sources of data for technology monitoring — scientific publications and patents — researchers often turn to news, business resources, conference materials, etc. The main methods tend to be text mining and bibliometric analysis at the

[10] In this approach, an ontological model of a trend is established, which is then used to analyse segments of a text containing external signs of the existence of a trend.

[11] TRIZ (or TIPS) can be used in combination with text mining to identify the maturity (or life cycle stage) of a given technology examined by comparing its characteristics with universal evolutionary patterns.

data processing stage and cluster and network analysis at the data structuring and visualization stage. In the majority of cases, they are combined with other supporting methods (principle component analysis, trend analysis, ontological modelling, etc.).

The combination of technology monitoring theories and practices aims to introduce a wider use of quantitative methods and automated procedures during large-scale applied projects, which, at present, are predominantly carried out on the basis of expert knowledge. The complexity of this task is caused by the highly resource-intensive nature of automated approaches when spread across the entire spectrum of technological fields. The expansion and increasing sophistication of analytical toolkits will make it possible to diversify the range of information sources used and, ultimately, increase the evidence base and effectiveness of technology trends monitoring. F

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