How to Design a National Innovation System in a Time of Global Innovation Networks: A Russian Perspective

Leonid Gokhberg and Vitaliy Roud, National Research University – Higher School of Economics

The quest for growth models based on science, technology, and innovation (STI) has been central to the Russian Federation (Russia)'s policymaking agenda for more than a decade.

Relying too much on the exports of primary resources (particularly oil and natural gas) as a major driver of development was recognized as unsustainable during the global financial crisis of 2008. The acknowledged importance of the reforms transformed into the urgent need for a new economy after the second half of 2014, when global oil prices dropped radically. According to a number of estimates, the resulting economic downturn, marked by inflation and depreciation of Russia's currency, has had an even greater impact on the performance of the national economy than the previous recession. Facing the compromise of the existing growth models, decision makers, as well as the broader expert community, designate STI as an alternative driver of sustainable growth.

The imperative for innovation-driven growth

At a glance, Russia maintains solid positions in the composite Global Innovation Index (GII) rankings (56th place overall in 2011, 51st in 2012, 62nd in 2013, 49th in 2014, and 48th in 2015). Mainly constrained by low rankings in pillars concerned with resource and energy efficiency of production as well as inadequate infrastructure, the GII captures Russia's high level of human capital and the accumulated capabilities for scientific research, inherited from the Soviet Union; along with functional high-technology sectors, these set the scene for the country's excellence in STI. However, the exploitation of this potential is hindered as a result of the following persistent systemic failures:

- unfavourable framework conditions (especially the quality of institutions, the quality of public administration and administrative barriers, and inadequate law enforcement);[1]
- limited access to finance and investment opportunities induced by a poor investment climate and even further deteriorated because of political, economic, and financial sanctions imposed by a number of states as a consequence of the Ukrainian crisis in 2014;
- a low share of enterprises aimed at global competitiveness; these are mostly monopolistic local markets with high entry barriers that are dominated by large (often state-owned) enterprises and create a bias towards rent-extracting behaviour that benefits from non-innovation-based competitive advantages promised by tighter connections with the state authorities;[2]
- obsolete institutional structure and the overall hampered performance of the research and development (R&D) sector, which is still dominated by public research organizations with a marginal (though gradually increasing) role for universities; and
- fragmentation and lack of contingency between the components of the innovation system—including sectoral and regional polarization, underdeveloped networking, and limited connections between industry and science,[3] reducing possible spillover effects of policy measures, considerably decreasing the efficiency of the regulation, and magnifying the costs and risks of establishing advanced value and knowledge chains.

These factors drastically hampered the positive dynamics exhibited by innovation during the decade of solid economic growth (average annual growth was 6.9% in 2000–08; 1.0% in 2009–13, and even lower in 2014–16).[4] As a result, the national innovation system demonstrated a high level of inertia and path dependency, reflecting stagnation or even the gradual loss of the competitive

Table 1: May 2012 Presidential Decrees: Quantitative targets to 2018

Target	Year
Raise labour productivity by 150%	2018
Increase the share of high-tech industries in GDP by 130% compared to the level of 2011	2018
Raise export revenue from nanotech products to 300 billion roubles	2020
Raise GERD to 1.77% of GDP (from 1.12% of GDP in 2012)	2018
Raise the average salary of researchers to 200% of the average salary in the region	2018
Raise the share of GERD performed by universities from 9.0% in 2013 to 11.4% by 2015 and 13.5% by 2018	2015, 2018
Increase total funding of public science foundations to 25 billion roubles	2018
Increase Russia's world share of publications indexed in the Web of Science from 1.92% (2013) to 2.44%	2015

Source: Presidential decrees: On long-term economic policy (No. 596); on measures to implement state social policy (No. 597); on measures to implement state policy in the field of education and science (No. 599).
Note: GERD = gross domestic expenditure on R&D.

positions it had held among a range of developed and rapidly developing countries. In times of crisis, overcoming the systemic flaws becomes crucial even in the face of the complications of tightening budget constraints.

Even if properly attributed, the ultimate goal of overcoming systemic flaws is not so straightforward to implement. The global nature of contemporary STI processes alters the priorities and principles of efficient policy design. Conventional objectives, such as compensating for internal systemic failures, fostering economic diversification and structural change, and massive technological upgrading of the industries have to be reconceptualized in order to provide new ways to balance risks and benefits of acting in the global environment. In order to be efficient, the scope of new policy models should include smart positioning in the global value and knowledge chains; should be fully cognizant of the international competition for the knowledge capital and human resources; and should account for global tendencies and technological trends—such as the next production revolution—that are going to drastically change the configuration of the global productivity frontier.[5]

Achieving the highest level of consideration from the Russian authorities, STI has been subject to intensive regulation. Since 2010 more than 50 policy documents have been adopted by Russian governmental bodies, including the framework-shaping Strategy for Innovative Development to 2020 (2012, subject to renewal in 2016); the State Programme for Development of Science and Technology, 2013–2020; and the Federal Goal-Oriented Programme on Research and Development in Priority Areas of Russia's S&T Complex (2012) among others. In May 2012, directives for Russia's development were set in the presidential decrees that introduced quantitative targets for the Russian Federation (see Table 1). The implementation of these targets is associated with an extensive governance scheme that puts a number of top-level governmental bodies in charge of boosting STI performance. These include the Presidential Administration of Russia, the Ministry of Economic Development, the Ministry of Science and Education, and the Ministry of Industry and Trade, as well as specialized interdepartmental commissions and other communication platforms that will facilitate the coordination among a broad range of initiatives.

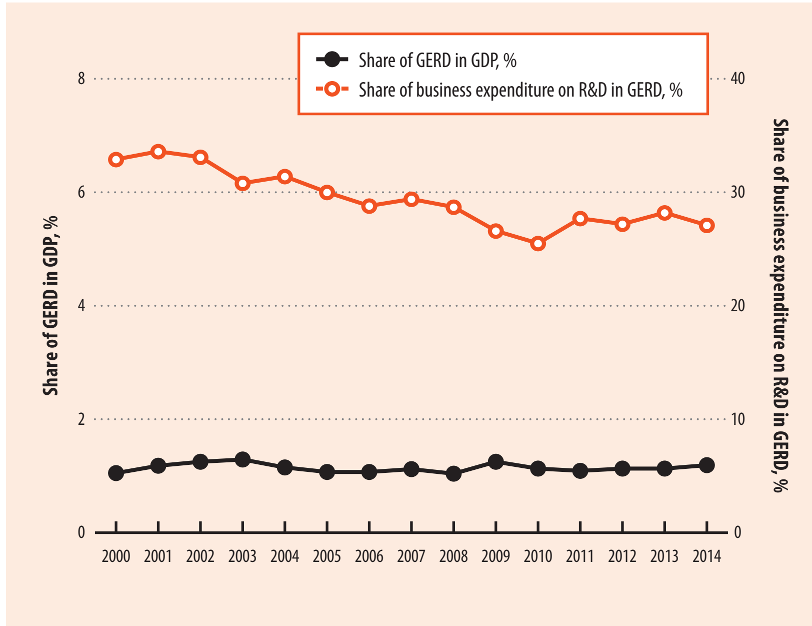
Science and technology

A comprehensive upgrade of the R&D sector represents a key area of ongoing reform in Russia. The observed aggregate trends indicate the exhausted capacity of the existing institutional structure and administrative models: These can no longer provide reasonable productivity gains even with an extensive increase of financing. Gross domestic expenditure on R&D (GERD) increased twofold in constant prices from 2000 to 2014 and now accounts for 847.5 billion roubles in current prices (roughly US$39.9 million PPP). That brings Russia into the group of top 10 leaders in total expenditure on R&D, a group in which the United States of America (USA) is 1st (US$456.9 million), China is 2nd (US$368.7 million PPP), the United Kingdom (UK) is 6th (US$44.1 million PPP), and Brazil is 8th (US$35.5 million PPP).[6] However, GERD today still accounts only for the 60% of GERD spent before the collapse of the Soviet Union and also lags behind most of the OECD economies for its proportion to GDP (see Figure 1). At the same time, scientific productivity has started to recover only recently (Figure 2); facing the most rapidly developing competitors, this inadequacy brings Russia from rank 9 in the share in total number of publications indexed by the Web of Science in 2001 down to rank 15 in 2015. Moreover, detailed examination of the areas of Russia's scientific specialization (Figure 3) reveals particularly low engagement in most areas of international research effort:[7] The country places 29th in 2015 with the participation of domestic scholars in 3.28% of more than 10,000 global research fronts (clusters of highly cited papers) identified by the Web of Science. The group of leaders for this indicator includes the USA (74.3% of all research fronts), the UK (32.3%), Germany (30.7%), and China (23.4%). Existing comparative advantages of Russian science appear to belong to the areas of traditional Soviet expertise—including physics, aerospace and astronomy, geosciences, mathematics, chemistry, and materials science—while poorly representing topics, such as life sciences, associated with the next industrial revolution.

In this regard, the comparative advantages and global visibility of Russian science is quite limited. Policy officials have recently begun to aim at increasing this global visibility through a range of mechanisms, from high-level ones such as presidential decrees to smaller ones such as the evaluation of programmes. Recognizing that there can be no 'national' science apart from the best available globally competitive scientific research appears to be a major achievement for Russian policy frameworks. A widely disputed declaration of the overarching set of quantitative objectives in terms of international benchmarking and impact assessment (specifically with the aim of increasing Russia's exposure in the international citation indexes) influenced the structure of ground-level regulatory initiatives. In particular:

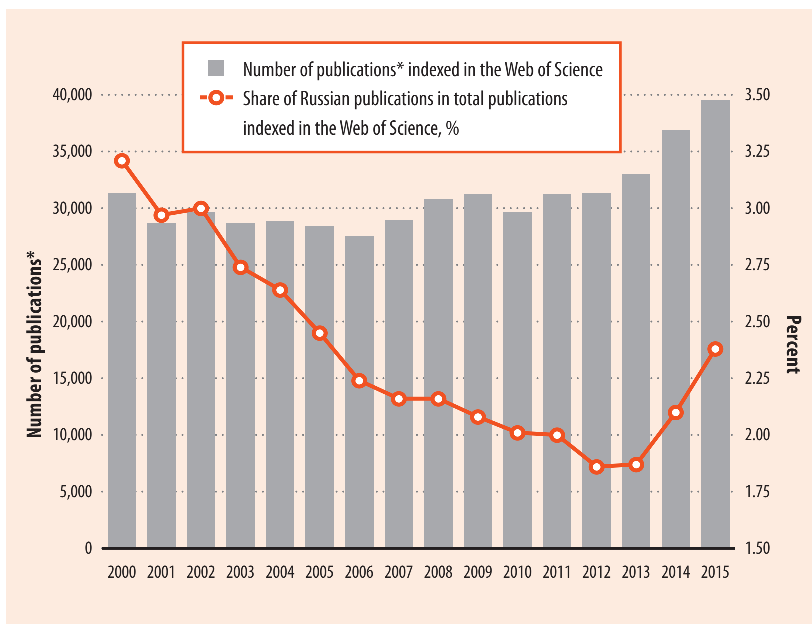
- A large-scale reform of the Russian Academies of Science was launched in 2013, resulting in the transformation of the extensive network of public research

Figure 1: Dynamics of expenditure on R&D



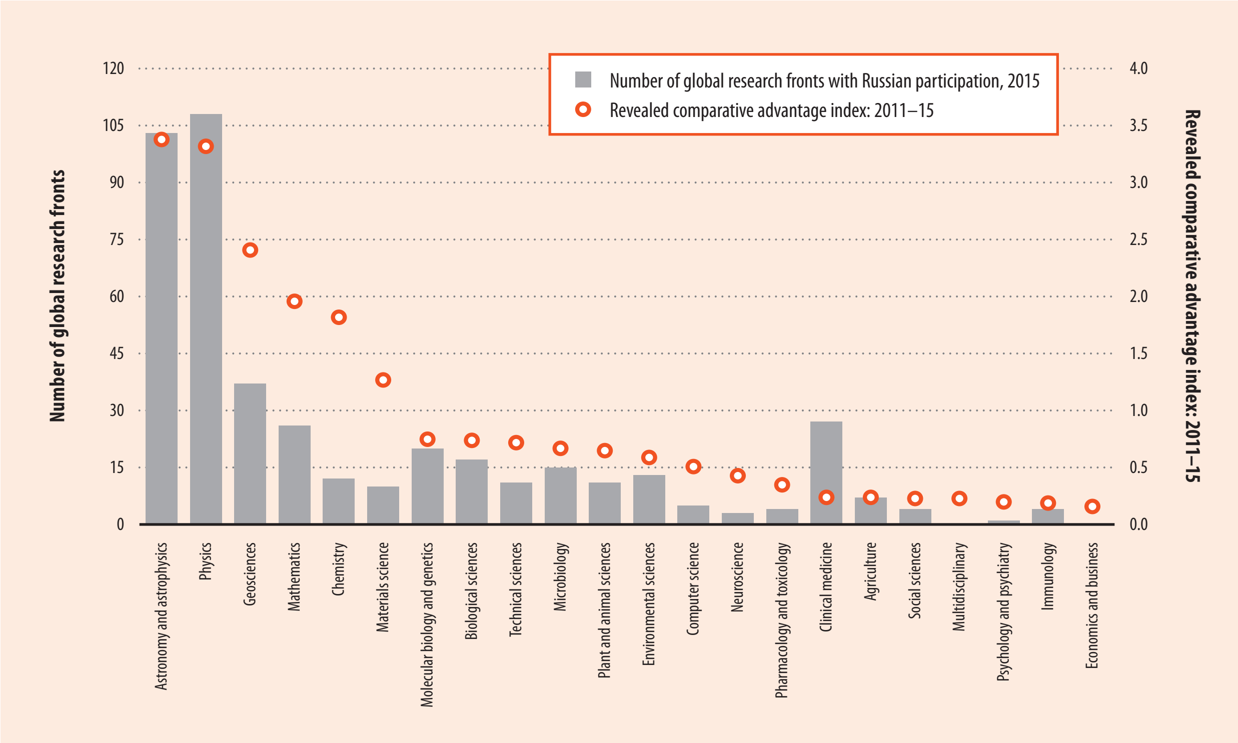
Source: HSE, 2016a.
Note: GERD = gross domestic expenditure on R&D.

Figure 2: Publication activity of Russian scientists



Source: HSE calculations based on Web of Science data, accessed 12 April 2016..
* Publications means articles, proceedings papers, and reviews.

Figure 3: Specialization of Russian science, 2015



Source: Authors' estimates, based on Web of Science data.
Note: Revealed comparative advantage index equals the proportion of the country's publications in the specific field of science under consideration divided by the proportion of world publications that in the same field.

organizations (more than 800 of these organizations account for nearly 50% of all Russian publications).[8] Key principles behind the reform that can currently be observed from outside imply preserving the research coordination and evaluation as well as expert functions with the Russian Academy of Science (which was merged with the two smaller academies of medical and agricultural sciences). Decisions on financing, property management, and infrastructure were relegated to a newly established Federal Agency for Research Organizations.

- Further optimization of the network of public R&D institutes, especially those that belong to the Academy of Sciences, is intended to foster the national research infrastructure and elaborate the regular efficiency monitoring procedures to ensure greater performance of public research in the civil sector. Such an optimization process involves merging field-specific smaller-sized research institutes into the so-called federal research centres, namely those specializing in computer science, biotech, agriculture, and so on.

- The 5/100 Programme for raising the global competitiveness of Russian universities (promoting at least the five top performing Russian universities into the top 100 and adding 10 more leaders to the top 200 of global university rankings). Participation in the programme has been granted on a competitive basis, conditional on an annual performance evaluation, and has provided access to the total budget of 10 billion roubles for 2013–14 and 40 billion roubles for 2015–16.

- Megagrants—a special governmental programme launched in 2010 to invite world-class researchers (of the 144 current researchers, half are of Russian origin) to establish highly productive laboratories in existing Russian universities and research centres aiming to develop new scientific schools with notable international publications (roughly 800 published papers were indexed in the Web of Science by 2016). A total budget of 27 billion roubles was allocated for 2010–16 with the requirement of joint financing (around 20%) from the host universities.

- A transition to performance-based reward schemes for researchers was launched. The scheme is to provide an 'efficient contract' with a base salary and a regular evaluation-based premium, thus increasing the researchers' salaries to 200% of the average wage in the region.[9]

Boosting the efficiency of applied science appears not to be so straightforward. Facing low business demand for domestic R&D and heavy dependence on the import of technologies (mainly in the form of machinery and equipment rather than licensing, for example) as the dominant strategy for acquiring technology, development of the capabilities in this direction should rely on multifaceted supporting schemes that combine favourable technology localization mechanisms, customs regulation, tax incentives, and complex risk-balancing supporting measures in the form of public-private partnerships. In 2015 two mechanisms of this type were launched: (1) a horizontal initiative aimed at competitive support for national projects with a highly innovative component (focusing on smart energy systems, agriculture, transportation, and health services) and (2) the National Technology Initiative (NTI), which targets the incubation of national technological leaders for emerging markets. The NTI can be thought of as a collection of special tools for the complex facilitation of prospective global market niches, starting from identification and foresight and ending with the fine-tuning of regulatory frameworks. Current thematic areas of the NTI include EnergyNet (concerned with distributed and portable smart power systems); FoodNet (advanced technologies in food and agriculture); SafeNet (personal security systems); HealthNet (personalized medicine); AeroNet, MariNet, and AutoNet (distributed systems of unmanned aerial, marine, and road vehicles); FinNet (decentralized financial systems and currencies); and NeuroNet (neurotechnologies).

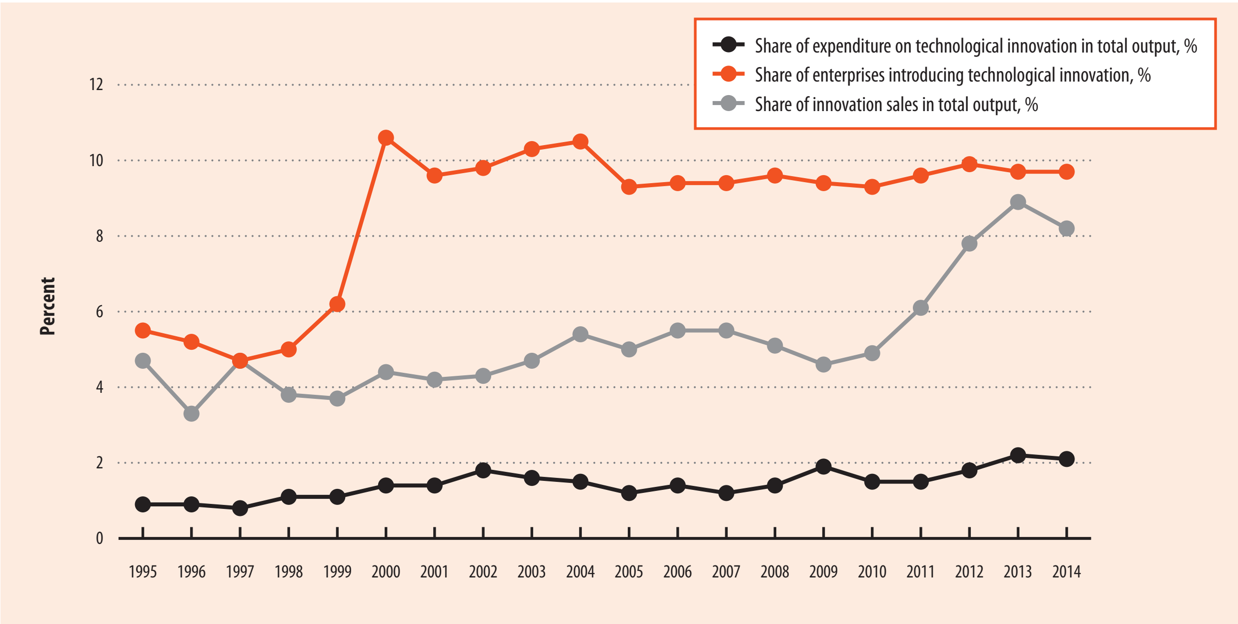
Efficient governance of the S&T complex relies heavily on priority identification mechanisms. Russia has established a systematic and multilevel foresight practice that produces inputs for strategic decision making processes in both public and private sectors. In 2011 the latest list of critical technologies was approved by the president, emphasizing eight major areas (information and communication technologies, transport systems and space, safe and efficient energy systems, environmental management, life sciences, nanotechnology, defence, and national security) with 27 total critical technologies on the second level of classification. Two key principles underpinning this list of critical technologies are that they must have potential effective impact for addressing grand challenges as well as perspectives for promoting national competitiveness. These lists were used as inputs for structuring a number of policy initiatives aimed at promoting R&D and innovation. S&T foresight-2030 is another regular long-term future-oriented activity comprising a part in the long-term strategic governance of Russian S&T.[10]

Industry and innovation

Unlike the public R&D sector, the innovation activity of business enterprises generally cannot be considered subject to directive intensification because—although budget spending on basic science can be ordered to increase within the network of state R&D labs, doing better innovation cannot be ordered—the ability to do better innovation depends to a great extent on framework conditions and the performance of other functional dimensions of the national innovation system.[11] The stability of innovation indicators (see Figure 4)—including the total share of innovation companies, shares of innovation expenditure, and innovation sales of total sales—reflects rather modest progress in promoting innovation as the best competitive strategy; this is the case as long as it is possible to successfully compete with some rent-seeking behaviour, such as corruption or monopoly. At the same time, certain positive dynamics can be traced. Although less than 10% of the country's industrial enterprises engage in technological innovation, the share of innovation expenditure in their total output as well as the share of innovation sales in their total output has been increased by roughly 30% since 2010. Still, these indicators show that innovation accounts for a very limited proportion of a firm's economic activity.

The observed dynamics can be related to the mix of measures aimed at promoting innovation and business R&D. The existing portfolio is quite diverse, ranging from *thematic state programmes* to support specific industries (e.g., pharmaceuticals, electronics, aircraft, and shipbuilding) and technological areas (e.g., composite materials, photonics, and biotechnology) to the *horizontal demand-side mechanisms*—a Federal Law on Public Procurement has a special way to foster the purchase of innovative as well as high-technology products; it also especially favours small and medium-sized enterprises (SMEs). A notable example of direct support

Figure 4: Key indicators of the innovation performance of industrial enterprises



Source: HSE, 2016b.

Note: Data refer to the statistical classification of economic activities in the European Community, NACE, rev 1.1, sectors C (Mining), D (Manufacturing), and E (Utilities). See http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Statistical_classification_of_economic_activities_in_the_European_Community_%28NACE%29.

for the functional activities within the national innovation system is the targeted support for engineering and industrial design, including the promotion of engineering service providers and prototyping centres. The Foundation for the Assistance to Innovative SMEs and a newly established Federal Corporation for the Development of Small and Medium Enterprises (reorganized in 2015 from the Programme for SME Development, which had been active since 2013) introduced subsidies to promote innovation in SMEs.

The range of the available tax incentives for R&D and innovation, including special benefits for high-tech exports,[12] has been expanded since 2011 to provide relief for the taxation of intellectual property–related profits and benefits for patent duty payments for SMEs and inventors. These activities fit into the overall trend of developing the intellectual property protection regulatory framework.

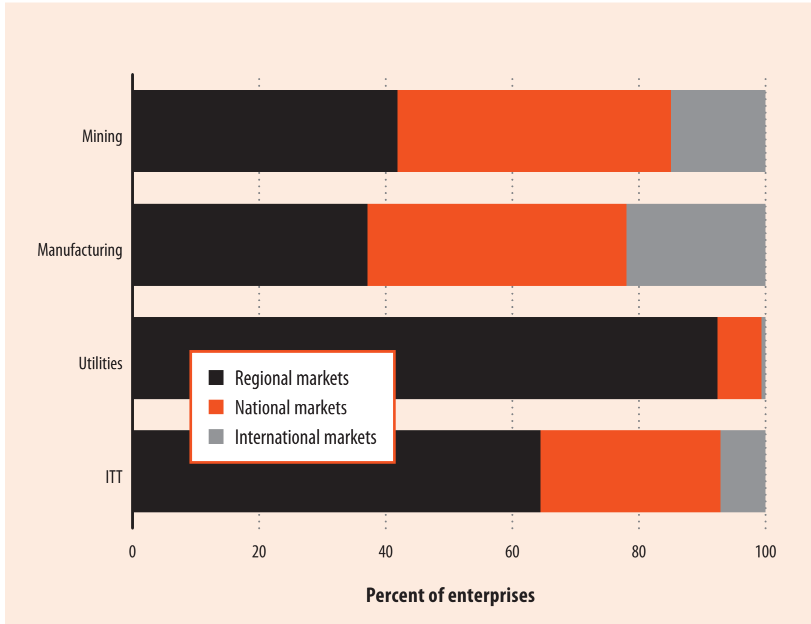
Another set of mechanisms, launched in 2009, was specifically designed in the spirit of promoting cross-sectoral interaction and compensating risks directly associated with advanced innovation strategies. As presented in several reports,[13] some of the highlighted measures provided competitive-based support for cooperation between companies, research organizations, and universities; others facilitate the development of the pilot innovative territorial clusters (25 active clusters presently receive support for infrastructure, commercialization, and technological transfer),[14] as well as the development of the technology platforms (34 active platforms engaging more than 3,000 organizations).[15] The coordination of these platforms employs the Foundation for Industrial Development (formerly the Technology Development Fund), which provides special loans for innovation projects. The platforms are also synchronized with other governmental thematic programmes. The Skolkovo Innovation Centre provides special taxation regimes and promotes global visibility of high-tech start-ups in the areas of nuclear technologies, energy efficiency and energy saving, space technologies, biomedicine, and strategic computer technologies. This centre now hosts more than 1,000 companies on an exterritorial basis and has an annual budget that accounts for more than 17.3 billion roubles.

The high-profile initiative imposed state-owned corporations to architect and implement innovation development strategies with the mandatory requirements of cooperating with SMEs, research organizations, and universities. Launched in 2010, this instrument has undergone several iterations of assessment. It is clear that this type of intervention should be introduced with a complex and regular evaluation system that promotes the efficient and effective implementation of the planned activities.[16]

The abovementioned range of supporting instruments forms a policy mix aimed at promoting innovation by combining horizontal and vertical measures that compensate for various functional flaws of the existing national innovation system. At the same time, it is important to be realistic when assessing the expected outcomes of sophisticated policies and pay attention to the actual presence and incentives of the potential benefactors within the economy.

The Russian experience shows that, for nearly 90% of enterprises, engagement in innovation activity, even at the national level, is not the most popular business strategy, which often limits the experience of domestic actors in networking and cooperation. Surveys on the strategic orientation of companies can estimate the availability of potential candidates for integration into the international value chains (Figure 5).[17] Of the observed Russian companies, only 22% of manufacturing enterprises, 15% of mining enterprises, and 7% of companies engaged in information and communication technologies consider international markets to be potentially important. Such strategic orientation leads to particular business models that result in a certain level of competitiveness and skill. This 'equilibrium' of business models and strategies is subject to change only through a very inertial and path-dependent trajectory.

Figure 5: Prospective markets for innovative enterprises by sector



Source: HSE, 2016b. Estimates by the authors based on data provided by Rosstat, the Federal Statistical Service of the Russian Federation.
Notes: The figure shows the percent of enterprises that consider particular markets (regional, national, or international) to be especially important for the future commercial success. ITT = Information and telecommunication technologies.

Conclusions

Over the last years Russia has developed an extensive STI policy framework and an elaborate portfolio of supportive instruments. The resulting policy mix appears to be sophisticated enough to address the challenge of effective governance of the STI complex. Time will show if the existing mechanisms are robust in the face of tightening budget constraints and unfavourable geopolitical conditions. At the same time, the potential outcomes of the expensive policies are entirely conditional on the ability to synchronize initiatives and thus maintain the holistic approach to the designed system of incentives that the actors of the NIS are facing. This will be impossible without integrating the systemic methods for policy evaluation and impact assessment. Providing the framework conditions is a necessity as soon as strategic objectives concern promoting massive innovation activity and large-scale integration into the global value and knowledge chains rather than merely supporting a selected narrow circle of national champions. The intensity of the country's integration into the global innovation space is, finally, an aggregate of the engagement of individual actors (firms, research organizations and universities, researchers, and inventors, etc.) into cooperative projects, aligning their expertise, interests, and needs with the emerging networks of partners. The promotion of a special competence of cooperative networking as a part of the general sophistication of the country's innovation and research strategies appears to be the first step towards fostering the openness of an innovation system. Mastering these skills helps to focus on mutually beneficial projects to overcome economic and political crises. In the case of Russia, this is demonstrated by the strong bilateral ties established with the European Union (e.g., access to the Horizon 2020 research and innovation programme that provides funding for 2014 to 2020 and participation in megascience activities such as CERN);[18] growing collaboration with Asia (e.g., within the Shanghai Cooperation Organisation, the Eurasian Economic Union, and the Association of Southeast Asian Nations) aimed at the joint development of high-tech, commercial space technologies, materials engineering, medicine, computing, and telecommunications; and special opportunities to cooperate within the BRICS countries. In order to succeed in the STI domain, policy makers are expected to broaden the time horizons of strategic planning and investment, thus ensuring economic and political stability, consistent administration, and a long-term intelligence elaborated via the systematic practice of foresight.

Notes

1 Polischuk, 2013.

2 Yakovlev and Zhuravskaya, 2013; Yakovlev, 2014; Kuznetsova and Roud, 2013.

3 Zaichenko et al., 2014.

4 IMF, 2016.

5 OECD, 2015.

6 HSE, 2016a; OECD, 2016.

7 This is an index of revealed comparative advantage, normalized from 0 to 1. See, for example, Todeschini and Baccini, 2016, pp. 4–7.

8 HSE, 2016a.

9 Gershman and Kuznetsova, 2014.

10 Gokhberg, 2016.

11 Edquist, 2011.

12 Gokhberg and Roud, 2012.

13 Gokhberg and Kuznetsova, 2015; Gokhberg and Roud, 2012; OECD, 2011.

14 Kutsenko and Meissner, 2013.

15 Proskuryakova et al., 2015.

16 Gokhberg et al., 2015.

17 See also Zaichenko et al., 2014.

18 Information about the European Union's Horizon 2020 programme is available at https://ec.europa.eu/programmes/horizon2020/en/what-horizon-2020. For further information on the directions of Russia's S&T cooperation, see Gokhberg and Kuznetsova, 2015; Kotsemir et al., 2015.

References

Edquist, C. 2011. 'Design of Innovation Policy through Diagnostic Analysis: Identification of Systemic Problems (or Failures)'. *Industrial and Corporate Change* 20: 1725–53.

Gershman, M. 2013. 'Innovation Development Programmes for the State-Owned Companies: First Results'. *Foresight-Russia* 7 (1): 28–43.

Gershman, M. and T. Kuznetsova. 2014. 'Performance-Related Pay in the Russian R&D Sector'. *Foresight-Russia* 8 (3): 58–69.

Gokhberg, L., ed. 2016. *Russia 2030: Science and Technology Foresight*. Moscow: National Research University Higher School of Economics. Available at https://issek.hse.ru/en/news/172190256.html.

Gokhberg, L., G. Kitova, and V. Roud. 2014. 'Tax Incentives for R&D and Innovation: Demand vs. Effects'. *Foresight-Russia* 8 (3): 18–41.

Gokhberg L., A. Klepach, M. Gershman, O. Fomichev, and A. Shadrin, eds. 2015. *Innovation Development Programmes of Russian State-Owned Companies: Interim Results and Priorities*. National Research University Higher School of Economics. Moscow: HSE.

Gokhberg, L. and T. Kuznetsova. 2011. 'S&T and Innovation in Russia: Key Challenges of the Post-Crisis Period'. *Journal of East-West Business* 17 (2–3): 73–89.

———. 2015. 'Russian Federation'. In *UNESCO Science Report: Towards 2030*. Paris: UNESCO.

Gokhberg, L. and V. Roud. 2012. 'The Russian Federation: A New Innovation Policy for Sustainable Growth'. In *The Global Innovation Index 2012: Stronger Innovation Linkages for Global Growth*, S. Dutta, ed. Fontainebleau: INSEAD and WIPO.

HSE (Higher School of Economics). 2016a. *Science and Technology. Innovation. Information Society: Pocket Data Book*. Moscow: National Research University Higher School of Economics.

———. 2016b. *Indicators of Innovation: Activity: 2014. Data Book*. Moscow: National Research University Higher School of Economics.

IMF (International Monetary Fund). 2016. *World Economic Outlook*, April. Washington, DC: IMF.

Kotsemir, M., T. Kuznetsova, E. Nasybulina, and A. Pikalova. 2015. 'Identifying Directions for the Russia's Science and Technology Cooperation'. *Foresight and STI Governance* 9 (4): 54–72.

Kutsenko, E. and D. Meissner. 2013. 'Key Features of the First Phase of the National Cluster Program in Russia'. *Working Paper* No. BRP 11/STI/2013. Moscow: Science, Technology and Innovation, National Research University Higher School of Economics.

Kuznetsova, T. and V. Roud. 2013. 'Competition, Innovation and Strategy: Empirical Evidence from Russian Enterprises'. *Voprosy Economiki* 12.

OECD (Organisation for Economic Co-operation and Development). 2010. *The OECD Innovation Strategy: Getting a Head Start on Tomorrow*. Paris: OECD.

———. 2011. *OECD Reviews of Innovation Policy: Russian Federation 2011*. Paris: OECD.

———. 2015. *The Future of Productivity*. Paris: OECD.

———. 2016. *OECD Science, Technology, and Industry Outlook*. Paris: OECD.

Polischuk, L. 2013. 'Institutional Performance'. In *The Oxford Handbook of the Russian Economy*, eds. M. Alexeev and S. Weber. New York: OUP USA Oxford Handbooks in Economics. 189–220.

Proskuryakova, L., D. Meissner, and P. Rudnik. 2015. 'The Use of Technology Platforms as a Policy Tool to Address Research Challenges and Technology Transfer'. *The Journal of Technology Transfer* 41 (5): 1–22.

Todeschini, R. and A. Baccini. 2016. *Handbook of Bibliometric Indicators: Quantitative Tools for Studying and Evaluating Research*. Weinheim, Germany: John Wiley & Sons.

Yakovlev, A. 2014. 'Russian Modernization: Between the Need for New Players and the Fear of Losing Control of Rent Sources'. *Journal of Eurasian Studies* 5 (1): 10–20.

Yakovlev, E. and E. Zhuravskaya. 2013. 'The Unequal Enforcement of Liberalization: Evidence from Russia's Reform of Business Regulation'. *Journal of the European Economic Association* 11 (4): 808–38.

Zaichenko, S., T. Kuznetsova, and V. Roud. 2014. 'Features of Interaction between Russian Enterprises and Research Organisations in the Field of Innovation'. *Foresight-Russia* 8 (1): 6–22.