Russia's Knowledge Economy Decline: Views From Inside

Harley Balzer

Summary

This paper begins with an overview of Russian assessments of knowledge economy challenges. It then focuses more specifically on problems in science and education. Special attention is devoted to bureaucratic competition, funding, personnel and the limited role of business in the knowledge economy. This is followed by examining several issues that merit particular attention in the aftermath of Crimea: potential partners for development; whether military R&D is an exception to prevailing difficulties; and the impact of sanctions. The concluding section focuses on consequences of decline and considers potential tipping points that could change the trajectory in positive or negative directions.

* * *

The two questions that have consumed the Russian intelligentsia since the 18th Century are *kto vinovat*' (who is to blame) and *chto delat*' (what is to be done). I have often joked that most Russians devote so much time and energy to the first question that they barely touch on the more crucial second question. In the case of Russia's declining capacity in the knowledge economy, this is hardly a joke. The Russian discourse is focused overwhelmingly on how bad things are and who caused the problems. Those who disagree that the current trajectory means long-term decline invoke Russia's great tradition in the natural sciences or Soviet successes in space and atomic energy, and they argue that the government simply needs to restore funding to an appropriate level in order for Russia's vast pool of talent to restore the nation's proper place in global science.

My own assessment of the decline in Russia's knowledge economy—education, science, technology and innovation—is already on the record (Balzer 2015; Balzer 2011; Balzer 2010; Balzer and Askonas 2016; Balzer and Askonas 2015). The discussion here will focus on Russians' published accounts and informal conversations with Russian colleagues who work in or study

Russia's knowledge economy. **[1]**

That few Russian colleagues address directly the topic of Russian decline is hardly surprising. In the current political environment, speaking truth to power in Russia may have significant unpleasant consequences. Even if the government does not bestir itself to go after every scholar criticizing economic and science and technology (S&T) policy, administrators at many research institutions and universities now monitor what their staff publish and say. **[2]**

Despite growing limits on expression, Russian readers remain sophisticated. The implications of assessments of Russia's situation, and especially of comparative analysis, are clear to attentive readers even if the consequences are not stated blatantly. To some extent we are back in a world familiar to those of us who studied the Soviet Union in the 1970s and 1980s. One could divide "Sovietologists" into two groups: those who resented being described as "bourgeois falsifiers" and those who understood that many Soviet colleagues who chose to review our work in this manner used it as a way to present our ideas to their academic community. We now have a limited number of analysts (including the 11 who wrote the initial short papers for this project) bravely stating their views openly. Far more Russian colleagues have opted to play it safe and package criticism in writings that identify problems without directly criticizing top leaders (or at least THE top leader).

The "who is to blame" conversation is interminable and unresolvable. Discussions of "what is to be done" focus on two key related issues: institutional structure and funding. The institutional debates involve the status of the Academy of Science vis-à-vis the higher education system. The funding discussions emphasize the share of GDP that should be allocated to science and, of course, in what ways and for which institutions. In increasingly rare instances, these discussions also note the role of military research and development (R&D). Russian discussions of the private sector/business mostly note that it plays a minimal role in Russia's knowledge economy.

To an outside observer, one of the persistent problems in the Russian discussion of these issues is a focus on inputs rather than efficiency or results. This perpetuates a Soviet approach described well by Gregory (2004), where investment was the one thing that could be measured reasonably accurately and therefore became the primary focus in planning. The Russian discourse is overwhelmingly consumed with the share of GNP devoted to education and science, with minimal attention to how effectively these funds are used. **[3]**

Inefficiency and high levels of corruption may be tolerable in times of solid economic growth (a.k.a., high oil prices). But when economic conditions deteriorate, pressure for greater accountability becomes significant. The Soviet economy experienced this problem in the Gorbachev era, when declining oil prices made the inefficiency of the system more apparent and deprived the regime of the resources needed to finance restructuring. The acute inefficiencies in spending by educational and research institutions, much of it resulting from absurd and sometimes venal bureaucratic procedures determining when funds are received and how they may be used, are a serious everyday problem. At a time of shrinking budgets, the inefficiencies require administrators to concentrate the limited resources, inevitably reducing support for lower priority institutions.

This paper begins with an overview of Russian assessments of knowledge economy challenges. It then focuses more specifically on problems in science and education. Special attention is devoted to bureaucratic competition, funding, personnel and the limited role of business in the knowledge economy. This is followed by examining several issues that merit particular attention in the aftermath of Crimea: potential partners for development; whether military R&D is an exception to prevailing difficulties; and the impact of sanctions. The concluding section focuses on consequences of decline and considers potential tipping points that could change the trajectory in positive or negative directions.

Russian Assessments and Forecasts

A growing number of prominent economists now speak frankly about Russia's economic model being in dire need of revision (Kudrin and Gurvich, 2014; Akindinova et al., 2016). Yaremenko's (2015: 9) attack on liberal dogma is a good example of recent frank criticism. He clearly states that "military overload" (*voennaia nagruzka*) was the "main source of structural deformation" in the USSR, adding that "all bureaucratic measures to speed up scientific-technical progress, as a rule, turn out to be unproductive." Kudrin was dismissed as Finance Minister in 2011 for criticizing the level of military spending.

How do Russians who work in or depend upon the knowledge economy view the situation? The first product of this project consisted of 11 papers written by Russian colleagues. Attention to the knowledge economy comes only in passing.

A sample of some 100 "experts" working in universities, research institutes, technology businesses, social organizations and government agencies provides a good place to start (See Appendix 1). **[4]** The experts interviewed emphasized the positive impact of Russia's long history as a center of research, solid record in important disciplines, high quality personnel and history of scientific productivity.

Possible Russian "strengths" that were cited by fewer than ten percent of the respondents are more revealing than the factors cited by larger numbers. These involved financial support, including diversity of sources of funding; availability of modern equipment; and cooperation across research institutes, universities and business. The small number of people who view these areas positively points to some of Russia's most acute problems. Financial support, equipment, and collaborative activity across sectors are far more integral to generating innovation than history, tradition, or even the overall quality of personnel. **[5]**

The pattern visible in the recent "expert" survey is matched by the approach taken in academic writings and the comments made by Russian interlocutors in conversations over the past several years. One group, now diminishing in size, continues to cite Russia's glorious tradition, apparently assuming that it outweighs all economic and other obstacles to progress. **[6]** A second group cites Russia's historical record to support their belief that if the government would just provide adequate funding, everything could be solved quite quickly. A third group, by now probably the majority, focuses on the growing problems and sees no quick fix. While a few now predict imminent catastrophe, the majority appears to envision a lengthy period of either continuing weak performance or uninterrupted gradual decline. This parallels Sergei Aleksashenko's (2016)

assessment of the Russian economy as being in decline rather than crisis. What is most striking to this observer is how few Russian experts talk about a possible "tipping point" at which the accumulating difficulties and their social consequences produce a more severe discontinuity. **[7]**

Unwillingness on the part of many Russian commentators to address decline directly may be due to an increasingly fraught political situation. My impression is that Russian specialists were more willing to be critical and discuss serious flaws in the decade before 2014 than since the annexation of Crimea and the resulting Western sanctions, which produced anti-Americanism and a Russian "pivot" to China. There is a striking disconnect between assessments of policy and the same experts' participation in technology assessments that project Russia continuing to play a major role in global scientific activity. **[8]**

Overall Assessments

Prognostication has been a feature of Russian-Soviet-Russian economic and science policy for a long time. A striking theme that appeared in early post-Soviet discussions of Russia's future emphasized the danger of the country turning into a natural resource–supplier for more advanced economies (Analytical Center, 1993). The same concern has persisted in subsequent analyses. In 2008, the Russian Academy of Sciences report on Russia's Scientific-Technical Development to 2030 noted the same danger: the country was losing its technology base as it increasingly derived income from the sale of natural resources, and hydrocarbons in particular (*Rossiiskaia Akademiia Nauk*, 2008).

The Academy of Sciences report is worth summarizing in some detail. It appeared at the end of Russia's "Putin economic boom"—the eight years when funds were available to address serious problems, but more often were squandered on massive infrastructure projects riddled with corruption. When Vladimir Putin became Prime Minister in August 1999, oil was priced at $12–14 a barrel; when he stepped down as President in May 2008, it was at $147. Had he retired then, history might refer to him as "Vladimir the Lucky." Hydrocarbon prices during Putin's third term have been far less favorable.

In addition to natural resource addiction, major causes for concern in the Academy's 2008 report included:

– Production technologies moving to developing countries that would have major advantages over Russia in terms of both quality and price.
– An even more serious situation in military technology, with Russia falling behind not only the developed nations but also "second tier" powers like China. The authors noted that China was rapidly improving the quality of its military equipment.
– The most pressing concern is the increasing importance of human capital for technical progress: the quality, socialization and collaborative work of Russian S&T professionals is identified as the decisive factor for the competitiveness of an innovation economy, and Russia has serious problems in this realm.

The negative tendencies proliferating in Russia require multiple areas of policy action:

– improving the quality of life;
– developing effective institutions to improve the quality of human capital: education, health care, housing;
– restoring the middle class to a dominant position;
– reducing social inequality;
– catching up with the developed nations in labor productivity.

The Academy experts describe Russia's economy as characterized by a large non-market sector that undermines motivation: economic development demands more competition, limits on natural monopolies, and a much larger and more dynamic small and medium business sector. Scientific and technical results from Russian R&D are not used in production, even though foreign firms do adopt Russian advances. Russia lacks effective ties between science and production.

The Academy report identifies serious problems with personnel. Science cadres are not being replaced at an adequate pace, and Russia's unique scientific schools are being undermined. The authors conclude that "failure to address this list of needs is creating a qualitatively new form of social-economic development in Russia, markedly different not only from the 1960s–1980s, but also from the 1990s and the first decade of the 2000s."

The Academy's report is framed in a global economic context: The authors predict that following the crisis of 2007–2008, global GNP will grow at only 3-4 percent per annum, while developed countries will grow at just 1.5–2 percent annually. The center of gravity of the global economy will shift to developing nations, especially China and India, which will account for more than one third of global growth. **[9]**

The authors list a dozen realms where Russia must significantly improve, although the extensive needs are not prioritized. Despite their critical analysis, the Academy authors state that Russia remains among the countries with the strongest scientific potential, exceeded only by the United States, Japan and China. If they are correct in their judgment of Russia's relative standing, the data they cite would suggest that Russia has the most cost-effective S&T enterprise on the planet.

Table 1. Domestic Expenditures for R&D, 2006 (data from OECD)

	Total ($1M)	as % of GDP	Per Person ($)
Russia	20,281.3	1.07	126.9
United States	343,747.5	2.62	1093.7
Germany	66,688.6	2.53	757.8
Japan	138,782.1	3.39	1023.3
United Kingdom	35,590.8	1.78	594.1
France	41,436.3	2.11	644.2
Sweden	11,815.0	3.73	1249.9

(SOURCE: *Rossiiskaia Akademiia Nauk*, 2008, p. 21)

The Academy report points out that the Russian state budget remains the overwhelming source of funding for R&D, yet the share of the budget in Russia devoted to this is 1.6–2 percent, while in developed countries it is 4–5 percent. The state sector includes 73 percent of S&T institutions and 79 percent of personnel (p. 23). The contradiction between praising Russia's capacity and criticizing budget policy remains a constant feature in Academy analyses.

Not surprisingly, the Academy authors point out that universities play a small role in R&D. The number of universities involved in R&D has shrunk from 453 in 1990 to 417 in 2006, which means that only about one third of Russian higher education institutions conduct R&D (p. 25).

While asserting that only three countries have greater scientific potential than Russia, the report notes that Russia ranks 9th in the world in the number of scientific publications, though just 15th in total citations and *only 120th in citations per article* (p. 25, author's emphasis). In patenting, Russia is among the leaders in just three of the 34 most important areas of technology (p. 26). Few Russian firms engage in innovation-enhancing research, and most new technology is imported (pp. 26-–7).

Despite the dire picture they paint, the Academy authors state that if the share of the Russian budget for non-military science is increased from 1.1 to 3.5 percent by 2030, this would raise Russia to third place in the world in the science-intensity of GNP (p. 67). The final 20 pages of the Academy report describe how Russia will become a world leader in an array of the most important areas of S&T. This will be accomplished by more state spending, a larger role for business, and greater integration into the global innovation economy. The report concludes with a seven-page list of tasks to be accomplished, identifying no priorities. The unstated conclusion is that without dramatic and comprehensive change, Russia's position in global S&T will continue to decline.

The Academy forecast is unusual in the sharpness of its criticism of just about every aspect of Russia's economy and knowledge economy. This may help to explain the devastating reorganization of the Academy beginning in 2013 (Dezhina, 2014). An equally important explanation is that the Academy has long resisted undertaking serious reforms on its own volition. **[10]** It is also the case that Academy facilities occupy a large amount of tremendously valuable real estate, including some of the most desirable locations in Moscow and St. Petersburg. Officials and insiders have long eyed these properties as tremendous opportunities for investment.

More typical documents on long-term prospects for Russian science and technology development focus on global trends and assume that Russia will occupy its rightful place in these realms of S&T. These documents tend to be both comprehensive in their coverage of leading fields of S&T and devoid of practical discussion about Russian capacity in the sectors described.

As is the case in almost every statement emanating from Academy of Sciences personnel, the key to fixing the problems is viewed as more funding, especially for Academy institutes. Rarely is the effectiveness of spending part of the discussion, though the crisis beginning in 2014 is inducing some analysts to raise important questions. Suvorov et al. (2015: 15) point out that while the levels of funding for health and education in Russia are respectable by world standards, the results do not match the investments. Korovkin (2016) speaks of "an underlying fundamental reality: a gap between the quality of the instruments and the results of their application." Frolov (2014: 80) states directly that the active state policy to promote innovation has not achieved significant results.

While Russia has most of the features of the world's national innovation systems, and in purchasing power parity (PPP) Russia spends about what Germany, France and the US spend (p. 81), inadequate accounting, planning and administration undermine benefits to the economy. Russian reliance on formal indicators contradicts the ability to effectively evaluate the level of S&T (p. 91). The Russian approach does not measure the economic effect of innovation, but rather the products of the innovation process: publications and patents do not measure economic contributions (p. 84). Few resources are devoted to branches where private business would be able to benefit—most funding goes to sectors dominated by state corporations (pp. 90–91). **[11]** As a result, Russia ranks together with Argentina at near zero high-tech exports, below countries like Mexico and Slovakia that spend a smaller percentage of GDP on R&D (Frolov, 2014:86). Russia also lags badly in the share of high technology exports as a proportion of industrial production and is a laggard in patent applications (p. 87).

Neglect of the quality of human capital in determining economic performance is another persistent problem (Gurtov et al. 2016). Even a discussion of the contribution of the "administrative resource" asserts that its contribution is difficult to assess because administrators are so different (Kamenetskii and Ias'kova 2015).

A recent discussion of the crucial importance of the Academy's role in basic science is more nuanced than the total dismissal of University contributions in most earlier accounts (Mindeli and Chernykh, 2016). The authors assert the Academy's dominance in basic science, but accept that universities may play an important role, while also noting that the Academy does engage in some applied research. While sharing the general Academy demand for more financial support, they admit that the prospects for higher levels of funding are not promising. Mindeli and Chernykh (2016: 118) point out that plans for basic science funding for 2015–2020 call for a 16 percent increase, which will not keep pace with inflation. They project that the combination of inflation and ruble devaluation will reduce real support for basic science by 20 percent by 2020.

Nevertheless, the president of the Siberian Division of the Academy, Aleksandr L. Aseev, recently called for the government to go beyond Putin's proposal to raise spending to 2 percent of GNP, noting that the crisis made it imperative to compensate for losses over the past two decades (Kolesova and Sobolevskii, 2016: 8). **[12]**

The likelihood of a coherent policy to address Russia's knowledge economy decline remains questionable. In a particularly frank assessment delivered in a lecture at the Polytechnical Museum, Irina Dezhina (2011) emphasized the chaotic nature of Russian government policy. In just about every important realm, priorities and approaches have shifted repeatedly. After the scientific community worked with the government to identify priority areas of S&T in 2006 and 2009, President Dmitry Medvedev announced a list of five priorities that matched the earlier ones only in the area of energy conservation and efficiency. Efforts to induce scientists from abroad to work in Russia initially focused on the Russian diaspora, but then shifted to attracting the best foreign scientists. The "megagrant" program to accomplish this was riddled with difficulties, and ended up awarding grants to a number of Russians who had joined the exodus.

Dezhina (2011) also chronicles seemingly incessant organizational "reforms." Changes in research institutes began with privatizing the "branch" industrial research institutes in the 1990s, which

resulted in most of them disappearing. Emphasis was then placed on "integration" of education and science, encouraging the Academy and higher education institutions (*Vysshee Uchebnie Zavedenii* or *VUZy*) to collaborate without much success. From the mid-1990s to the early 2000s some Academy institutes were closed, and the emphasis was on research at *VUZy*. The results were not impressive. After 2004, a program was designed to reduce scientific institutions by 40 percent, but this was not achieved. Since 2006, the government has introduced a series of programs to create elite universities and integrate science with education. The result is three groups of universities: a small (and shrinking) number of elite universities, a larger number of regional institutions, and quite a few that might be viewed as endangered species.

Dezhina emphasizes that all of these programs have essentially ignored entrepreneurial activity in Russia. Science remains overwhelmingly a State activity. Some 73 percent of R&D institutions are federal property, and they employ 77 percent of the workers engaged in R&D. About two thirds of funding for S&T comes from the government, including more than half of the support for science in the "business" sector. Financing from business represents just 26 percent of total spending.

In a subsequent paper, Dezhina (2014) suggests that the Government seems intent on dismantling the administrative system of the Academy, but does not appear to have a "clear strategy in place for the long-term development and improvement of the country's scientific output." **[13]** Dezhina's (2016) analysis of Russian innovation policy describes similar confusion. The budget for 2013–2015 does not mention innovation, but by the end of 2014 there was a shift to emphasizing its importance. **[14]** The government began introducing the *Natsional'nii vytiagivaiushchii proekt* (National "Pulls" Project) to support promising innovation opportunities involving collaboration across sectors. This was followed by a *Natsional'nii tekhnologicheskii initsiativ* (National Technology Initiative, NTI) to determine priorities over the coming 10–15 years. These programs appear to duplicate efforts rather than produce synergies. If the government follows through on its promise to stimulate collaboration among business and universities along with state efforts and keeps the promise to provide support for an initial period of 5–7 years, the NTI could have a positive effect. Whether the government will be able to provide the promised level of funding remains to be seen; whether the 50 percent from "other sources" will be forthcoming during a severe economic crisis is also an open question.

The impact of the chaos has been particularly devastating for the younger generation. About 70 percent of young Russian specialists interviewed in late 2013 viewed the Academy reform as something negative, with a growing number discussing their desire to move abroad (Kolesova, 2014). Many young scientists talked frankly about being forced to choose between staying in Russia or staying in their profession (Prikhodchenko, 2013).

Dezhina (2016) Notes two contradictory currents in Russian innovation policy: innovation has been accorded higher priority as a realm requiring state support at a time when the government budget is increasingly less able to provide the needed funds. The solution is to replace the long-dominant technocratic approach with a market orientation, something that would be facilitated by greater international collaboration in technology as well as in science.

Similar conclusions are voiced in a study of Russia's natural resource sector by Kasimov et al.

(2015). They find that Russia is fully prepared to participate in the global effort to introduce more efficient and environmentally friendly hydrocarbon extraction, along with widespread recycling. They add that the expert views they cite "incorporate a degree of uncertainty, especially with regard to how and when (or whether) the markets, technologies, products, and services will develop in the expected ways." Where Kasimov et al. (2015: 81) frame the shift in approach as a response "to the threat of losing its position in traditional segments because of the constant tightening of international environmental quality standards for products and production technologies," Kirshin (2014) is quite direct in stating that the crucial shift to an economically viable model of economic growth will require abandoning the hydrocarbon-based model of economic development.

Contradictions and policy confusion have also characterized efforts to improve education and increase its role in research.

Education

The prognosis for education is only slightly less bleak than for research institutes. The vast majority of commentaries have bemoaned the declining funding for education and the lower quality of students and instructors. Most would agree with Korovkin (2016): "Inside the country the quality of universities and their graduates is seen with increasing skepticism." This reflects the continuing intense public interest in higher education. It also derives from the government policy emphasizing research in VUZy manifested in substantial funding for a select group of "leading" universities and a focus on global rankings. Support for elite institutions has been maintained at the same time that the government cuts budgets and implements policies to amalgamate some higher education institutions and close others.

One of the seemingly inevitable trends for Russia is a reduction in the number of higher education institutions and research facilities. Both economics and demographics are driving this shift, though resistance remains fierce. Faced with overwhelming budget challenges, the government must choose between funding all claimants at a reduced level or concentrating resources in the strongest institutions. Rumors have repeatedly circulated regarding draconian reductions in personnel and/or numbers of institutions. The government has thus far amalgamated some universities, and is in the process of developing a program to evaluate research institutes. While many expect major cuts, others are more sanguine. Efimov (Akvobr.ru., 2014) suggests that the initial review of institutions will identify the strong ones, but will give the others a five-year period to improve or face more drastic consequences. Left unsaid is how the weaker institutions will manage to raise their quality in a period of declining financing.

The various projects to create leading universities may offer some indication of what to expect. Each time the government has introduced a new program to support excellence, the number of institutions receiving priority funding has been reduced (Balzer and Askonas, 2014:3).

The emphasis on university-based research has elicited howls of protest from Russia's Academy of Sciences and other stand-alone research institutions. **[15]** Academy supporters persist in arguing that Academy scholars are more productive than university faculty. While accurate, the data ignore the heavy teaching loads at VUZy, compared to nearly total freedom of Academy personnel. This

is a remnant of the Soviet system where most VUZy focused on teaching while Academy and industrial research institutes conducted the R&D. In a market economy, a system allowing hundreds of thousands of scholars to devote all of their time to research became impossible to support.

Funding

It is difficult to find researchers in any country who do not believe they could accomplish more with additional financial resources. The discussion above illustrates that in Russia, this problem is particularly acute (most recently Mindeli and Chernykh, 2016). That it may be tipping into a genuine crisis stems from the declining value of the ruble since 2014. This makes imported supplies and equipment far more expensive (essentially a doubling of prices since 2014), limits foreign travel by Russian scientists, and makes hiring foreigners to teach or collaborate in research far more expensive. (One positive result of the devaluation is that foreigners with dollars or euros now find that, even with inflation, most costs in Russia are 40–50 percent lower than two years ago. But that does not help Russian institutions paying salaries or stipends in foreign currency to attract visitors.)

Several dozen conversations with Russian colleagues over the past two years have indicated that the cost of foreign supplies, equipment, travel, and personnel have put severe pressure on their programs to internationalize education and research. Yet at a session at the Kennan Institute in November 2015, when I asked Minister of Education and Science Dmitry Livanov about this, his response was the universities are doing just fine, since the 5/100 program, designed to elevate five Russian universities into the top 100 in the world by 2020, is fully funded. While the decline of the domestic currency does permit the Russian government to reap more rubles from sales of natural resources, allowing it to come close to meeting budget needs in rubles, this does not address the question of reduced capacity to purchase foreign equipment or hire foreign specialists. As will be discussed in the sections on import substitution and military technology below, in the past decade Russia has increasingly relied on key imported components for much of its advanced technology. These are the most difficult items to replace, and when sanctions do not preclude transfer of specific items, their cost has doubled.

Personnel

Russia's strong tradition of good education at the nation's elite institutions of higher learning continues to generate a stream of graduates well prepared in math, natural science and computer science. How long this may continue given the generally accepted decline in elementary and secondary education is an open question. **[16]**

Many observers believe that the quality of students has been declining, initially in elementary and secondary education, but now also in higher education. Faculty members are aging, while administrators rarely have training for their increasingly difficult roles. In some instances, retiring politicians have been appointed to head universities, with at best mixed results (interviews).

One topic that has largely disappeared from Russian discussions during the current economic crisis is the impact of demography and the military draft on higher education. The declining number of

18-year-olds and high enrollments in higher education mean that the number of young people, especially males, available to enter the labor force is far from adequate. The quantitative problems are exacerbated by an increasingly voiced concern regarding quality.

The downside of Russia's enrolling a large share of high school graduates in higher education is that few students now attend vocational or technical schools. Russian policy analysts frequently mention the German model of technical training, but this has had little practical impact. In surveys over the past 15 years, 85–90 percent of Russian businesses consistently report that they are not able to find enough skilled workers (Kuvalin and Moiseev, 2014: 111–12). Employers state that they must provide their own training programs. In 2016, Deputy Prime Minister Olga Golodets stated that only about one third of Russian students really need higher education. **[17]**

Three things that are not in question are that Russian industry is desperately short of skilled workers; that there is also a shortage, though less critical, in the supply of qualified engineers (reported by about one third of businesses surveyed by Kuvalin and Moiseev, 2014), and that the best and brightest S&T graduates continue to leave Russia in significant numbers. **[18]** Russian sources are quite open about the deficit of skilled workers and technical personnel, and increasingly have been willing to analyze the brain drain as a permanent rather than temporary or reversible phenomenon.

Business

With a few notable exceptions, there is a remarkable consensus in the Academy and think tank community (though far less in the Government) that innovation is more likely to come from dynamic small and medium businesses, and that private firms are more competitive and innovative than large state enterprises. Yet, government policy, both during the hydrocarbon boom in 2000–2008 and then through anti-crisis measures after 2008 and 2014, has caused the Russian economy to be even more dominated by large state enterprises than it was in 2000. Private businesses spend minimal amounts on R&D, and most do not even try to innovate in technology (Dezhina, 2011).

After Crimea

The annexation of Crimea took place at the same time that Russia's systemic economic slowdown became a more serious challenge. Western sanctions, followed by Russian counter-sanctions, exacerbated the economic consequences. The result, noted by Dezhina (2016), is that Russia's leaders now devote more attention to fostering innovation while having less ability to provide the financial support to realize these efforts. The growing need for international collaboration and foreign inputs is challenged by the sharp decline in the value of Russia's currency.

Sources of Help/Cooperation

One of the most significant lacunae in official programs for knowledge economy development in the future is a discussion of where Russia might find significant assistance in upgrading technology and productive capacity. With post-Crimea sanctions cutting off the already weakened European and American ties, the remaining options are the Eurasian Economic Union (EEU) and China. Without Ukraine, the EEU will be of little help (Kotsemir et al., 2015; Chin and Michael, 2014).

Belarus, Kazakhstan, Kyrgyzstan and Armenia do not offer access to advanced technology (Sal'nikov et al., 2016; Solov'ev and Goriachev, 2016)

Cooperation with China has enormous potential, but also presents tremendous problems (Gabuev 2016). Russians remain wary regarding the threats posed by China's rapidly growing economic and military power. Journalists consistently publish articles warning of long-simmering Chinese claims on Russian territory. Chinese increasingly regard Russia as a less-developed country. Despite consistent signing of agreements by top leaders of the two nations, Chinese remain unwilling to make major investments in Russia (Izotov and Suslov, 2011).

Scientific collaboration between Russians and Chinese has been heavily encouraged by leaders of the two nations. While this has produced some results, it remains weak compared with Russian cooperation with Europe and the US. Beginning in 2014, Russian colleagues frequently spoke about being advised to work with Chinese partners and to encourage their graduate students to learn Chinese. There has been a slight increase in joint publications with Chinese by Russian scholars. But most established Russian S&T specialists do not know Chinese, Russians retain a belief that Chinese are imitators rather than innovators (multiple interviews), while Chinese scientists increasingly regard Russian work in many fields as being behind the "frontier."

The closer relationship with China may be having a negative effect on Russia's prospects for the type of reforms most likely to generate significant improvements in the economy and knowledge economy. In a recent paper (Balzer and Askonas, 2016), I suggested that China is experiencing a "Xi change" in its approach to development. A recent article by Vernikov (2015) reviews earlier work by Speranskaia (2009) on the Chinese and Russian banking systems, and finds that Russia's banks now more closely resemble China's than was the case five years earlier. Given that China's banking system has been sharply criticized by Chinese economists, this is a striking and potentially damaging approach. China's banks are state-owned and consistently make low-interest loans to state-owned enterprises (SOEs) while limiting their lending and charging higher rates to the more dynamic private sector. Hong and Nong (2014) conclude that if the low-interest loans and other subsidies supporting SOEs are calculated, the vast majority of China's state enterprises are losing money at a rate of 5–7 percent per year. Panne and Antonenko (2014) provide data demonstrating that the Russian state sector performs less efficiently than the private sector, and the impact of nationalizations in 2001–2011 has been overwhelmingly negative. They claim that Gazprom and Rosneft would have been far more efficient if they had been broken up into smaller, private companies. Russia is in danger of emulating China's failures rather than its successes.

Investment from and collaboration with China is also limited by Chinese concerns about the sanctions imposed on Russia over Ukraine. Chinese banks and businesses fear that even activity not subject to the sanctions could produce consequences that would damage their economic relationship with the US and Europe.

Impact of Sanctions

Russian commentators generally deny that post-Crimea sanctions are having a significant impact (Ivanter, 2016). While some Russian analysts have reported important successes in import substitution, others have questioned just about every one of these purported achievements

(Dmitrievskii et al., 2016; Faltsman 2015a; 2015b; Kokoshin and Bartenev, 2015; Koshovets and Granichev, 2015). A number of economists suggest that Russia's counter-sanctions have done more damage to Russia's economy than the Western sanctions.

Some have noted that problems resulting from the sanctions have had an impact in the defense sector as well as and in some instances more than the economy overall.

Is Military R&D an Exception?

Given that sanctions have affected the Russian military and defense industry along with the overall economy, we need to ask whether military S&T is an exception to the general decline. In an article published shortly before he became Prime Minister, Vladimir Putin (1999) asserts that Russia was competitive in global S&T only in the military-industrial sector. **[19]** Data does show that the defense industry has received a growing share of funding, though much of what we would like to know about the Russian military industrial complex remains difficult to discern.

Nevertheless, important bits of data have been included in open source material. In an account of the defense and fuel-energy sectors, Fal'tsman (2015) describes Russia's growing dependence on imported components for crucial areas of production. A large share of Russia's innovation capacity is in the defense industrial sector, and the entire economy relies on the energy sector for its financial well-being. These two sectors are crucial to most of Russia's economic activity. The sanctions affect 68 percent of the imports used in the oil and gas sector (Fal'tsman 2015: 118). Russia depends on South Korea for 90 percent of drilling platforms. Russia's defense industry is more diverse, but in the crucial area of electronics, a persistent Russian bottleneck, the situation is quite tenuous. Data indicates that 65–79 percent of the electronics used in Russian missiles and space rockets are imported (Fal'tsman 2015: 119). Russia does not produce drones, and Fal'tsman notes that all of the piston motors used in these aircraft would need to be imported.

The conflict with Ukraine was creating serious problems for Russia's defense industry even before the sanctions were imposed. Key components produced in Ukraine include motors for civilian and military helicopters and some types of warships. Even if Russia is able to produce comparable products, time and significant investment will be needed to replace the imports. Fal'tsman (2015:18) estimates that replacing the Ukrainian contribution will require, at minimum, four years and $20 billion. Other Russian experts, speaking off the record, suggest that the situation will be even more difficult, with enterprises like Yuzmash no longer able to fill Russian orders.

Fal'tsman's data is reinforced by other Russian specialists. Ivanter (2016: 3–4) broadly dismisses the importance of sanctions but does note that they have affected the defense industry. Nearly 100 percent of Russia's helicopter engines came from "Motor Sich" in Zaporozh'e, Ukraine. A Russian factory now produces about 50 engines per year, but Russia's military needs 300. Mindeli and Chernykh (2016: 116–117) express concern that the shift of funding priority to applied and military science will have a significant negative effect on Russia's overall science capacity.

Consequences

Most of the analysts describing conditions in Russia's knowledge economy in the period since

Crimea have refrained from offering predictions about the likely consequences of accumulating problems. There has been a preference for projecting the benefits of accepting scientists' advice to increase funding and adopt other policy prescriptions. In the papers produced for the first phase of this project, several authors noted in general terms the potential for social unrest resulting from the economic crisis.

A more detailed discussion of social and political consequences of continued deterioration in education and science is presented in the recent *Voprosy Ekonomiki* article by Akindinova, Kuz'minov and Iasin (2016). They begin by noting that in the 2000s Russia was able to narrow its gap in economic growth compared with developed countries, but that since 2014 Russian growth has ceased. While the situation is not yet critical, failure to reverse the slowdown means that Russia could soon be overtaken in per capita income by China. **[20]**

While Russia's total GDP is not yet a serious problem, the distribution of income is already a significant concern. Akindinova et al. (2016) note that inequality increased dramatically during a period of rapid economic growth, and Russia now resembles much poorer countries in the region. In 2016, this means Russians will be divided into two groups: about 40 percent of the population will be a middle class able to spend half of its income on discretionary purchases including private education, health care and pensions. The remaining 60 percent will not have this option.

Fixing the economic stagnation will require taming inflation to restart investment, stimulating competition by reducing the state's role in the economy, ending monopolies, and shrinking the large informal sector (now 30-40 percent of the economy). These economic changes are crucial if Russia is to remain globally competitive in science and technology. Russia devotes about half the share of GDP to higher education that is provided in developed countries (0.7 percent compared to 1–1.5 percent). They state that "Russian scientists now participate in work in fewer than 5 percent of the currently most promising areas of research" (Akindinova et al., 2016: 27).

Regional budgets are of particular importance for education, yet regional and municipal debt has increased from 2.5 percent of GNP in 2009 to more than 3 percent in 2015 (p. 29).

In an article published in 2012, Yasin identified three scenarios for the development of the Russian economy: inertness, gradual development, and decisive shift (Yasin, 2012). While this analysis remains valid, the economic results from 2014–2015 caused the authors to add a "mobilization" scenario (p. 33). Experts interviewed think the government will be tempted to try mobilization, but a majority does not believe that it will be successful. Unspoken is that such a failure would accelerate the prospects for further decline. If the "inertia" economic scenario is the future, the quality of public goods like education, health care and communal services will deteriorate even further.

The social consequences of further decline could become serious. The impact will be clear to the majority of Russia's population by 2018 (Akindinova et al., 2016: 31). Affluent Russians will replace free social goods with private ones (many already do this except for general education schools), but the larger group of those who do not have this possibility will be inclined to protest activity.

The authors point out that ignoring mass social demands based on constitutional guarantees is just about impossible. The best the regime might do is try to prevent the joining together of protests by "clients" who are deprived of promised services with protest actions by the "professionals" who work in the public goods sector: medical and educational personnel. They add that the regime cannot ignore the 2012 decree by President Putin to raise the pay of professionals in the budget sector, even though this process is essentially frozen. The situation is likely to provoke consolidated protests in 2018–2020.

Akindinova et al. (2016: 31–32) predict "the negative consequences of the inertness scenario will be sharp differentiation in the quality of education and medicine available to different social layers of the population. Families in the upper middle class (15–20 percent of the population, almost entirely living in large cities) will create 'for themselves' private educational and medical services of high quality." Their children will attend the better universities. "In other words, the positive results of President Putin's social policy, which form the basis of his social-political support, will be destroyed." Given how serious the consequences of the inertia scenario will be for the authorities, they might be drawn to a reform scenario, enhancing competition for the provision of various social services. This would involve accepting far more private activity, and would require secure property rights.

The analysis by Akindova, Kuz'minov and Iasin goes about as far as any "in system" criticism has gone in assessing both the problems and their potential consequences. My impression is that some of the analysis in academic journals was more frank and direct in 2012–2013, before the Crimea invasion, than in 2015–2016. Warning about problems in an attempt to influence policy was easier to do before the aggravated security environment and onset of the economic crisis. It will be important to carefully monitor whether the shift back to criticism and reform proposals becomes more widespread. And of course, it is even more crucial to observe whether any of the advice is accepted.

The Akindova et al. (2016) article does lead a reader to pose one of the most important questions missing from nearly all Russian commentaries: could something happen to markedly change the political and policy environment?

Is There a Tipping Point?

What might produce a significant change in the social-political situation or in economic policy that could either generate greater support for the knowledge economy or that might accelerate decline and provoke social unrest?

Positive developments should not be ruled out, even if they appear unlikely. Something could produce a significant increase in oil and gas prices, relieving pressure on the Russian economy and allowing far greater investment in S&T. Hydrocarbon prices did recover quickly after the 2008 crisis, and some of us suspect that President Putin expected a similar recovery in 2014. However, most serious Russian analysts understand that unlike 2008, the 2014 crisis is a Russian rather than a global phenomenon, and that serious problems in Russia's natural resource model of economic development preceded not only oil price decline but also the Ukraine invasion and resulting sanctions and counter-sanctions.

A second positive factor would be significant collaboration with China (and possibly India) to enhance economic and S&T development. While much ballyhooed by Russian leaders, in the press and in some academic circles (for example, Makarov, 2016), the "pivot to China" remains in the realm of potential rather than achievement (Gabuev, 2016b).

In conditions of decline, tipping points that could have negative social and/or political consequences are more plausible. It is nearly impossible to predict what single event might catalyze accumulating dissatisfaction, but the combustible material does exist to ignite another cycle of social protest like those in 2005 and 2011–2012.

The most obvious driver of social protest or political upheaval would be if Russia's economic problems become more acute. If the hydrocarbon economy does not recover or diversify, the Russian government will likely have expended the available reserve funds by 2018. This would remove the cushion that has allowed the regime to continue to finance social programs and military spending. The choices among competing economic priorities would become difficult. Social protest did produce changes in the government's policy to "monetize" social benefits in 2005. Widespread protest could materialize again. The scenario discussed by Akindinova et al. (2016), with citizens disaffected by shrinking social benefits combining with the professionals who provide those benefits could represent a potent threat.

Hydrocarbon prices might decline again. The global energy situation has changed significantly. Recent analyses of America's shale oil potential suggest that new fields would be competitive at far lower prices than the existing deposits. Russian leaders repeatedly claim that prices have stabilized, but the latest data on shale gas suggest that the Saudi gamble on their ability to drive new technologies out of the market by maintaining low prices might work with older shale deposits but is not going to prevent newer, lower cost, development. Instead of $60, newer fields in Texas and Oklahoma are viable at $35–39 (Crooks, 2016).

A more personalized source of difficulty would be if Vladimir Putin for some reason loses his Teflon. There is enough good satire out there that one or two serious missteps could well provoke a shift in public attitudes. What most media sources refer to as Putin's "popularity" is actually a survey question about whether people approve of his job performance. When Russians are asked if they would vote for Putin again, the responses have fluctuated in the 45–60 percent range, well below the 80–90 percent scores on job approval (Balzer, 2015b).

Conclusion

The Russian expert community's discourse on the country's economic trajectory is in general more negative than most assessments of the country's knowledge economy future. This would appear to be a contradiction, given that most assessments of the prospects for education, science, technology and innovation emphasize the need for higher levels of funding—something nearly impossible to envision given the current economic situation. The contradiction may be due in part to at least some of the economic analysis being done by individuals who are not involved in economic policy-making or business, and who therefore have somewhat less personal stake in the economy's performance. Nearly all the forecasts of Russia's knowledge economy prospects are

written by government officials, university personnel, or researchers employed in institutes supported by the state. While certainly capable of independent thought, these analysts are less inclined to predict dire consequences that will have overwhelmingly negative implications for their own institutions.

In conversations in June 2016, I repeatedly asked Russian colleagues about the contradiction between their continuing efforts at greater internationalization and the increasing anti-Western rhetoric and behavior of Russia's security services. The most intriguing responses suggested that while this certainly creates problems, it represents different government agencies "doing their jobs." The education and science officials continue to seek cooperation and integration, while the security agencies focus on protecting Russia. Many of my interlocutors viewed this as normal.

I gave this analysis careful thought. It does draw on a nearly universal phenomenon of competition among government agencies. Yet other conversations indicate that there has been a significant shift in policy at the top in Russia, tipping the balance far more in favor of the security agenda. Andrei Fursenko, while Minister of Education and Science, worked closely with the Basic Research and Higher Education Program, sharing the financing and then adding additional Russian universities entirely at Russian expense but still relying on international selection committees organized by his American partners. Fursenko now serves as President Putin's advisor on Education and Science. In June 2014, I met with Fursenko and listened to a long analysis of why many Iranian scientists are willing to accept participating in the protracted and sometimes painful system of peer review for publications in major scientific journals, while their Russian counterparts more frequently reject the system and publish their work in Russian-language journals. Fursenko suggested that this explains why Iran ranks ahead of Russia in scientific publications in fields like nanotechnology. The clear implication of Fursenko's account was that Russians need to do a much better job of accepting and adopting international standards. A year later, in July 2015, Fursenko told me that Russians were tired of Americans' condescending approach to Russia, that Russia will be accepted in the Euro-Atlantic community only as "an obedient child," and that things now will be different for the next two decades.

These two conversations suggest that rather than something changing in the basic character of science and technology, something has happened in Russian policy circles to provoke a shift away from integration with Western colleagues and Western knowledge economy institutions. While greater integration with Asia is being proposed as the alternative, a majority of Russian specialists appear to remain skeptical.

Many Russian knowledge economy professionals are now articulating a serious assessment of the decline in Russia's education, research and innovation systems. Russia's top political leadership echoes these concerns, but whether due to different priorities, competing economic and bureaucratic interests, or venal intentions, the policies on offer remain in the realms of continuity or compromise measures. Chances for more thorough reforms proposed by a growing number of economists, educators and scientists appear remote. Many experts believe that Russia's leaders will find mobilization more attractive than institutional reform, but few expect it will succeed, leaving inertia as the most likely condition. Most of the critical observers anticipate a continued slow decline, similar to what Aleksashenko (2016) foresees in the Russian economy. Few are prepared for the possibility of a sharper discontinuity. While the abrupt demise of knowledge

economy institutions remains an unusual historical phenomenon, the Russian situation does call for greater attention to possible tipping points.

Harley Balzer retired in June 2016 from his full-time positions in the Department of Government, School of Foreign Service and Department of History at Georgetown University. In 1982–1983 he served as a Congressional Fellow, with responsibilities including helping to secure passage of what is now known as Title VIII of the State Department appropriation. In 1992–1993 he served as Executive Director of the International Science Foundation, and subsequently worked with the MacArthur Foundation and Carnegie Corporation to design the Basic Research and Higher Education Program for Russia.

Addendum

This paper was completed July 25, 2016. On August 19, 2016, historian Olga Vasileva, replaced Dmitri Livanov as Minister of Education and Science. Vasileva's previous position was as Deputy Head of the Presidential Administration for Public Projects, a time when policy was curbing independent initiative by civil society. While the appointment of a social scientist has been welcomed by some observers, Vasileva's dissertation concerned Soviet policy toward the Church in 1942–1948, under Joseph Stalin. It is too early to gauge the full impact of the new leadership, but a few signs are already visible. The staff responsible for the 5/100 program, designed to elevate five Russian universities into the top 100 in global rankings, has been dismissed from the Ministry (personal communication). It may be purely coincidental that the lead article in the August issue of Russia's major higher education journal called into question global university rankings. [Vorob'ev, A. E. 2016. "Globalnyii ili natiionsl'nyi reiting–chto vuzam vybrat? (Global or national rating–which should higher education institutions choose?)," *Alma mater*, No. 8, pp. 5–11.]

Notes

1. Many of my discussions with Russian colleagues over the past several years took place prior to my being invited to participate in this project, and therefore I was not able to ask permission to cite the conversations in this paper. I have therefore refrained from identifying individuals by name.
2. One prominent economist traveled to Washington last year to participate in a small conference at AEI. Because this person did not formally apply for a *komandirovka* (business trip), even though the project was fully funded by AEI, the Director of the institute employing the individual instituted a disciplinary review and used it to limit foreign travel. This individual has been far less visible in print since these events.
3. I frequently cite the contrast between East Asia and Latin America. Countries in both regions devote about the same share of GDP to education, but reap markedly different results from the investment.
4. The interviews were conducted in the final months of 2015. Goland, Mikhail, Galina Kitova and Tatiana Kuznetsova. 2016. *Russian Science, An Insider's View* , Moscow: Higher School of Economics, February. https://www.hse.ru/en/news/science/173730621.html.

5. Accepting that a proud history and massive investment are being dissipated is not easy. In 2001, at a conference at the Carnegie Endowment to mark "ten years after" the breakup of the USSR, Loren Graham chaired a session on education, science and social issues. Murray Feshbach and I presented quite gloomy assessments of trends in Russian science, education and demography. At the end of the session, Professor Graham felt compelled to say that he could not agree with the panelists, primarily because when a nation has developed a strong system of education and scientific research, it is not likely to lose that capacity quickly. In March 2016 Professor Graham and I were invited to speak together at Wellesley College. In the course of the Q&A session, he again referred to Russia's loss of knowledge economy capacity, this time citing it as something highly unusual in world history. Professor Graham's (2013) book *Lonely Ideas* would suggest that a shift to an innovation-based economy would be a radical departure from past Russian performance. This does not mean that it cannot happen, but it remains difficult to identify any indicators of meaningful change.
6. One of the most blatant examples of the historical strength argument came at a meeting with then Director of Russian Railways Yakunin in 2011. When I asked him about Russia's capacity in S&T, his response was "We launched Sputnik."
7. An exception has been Nikolai Petrov, who has predicted dire consequences several times in the past few years. While the timing has not matched his forecasts, the social problems he identifies remain a serious concern.
8. This has been characteristic of programs for Russian S&T to 2020 and 2030, and also in discussions of the program for socio-economic development to 2035, due to be released in the summer of 2016.
9. Predicting future economic growth is never an exact science. The most recent predictions cited in the *Financial Times* put US growth at 3 percent for 2016, while China is estimated to grow at 5–6 percent. Russia and Brazil are predicted to shrink, while India should achieve reasonable growth levels.
10. When I became Executive Director of the International Science Foundation, I met with Academy Vice President Mesiats to elicit his views on how we could best organize the Foundation. He responded that "whoever pays the piper calls the tune." I replied that this might well be the case, but that the dancers are likely to dance better when they like the music. Academician Mesiats proceeded to explain that the Academy was the one institution in Russia that was not in crisis, and therefore would wait 5–10 years to see how things turned out elsewhere. Then it might consider reform. When we parted, he did offer me a Zil limousine and driver to take me back to my hotel. This meeting caused me to predict that without reform the Academy would likely shrink by 50 percent in the next decade or two. I was overly optimistic. The number has been closer to 75 percent.
11. A growing number of analysts confirm the need for a larger non-state sector. Dmitrievskii et al. (2016) make this case for the oil and gas industry. Panne and Antonenko (2014) conclude that Gazprom and Rosneft are less effective than if Russia had allowed several more agile private companies. They find essentially the same story in most sectors.
12. Avdeev lauded Russia's capacity in semi-conductors, proclaiming that despite reduced funding, "science has shown itself more than competitive at the world level." Russia ranked 12th in the world in Thomson Reuters data on semiconductors for 2011–2015, with 3,566 publications. China led the rankings with 7,121 publications, something Avdeev attributes to the "number of specialists in China." However, data show this is not

correct. The Chinese publish twice as many articles as Russians with *fewer* specialists in nanotechnology.

13. Dezhina has a negative view of the shift to university-based science. Given that Loren Graham and I were among the drivers of this policy, it is of particular interest. We were certainly correct that even in a distorted market economy, the Academy system would not be financially sustainable. But we failed to consider the heavy weight of bureaucratic oversight in the Russian system: the excessive Soviet-era teaching loads were not reduced to allow time for faculty to conduct research; older faculty (the vast majority of those still teaching) were so unused to doing research that they could not change their behavior; and salaries have not risen to a level that would attract talented younger researchers to University positions, with the exception of the (consistently declining number of) elite and well-funded institutions. Many of the best graduates continue to go abroad.
14. Dezhina attributes this to Western sanctions, but the decline in global hydrocarbon prices would also have been a factor.
15. Full disclosure requires noting that the author played a role here. After Soros chose to shut down the International Science Foundation, Balzer was one of the lead authors in the Basic Research and Higher Education (BRHE) program proposed by the MacArthur Foundation with additional support from the Carnegie Corporation. The Russian Ministry of Education and Science agreed to match the private foundation funding. Over a dozen years, the program established 16 Research and Education Centers at Russian universities. When we began discussions with Russian Ministry of Education colleagues in 1997, we were told to avoid using the term "Research University." By 2006, the Russian government devised its own program to establish research universities.
16. A study currently ongoing at the Higher School of Economics on engineering education in China and Russia found that Russian students entering higher education in technical fields were less well-qualified in basic math and physics than their Chinese counterparts. The researchers have suggested that this reflects better secondary education in China along with a far smaller portion of high-school graduates in China successfully passing the crucial entrance examinations for higher education. Russian higher education institutions enroll one of the highest proportions of secondary school graduates in the world; China—one of the lower shares among leading Knowledge economy nations. The researchers also found that Russian students manage to nearly close the gap with their Chinese counterparts by the third year of university study. This likely reflects the contradiction in the Chinese system that makes entering higher education tremendously competitive, while once enrolled a student is nearly guaranteed a diploma (graduation rates close to 99 percent). Seminar at Higher School of Economics, Moscow, June 21. 2016.
17. http://edesknews.com/golodets-two-thirds-of-russians-in-higher-education-is-not-necessary/.
18. In 2006, I interviewed a top administrator at St. Petersburg State University and asked about the placement of his students who had recently completed their Kandidat of Science dissertations. He replied that of 27 students who had defended in recent years, 24 were abroad. The others were women who had young children. When we spoke again in 2011, I asked if things had changed. His response was "slightly." The problem receded a bit during the excitement of the 2011–2012 election protests, but has become severe again with the economic crisis and Ukraine invasion.

19. An English translation by the author is available: Balzer, Harley D. 2006. Vladimir Putin's Academic Writings and Russian Natural Resource Policy, *Problems of Post-Communism*, Vol. 53, No. 1, January-February 2006, pp. 48–54.
20. The unstated implication is that if China has a population ten times the size of the Russian population, the Chinese economy would be ten times as large as Russia's.

Appendix: Data From Goland et al. Survey

1) "What do you think are the strong points of Russian science?

Long tradition of scientific activity	62.3%
Groundwork in many key disciplines	60.7%
Highly qualified personnel	52%
History of creativity among the population	47.5%
Broad network of scientific organizations	9.3%
Participation in international cooperation	14.8%
Significant government financial support	9.8%
Equipment for new and advanced research	6.6%
Other	3.3%
Wide range of support mechanisms	1.6%
Cooperation among institutes, universities & business	1.6%

2) What are the most serious problems preventing improvement in Russian science?

Aging of personnel	57.4%
Shortage of competent specialists in cutting edge research areas	52.5%
Poor integration with business	50.8%
Low prestige of scientific work	42.6%
Low domestic demand for results of research	42.6%
Low material-technical base	39.3%
Declining quality of R&D, Russian science lagging	39.3%
Brain drain	39.3%
Little attraction for private investors	36.1%
Lack of government funding	36.1%
Low participation in global science	36.1%
Insufficient influence on education programs	21.3%
Poor quality of related legislation	19.7%
Research results not competitive internationally	16.4%
Geopolitical pressure on international contacts	9.8%
Other	9.8%

3) Which of the measures recently introduced in science administration have had a positive impact?

Subsidizing collaborative university-institute projects	48.3%
Enabling universities/others to create small innovation enterprises	34.5%
Innovation development programs at state enterprises	31%
Allow transfer of IP rights to authors	31%
Establishing national research universities	29.3%
Establishing national research and government science centers	24.1%
Creating the Russian Science Foundation	22.4%
Measures to encourage young people to work in science	22.4%
Creating the Skolkovo Center	22.4%
Creating innovation infrastructure	22.4%
Mega grant program	20.7%
Establishing technology platforms	17.2%
National Technology Initiative	15.5%
Guarantees for intellectual property	15.5%
Changing the way government labs are set up for R&D	15.5%

4) Which measures have made scientific work more productive?

Large-scale government projects	50.8%
R&D support through foundations	47.5%
Closing “non-functioning” scientific institutions	37.3%
Public recognition for best scientists/scientific work	37.3%
Concentrating funding in organizations with best results	35.6%
Supporting international research projects/collaborations	35.6%
Establishing new research centers	18.6%
Other	16.9%

5) What measures are most likely to generate a breakthrough in scientific research and its applications?

Enterprise research departments	53.4%
Large government interdisciplinary research institutes	34.5%
Government scientific organizations	31%
Major integrators of multiple organizations and projects	29.3%
Higher education institutions	20.7%
Other	15.5%

6: Who should formulate commissions for science?

Government, for important socio-economic and security needs	82.5%
The business community to solve economic needs	56.9%
Science	39.7%
The public through crowdsourcing	12.1%
Other	8.6%

Bibliography

Aganbegian, A. G. 2014. "Sotsial'no-ekonomicheskoe razvitie Rossii: analiz i prognoz (Social-economic development of Russia: Analysis and forecast)," *Problemy prognozirovaniia*, No. 4, pp. 3–16.

Akindinova, N, Ia. Kuz'minov and E. Iasin. 2016. "Ekonomika Rossii: pered dolgim perekhodom (The Russian Economy: Before the long transition)," *Voprosy ekonomiki*, No. 6, pp. 5–35.

Akinfeeva, E. V. and V. I. Abramov. 2015. "Rol' naukogradov v razvitii natsional'noi innovatsionnoi sistemy Rossii (The role of science cities in development of Russia's national innovation system)," *Problemy prognozirovaniia*, No. 1, pp. 129–140.

Akvobr.ru. 2014. "*Obrazovanie–2030: Stsenarii dlia Rossii* (Education 2030: Scenarios for Russia)," Interview with Valerii Sergeevich Efimov, Director of Institute for Strategic Reseach and Design, Siberian Federal University. www.akvobr.ru/obrazovanie_2030_scenarii.html; www.akvobr.ru/obrazovanie_2030_prodolzhenie.html.

Aleksashenko, Sergei. 2016. "Is Russia's Economy Doomed to Collapse?" *The National Interest*, July 2. http://nationalinterest.org/feature/russias-economy-doomed-collapse-16821?page=show.

Analytical Center. 1993. "*Nauka Rossii segodniia i zavtra (Russian Science today and tomorrow)*," Moscow: Analiticheskii tsentr po nauchnoi i promyshlennoi politike, Ministerstvo nauki i tekhnicheskoi politiki; Gosudarstvennyi komitet popormyshlennoi politike; and Rossiiskaia Akademiia Nauk. Part I.

Balzer, Harley D. 2015a. "Will Russia Waste Another Crisis? The 2014-15 Economic Downturn and the Prospects for Russian Economic Reform," IN *Putin's Third Term: Assessments amid Crisis*, Washington, DC: Center on Global Interests, March, pp. 29–46.

Balzer, Harley D. 2015b. "The Ukraine Invasion and Public Opinion," *Georgetown Journal of International Affairs*, Vol. 16, No. 1, Winter/Spring, pp. 82–93.

Balzer, Harley D. 2011. "Russian Higher Education to 2020," *Russian Analytical Digest*, No. 95, May 30, 2011, pp. 2–5.

Balzer, Harley D. 2010. "Obucheniie innovatsiam v Rossii i v Kitai", (Learning to Innovate in Russia and China)," *Pro et Contra*, May-June pp. 52-71. English Version available as Working Paper No. 2011-17, Mortara Center for International Affairs.

Balzer, Harley D. and Jon Askonas. 2016. "The Triple Helix After Communism: Russia and China Compared," *Triple Helix Journal*, Online January.

Balzer, Harley D. and Jon Askonas. 2014. "Innovation in Russia and China Compared," *Russian*

Analytical Digest, No. 155, September 23, pp. 2-10. Available at: www.css.ethz.ch/rad.

Chulok, Aleksandr Aleksandrovich. 2014. *Osnovnye rezul'taty prognoza nauchno-tekhnologicheskogo razvitiia Rossiiskoi Federatsii na period do 2030 goda: vozmozhnosti ispol'zovaniia dlia razvitiia universitetov* (Fundamental results of predicting scientific-technical development of the Russian Federation for the period to 2030: Potentisal uses for university development) Presentation at Higher School of Economics, Moscow, February 6. PowerPoint available at: http://5top100.ru/upload/iblock/d77/d77181f78d0f73ab34f75e457bec4cac.pdf.

Chuprin, Vladimir. 2016. "Rodina znaet, no ne slyshit (The Motherland knows, but does not hear)," *Moskovskii' komsomolets*, No. 137, July 1, p. 12.

Crooks, Ed. 2016. "US shale is lowest-cost oil prospect," *Financial Times*, July 13. https://next.ft.com/content/0a7a817a-4863-11e6-8d68-72e9211e86ab.

Dezhina, Irina. 2014. *Russia's Academy of Sciences' Reform: Causes and Consequences for Russian Science*, Paris: IFRI Russia/NIS Center, Visions No. 77.

Dezhina, Irina. 2011. "Igra v kukly (Playing with Dolls)," Lecture January 27 at Polytechnical Museum, Moscow. Transcript at http://polit.ru/article/2011/03/31/dolls/.

Dezhina I. and A. Ponomarev. 2016. "Approaches to the Formulation of Russia's Technological Priorities," *Foresight and STI Governance*, vol. 10, no 1, pp. 7–15.

Dmitrievskii, A. N., N. I Komkov, M. V. Krotova, and V. S. Romanov. 2016. "Strategicheskie al'ternatrivy importozameshcheniia oborudovaniia TEK dlia neftegazovogo kompleksa (Strategic alternatives for import substitution of equipment for the Fuel-Energy Complex for the oil and gas industries)," *Problemy prognozirovaniia*, No. 1, pp. 18–35.

Efimov, Valerii Sergeevich. 2012. Buduschee bysshei shkoly v Rossie: ekspertnyi Vzgliad. Forsait-issledovanie–2030. Powerpoint presentation, Krasnoyarsk, May 25.

Fal'tsman, Vladimir. 2015a. Importozameschenie v TEK i OPK (Import Substitution in the Fuel-Energy Complex and the Defense-Industrial Complex)," *Voprosy e'konomiki*, No. 1, January, pp. 116–124.

Fal'tsman, V. K. 2015b. "Forsirovanie importozameshcheniia v novoi geopoliticheskoi obstanovke (Forcing import-substitution in new geopolitical conditions)," *Problemy prognozirovaniia*, No. 1, pp. 22–32.

Frolov. A. S. 2014. "Problemy planirovaniia nauchno-tekhnologicheskogo razvitiia na gosudarstevnnom urovne (Problems of planning scientific-technical develpment at the state level)," *Problemy prognozirovaniia*, No. 6, pp. 79–91.

Gabuev, Alexander. 2016a. *Friends with Benefits? Russia-Chinese Relations After the Ukraine Crisis*, Moscow: Carnegie Moscow Center, June.

Gabuev, Alexander. 2016b. “A Pivot to Nowhere: The Realities of Russia’s Asia Policy,” http://carnegie.ru.commentary/2016/04/22/pivot-to-nowhere-realities-of-russias-asia-policy/ixfw.

Graham, Loren R. 2013. *Lonely Ideas: Can Russia Compete?*, Cambridge: MIT Press.

Gregory, Paul R. 2004. *The Political Economy of Stalinism: Evidence from the Soviet Secret Archives,* Cambridge and New York: Cambridge University Press.

Gurtov, V. A., N. Iu. Garifullina, and S. V. Sigova. 2016. “O prognoznoi kadrovoi potrebnosti Rossiiskoi ekonomiki: kachestvennyi aspekt (Forecasting the need for personnel in the Russia economy: The qualitative aspect),” *Problemy prognozirovaniia*, No. 1, pp. 90–101.

Gwynne, Peter. 2014. “US-Russia tensions hit scientists,” Physics World, August 20. http://physicsworld.com/cws/article/news/2014/aug/20/us-russia-tensions-hit-scientists.

Hong, Sheng and Zhao Nong. 2013. *China’s State-Owned Enterprises: Nature, Performance and Reform*, Singapore: World Scientific.

Iaremenko, Iu. V. 2015. “Sovremennaia ekonomika Rossii: analiz i strategiia razvitiia (Russia’s economy today: Analysis and strategy for development),” *Problemy prognozirovaniia*, No. 5, pp. 4–10.

Ivanov, V. N., A. V. Suvorov, E. E. Balashova, and S. V. Treshchina. 2014. “Analiz dinamiki obshchestvennykh i chastnykh raskhodov na zdravokhranenie i obrazovanie v sovremennoi Rossii (Analysis of the dynamics of public and private expenditures on health and education in contemporary Russia),” *Problemy prognozirovaniia*, No. 6, pp. 31–43.

Ivanter, V. V. 2016. “Strategiia perekhoda k ekonomicheskomu rostu (Strategy for the transition to economic growth),” *Problemy prognozirovaniia*, No. 1, pp. 3–7.

Izotov, D. A. and D. V. Suslov, “Poka tol’ko namereniia: pervye itogi realizatsii programmy sotrudnichestva mezhdu vostochnymi regionami Rossii i Severo-Vostokom KNR (2009-2018gg.),” ” *EKO*, No. 3 (441) 2011, pp. 160–178.

Kamenetskii, M. N. and N. Iu. Ias’kova. 2015. “Administrativnyi resurs kak faktor povysheniia effectivnosti sistemy gosudarstvennogo upravleniia (The ace as a factor raising the effectiveness of the system of state management),” *Problemy prognozirovaniia*, No. 2, pp. 33–42.

Karaulova, Maria and Mikhail Gershman 2015. “Russia: Nanotechnology (Country Profile),” Manchester University: Manchester Institute of Innovation, Working Paper, Project on Emerging Technologies, Trajectories and Implications of Next Generation Innovation Systems Development in China and Russia, February.

Khlostova, Iana. 2016. “Nauchnaia organizatsiia ne dolzhna zhdat’, kak nevesta na vydan’e (A Scientific Organization Should Not Have to Wait Like a Bride of Marriageable Age),” Gazeta.ru,

April 13. http://www.gazeta.ru/science/2016/04/13_a_8171645.shtml.

Kirshin, I. A. 2014. “Ekologicheskie ogranicheniia sovremennogo ekonomicheskogo rosta (Ecological limitations on contemporary economic growth),” *Problemy prognozirovaniia*, No. 3, pp. 86–95.

Kokoshin, A. A. And V. I. Bartenev. 2015. “Problemy vzaimozavisimosti bezopasnosti i razvitiia v strategicheskom planirovanii v Rossiiskoi Federatsii: ot tselepolaganiia k prognozirovaniiu (Problems of interdependence of security and development in Russian Federation strategic planning from setting goals to forecasting),” *Problemy prognozirovaniia*, No. 6, pp. 6–17.

Kolesova, O. 2014. “Chemodan, vokzal . . . Reforma RAN vyzvala u molodykh zhelanie uekhat (Suitcase, Train Station . . . The Reform of the Russian Academy of Sciences Has Encouraged the Youth to Leave),” *Poisk*, No. 4–5, January 31.

Kolesova, Ol’ga, and Andrei Sobolevskii. 2016. *“Beg bosikom: Chto meshaet dvizheniiu nashei nauki* (Running barefoot: What is disturbing the activity of our science),” Poisk, No. 23, June 3, pp. 8–9.

Korovkin, A. G. 2016. “Makroekonomicheskaia otesenka sostoianiia regional’nykh rynkov truda v evropeiskoi chasti Rossiiskoi Arktiki (Macroeconomic evaluation of the regional labor markets in the European region of the Russian arctic),” *Problemy prognozirovaniia*, No. 1, pp. 74–89.

Koshovets, O. B. and N. A. Ganichev. 2015. “Eksport Rossiiakikh vooruzhenii kak osobyi faktor razvitiia vysokotekhnilogichnoi promyshlennosti Rossii (Export of Russian arms as a special factor in the development of high-technology industry in Russia),” *Problemy prognozirovaniia*, No. 2, pp. 121–134.

Kozlovskaia, O. V., E. N. Akerman and Iu. S. Burets. 2016. Malye innovatsionnye predpriatiia pri nauchnykh i obrazovatelnykh uchrezhdeniiakh v regionakh AIRR: sotsiologicheskoe issledovaniei napravleniia sovershenstvovaniia zakonodatel’stva (Small innovation firms under scientific and educational institutions in regions participating in AIRR (Association of Innovative Russian Regions):sociological research and directions for improving the legal basis),” *EKO*, No. 6, pp. 143–154.

Kuvalin, D. B. And A. K. Moiseev. 2014. “Rossiiskie predpriiatiia vesnoi 2014g: Deiatel’nost’ v usloviia zamedlenniia ekonomicheskogo rosta (Russian enterprises in the Spring of 2014: Activity in conditions of slowing economic growth),” *Problemy prognozirovaniia*, No. 6, pp. 99–114.

Makarov, I. A., Ed. 2016. *Povorot na Vostok. Razvitie Sibiri i Dal’nego Vostoka v usloviiakh usileneiia aziatskogo vektora vneshnei politiki Rossii (Pivot to the East: The Development of Siberia and* the Far East in conditions of strengthening the Asian vector of Russian foreign policy), Moscow: Mezhdunarondyi otnosheniia.

Mamonov, M. E., A. A. Pestova, E.M. Sabel'nikova, and A. Iu. Apokin. 2015. "Podkhody k otesenke faktorov proizvodstva i tekhnologicheskogo razvitiia natsional'nykh ekonomik: obzor mirovoi praktiki (Approaches to evaluating factors of productivity and technological development of national economies: a review of world practices)," *Problemy prognozirovaniia*, No. 6, pp. 45–57.

Mindeli, L.E. and S. I. Chernykh. 2016. "Finansirovanie fundamental'nykh issledovanii v Rossii: Sovremennye realii i formirovanie prognoznykh otsenok (Financing basic research in Russia: Contemporary realities and formation of evaluation prognosis)," *Problemy prognozirovaniia*, No. 3, pp. 111–131.

Panne, Ia. Sh. and N. S. Antonenko. 2014. Izmenenie sootnosheniia mezhdu chastnym i gosudarstvennyi sektorami v rossiiskom krupnom biznese v 2000-2013 gg: sub'ektnyi podkhod (Changes in the relationship between private and state sectors of Russian big business in 2000-2013: subjective approach)," *Problemy prognozirovaniia*, No. 3, pp. 32–145.

Pogosov, I. A. 2015. "Faktory dolgosrochnogo ekonomicheskogo rosta: nauchno-tekhnicheskii progress i kapitaloemkost' proizvodstva (Factors in long-term economic growth: technical progress and capital intensity of production)," *Problemy prognozirovaniia*, No. 5, pp. 11–124.

Pogosov, I. A. and E. A. Spokolovskaia. 2015. "Faktory dolgosrochnogo ekonomicheskogo rosta: sootnoshenie kapitala i truda v priroste valovogo dokhoda ekonomiki, chislennost' zaniatykh I proizvoditel'nost' truda (Factors in long-term economic growth: the relationship of capital and labor in growth of gross income in the economy, number employed and labor productivity)," *Problemy prognozirovaniia*, No. 6, pp. 31–44.

Prikhodchenko, P. 2013. "Zhalko, esli vperedi vybor–professiia ili strana (It is sad if we face a choice between a profession or a country)," Gazeta.ru, Dec. 17. www.gazeta.ru/science.2013/12/17_a_5806413.shstm.

Podorvaniuk, Nikolai. 2016. "Ran'she kitaitsy pokupali tekhnologii–seichas mozgi (The Chinese used to buy technology–Now they buy brains)," Gazeta.ru, June 6, http://www.gazeta.ru/science/2016/06/06_a_8287283.shtml.

Rossiiskaia Akademiia Nauk. 2008. *Prognoz nauchno-tekhnologicheskogo razvitiia Rossiiskoi Federatsii na dolgosrochnuiu perspektivu (do 2030g.) (Pronosis of the long-term perspective of scientific-technical development of the Russian Federation to 2030.)*
Moscow.

Sal'nikov, V. A., A. A. Gnidchenko and D. I. Galimov. 2016. "Otsenka otraslevykh effektov integratsii Rossii, Belorussii i Kazakhstana za schet proizvodvennoi kooperatsii (Evaluating the sectoral effects of integrating Russia Belarus and Kazakhstan on the basis of cooperation in production)," *Problemy prognozirovaniia*, No. 1, pp. 134–148.

Solov'ev, S. A. And S. A. Goriachev. 2016. "O programme modernizatsii inzhenerno-tekhnicheskoi sistemy APK Rossii, Belorussii i Kazakhstana (On the program for modernizing

the engineering-technical system of the agricultural-industrial comlex of Russia, Belarus and Kazakhstan)," *Problemy prognozirovaniia*, No. 3, pp. 149–54.

Suvorov, A. V., N. V. Suvorov, V. G. Grebennikov, V. N. Ivanov, and O. N. Boldo. 2015. "Otesenki dinamiki i struktury chelovecheskogo kapitala dlia Rossiiskoi ekonomiki za 1991-2012gg (Evaluation of the dynamics and structure human capital for the Russian economy, 1991-2012)," *Problemy prognozirovaniia*, No. 2, pp. 3–15.

Vernikov, A. V. 2015. "Sravnitel'nyi analiz Rossiiskoi i Kitaiskoi modeli bankovskikh sistem: piat' let spustia (Comparative analysis of the Russian and Chinese models of the banking system: Five years later)," *Problemy prognozirovaniia*, No. 2, pp. 108–120.

Yasin, E. G. 2012. "Stsenarii dlia Rossii na dolgosrochnuiu perspektivu. Novyi impul's cherez dva desiatiletiia (Long-term scenarious for Russia. New impetus after two decades)," Moscow: Higher School of Economics, Report at 13th International Conference on Problems of Economic and Social Development, April 3–5.