

A Technological Divorce: The impact of sanctions and the end of cooperation on Russia's technology and AI sector

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The economic consequences of Russia's invasion of Ukraine will take weeks, months, and probably even years to be fully revealed. But the consequences for the technology sector in general and for Russia's artificial intelligence industry are already clear. Economic sanctions imposed by the United States, the European Union, and key Asian countries such as South Korea and Japan have combined with the voluntary withdrawal of most major multinational corporations from their Russian projects due to the reputational costs of conducting business in Russia and/or cooperating with Russian partners. The withdrawal of these countries and entities will have a long-term negative impact on Russia's technology sector and AI development in particular.

This paper describes what is known about the impact of the war on Russia's technology sector one month after the start of the conflict. It shows the extent to which the sundering of ties is likely to damage Russia's technology sector, noting the impacts of the ban on exporting advanced microprocessors to Russia, restrictions on the use of Western software in Russia, and the potential for increased brain drain in Russia's IT sector. The final section turns to measures that the Russian government has announced it will take to ameliorate these impacts and analyzes the potential effectiveness of these measures.

For context, it is useful to provide a brief sketch of the Russian technology ecosystem that existed before Russia's invasion of Ukraine in February.¹ The Russian technology sector has faced significant challenges for years. These include a top-down driven system with largely government funded entities, very limited private sector initiative in technology, and significant brain drain among Russia's youth who are interested in working in the technology sector.

Russia's leadership, and Russian president Vladimir Putin in particular, understand these challenges and were taking steps to boost Russia's ability to compete internationally. These initiatives included passing legislation that would allow practical experimentation with new technologies and removing regulatory barriers, in addition to developing incentives to keep younger technology experts in Russia, educating Russia's domestic populace on the importance of modernizing Russia technologically, and increasing the number of programs in the education sphere to bring people into the technology space. Despite these initiatives, the ability of the Russian technology sector to compete in the future remained uncertain and the current reactions to Russia's invasion of Ukraine are certainly going to make this trend more negative.

The impact of international sanctions on the ICT ecosystem

The wide-ranging and comprehensive international sanctions imposed on Russia after its invasion of Ukraine are likely to have a devastating impact on its information and computing technology ecosystem and

¹ For an in-depth look at Russia's technology and artificial intelligence ecosystem, see our report, *Artificial Intelligence and Autonomy in Russia*, at <https://www.cna.org/centers/cna/sppp/rsp/russia-ai>.

its artificial intelligence sector. The EU and the United States have banned a wide range of high-tech products, including communications systems, electronic products, and semiconductors. Several Asian countries—most damagingly, Taiwan and South Korea—have also joined the sanctions regime. One estimate suggests that 50 percent of high-tech exports to Russia have been banned.²

A large number of foreign software and computer technology manufacturers, as well as internet service providers have suspended their operations in Russia as a result of either the sanctions regime or the reputational and moral costs of continuing to conduct business in Russia. In addition, the Russian media watchdog agency Roskomnadzor has, in its own turn, restricted access to a number of Western social networks. Software firms that have ended or suspended their work in Russia include Oracle, the world's largest database management developer; Autodesk, the world's largest supplier of software for construction and mechanical engineering; network equipment manufacturer Cisco Systems; and German software companies SAP and Siemens. Saber Corporation, a major supplier of software and technology for the US travel business, has terminated its distribution agreement with Aeroflot by deleting data on the Russian company's flights from its global air ticket booking system. Microsoft has temporarily stopped selling its products and services in Russia and has disabled Russian-language support for Microsoft Office in the Android mobile app. Apple and Dell have likewise stopped selling their products and services. Finally, Intel and AMD, major manufacturers of processors, have stopped shipping their products, including client, server, and graphic processors, to Russia. Even for companies that are not willing to suspend trade with Russia, deliveries of products will become much more difficult, with major logistics and transport companies such as DHL, FedEx, UPS, CMA CGM, and Kuehne+Nage all suspending deliveries in Russia.³

In the field of internet services, the Swedish audio streaming service Spotify has closed its office in Russia indefinitely, while music streaming service Deezer has decided to leave Russia permanently. The eBay marketplace has temporarily halted deliveries of orders to Russia, and online accommodation booking services Booking.com and Airbnb are no longer working with accommodation facilities in Russia. The PayPal electronic payment system has also stopped providing services in Russia, though clients will be able to withdraw funds for a certain period of time. Rockstar Games, the creators of popular video games such as Grand Theft Auto, Red Dead Redemption, and Max Payne, as well as Activision Blizzard, the creators of Call of Duty and World of Warcraft, have suspended sales of their games in Russia. Finally, the popular educational service Coursera has closed access to courses created by Russian authors and universities, and has limited access to its course offerings for users from the Russian Federation.⁴

In the realm of social networks, the Russian media watchdog Roskomnadzor has fully blocked Facebook in Russia, after 10 days of traffic slowdown. It justified the decision by referring to numerous cases of discrimination against Russian media and information resources by the social network, as well as its refusal to unblock the accounts of four Russian media organizations. Access to Twitter was also restricted according to a decision of the Prosecutor General's Office. Meanwhile, WhatsApp, Instagram, and YouTube remain accessible in Russia, although Google has announced that it will temporarily halt the sale of contextual advertising of the Google Ads service on its platforms in Russia. This restriction applies to both the search engine itself and to YouTube video hosting. Earlier, Roskomnadzor demanded that Google stop distributing

² “There is potential to minimize damage: authorities and experts on Russia's readiness for sanctions” (Потенциал для минимизации ущерба есть: власти и эксперты о готовности России к санкциям), TASS, Feb. 28, 2022, <https://tass.ru/ekonomika/13892605>.

³ “What foreign IT products and services Russia has to substitute,” TASS, Mar. 5, 2022, <https://tass.com/economy/1417381>.

⁴ “What foreign IT products and services.”

“fake information” about Russia’s military operation in Ukraine and restrict access to unreliable content, actions that Google refused to undertake.⁵

These departures from the tech sector are not limited to Western companies. Samsung, a company that has had extensive links to the Russian artificial intelligence industry, has temporarily stopped exports of its products—which range from chips to smartphones to consumer electronics—to Russia as a result of South Korea’s implementation of sanctions against Russia. For now, it is continuing to provide support services and its mobile applications continue to work on Russian territory.⁶ Most critically, the Taiwan Semiconductor Manufacturing Company (TSMC), which is the world’s largest semiconductor manufacturer, will stop supplying its products to Russia as a result of Taiwan joining the international sanctions regime. TSMC will also stop producing semiconductors developed in Russia under the Elbrus and Baikal brands.⁷ As a result, most Russian chip and server manufacturers will not be able to operate for the foreseeable future. Russia does not have domestic alternatives capable of producing semiconductors of the quality required for high-tech needs because the photolithographic equipment also has to be imported from the West and requires the transfer of technologies that are blocked by sanctions.⁸ Russia will also not be able to develop domestic alternatives, since such development would require the transfer of technologies that have been restricted by sanctions since 2013. Most alternative producers also rely on production technologies with US components, so they will not be able to fill Russia’s orders either. Even though China has made strides in developing its domestic microelectronics productions in the wake of US restrictions on Chinese producers, Chinese producers such as SMIC will be unable to substitute for TSMC in exporting high-quality microprocessors to Russia.⁹ Russian experts note that because US companies continue to cooperate with SMIC, which is also sanctioned by the US, that cooperation could potentially be restricted by the US as well because the US market may be more advantageous for the Chinese company than the Russian one.¹⁰ When the US restricted the supply of microprocessors to the Russian space sector in 2013-2014, there were hopes that either domestic or Chinese companies could fill the void.¹¹ However, as of 2021, Roskosmos is still experiencing launch cancellations due to the shortfalls in these technologies.¹²

Russia reportedly has a one-to-two-year supply of processors, according to the director of the Russian Association of Electronics Manufacturers and Developers. Limitations on the import of hard disks and

⁵ “What foreign IT products and services.”

⁶ “Suspension of Samsung supplies to Russia is temporary, says source,” TASS, Mar. 5, 2022, <https://tass.com/politics/1417211>; “Which foreign companies, brands suspended activities, supplies to Russia,” TASS, Mar. 3, 2022, <https://tass.com/politics/1416183>.

⁷ “Which foreign companies, brands suspended activities, supplies to Russia,” TASS, Mar. 3, 2022, <https://tass.com/politics/1416183>.

⁸ Nikita Korolyov, “Chip from the machine” (Чип из машины), *Kommersant*, Nov. 18, 2021, <https://www.kommersant.ru/doc/5079398>.

⁹ Katerina Terekhova and Aleksei Dertev, “Denial on development: how Russian technologies will survive without microprocessors” (Запрет на развитие: как российские технологии выживут без полупроводников), *Forbes Russia*, Mar. 4, 2022, <https://www.forbes.ru/tekhnologii/457563-zapret-na-razvitie-kak-rossijskie-tehnologii-vyzivut-bez-poluprovodnikov>.

¹⁰ Terekhova and Dertev, “Denial on development.”

¹¹ Ivan Cheberko, “USA has forbidden the supply of chips to Russian satellites” (США запретили поставку чипов для российских спутников), *Izvestiya*, Mar. 11, 2014, <https://iz.ru/news/567232>.

¹² Jake Rudnitsky, “Russian Space Chief Says U.S. Sanctions Keep Satellites Grounded,” Bloomberg, June 7, 2021, <https://www.bloomberg.com/news/articles/2021-06-07/russian-space-chief-says-u-s-sanctions-keep-satellites-grounded>.

computer memory will hit much sooner, as supplies of these components will only last for three to four months.¹³ Sanctions on microprocessors are expected to hit the Russian civilian and defense sectors much harder than sanctions on software, since the latter can be developed domestically more easily. Russian political leaders and technology companies are hoping that Western dependence on key natural components used in making microprocessors, including neon, helium, and palladium, will force them to reconsider the most damaging sanctions.¹⁴

Russian industry leaders believe they will be able to create domestic substitutes for sanctioned foreign components and finished products. Alternatively, some Russian experts believe that many sanctioned devices will be imported indirectly by Russians traveling to countries where such products may be purchased and bringing them back into Russia. Others, however, believe that such imports will remain insignificant because the country's financial problems will make them unaffordable to the vast majority of potential consumers. Instead, Russians will gradually switch to cheaper Chinese products.¹⁵ Smartphones and other high-tech consumer products may be imported from Chinese producers such as Huawei, which could replace familiar US, European, and Korean brands such as Apple, Nokia, and Samsung.¹⁶ The head of Cognitive Pilot, a company that builds AI-based autopilots for agricultural customers, believes that even neuroprocessors could be made domestically within three to four years. She believes that Russian processors of sufficiently high quality exist but are too expensive. This problem could be rectified through government subsidies. She also thinks that cooperation with foreign firms will continue through subsidiary offices registered in countries that are not subject to sanctions.¹⁷

The potential financial impact of these sanctions is variable. While some companies, such as Rostelecom, claim that their liquid assets are fully in rubles and will not be affected by limits on transactions in foreign currencies, others, such as Yandex, have already warned about the risk of default if creditors demand that they make good on their debts. Yandex currently has \$1.25 billion in loans that could be called in by foreign creditors and has stated that it does not have enough reserves to pay off this debt.¹⁸

¹³ Nikita Korolev, "Semiconductors of microelectronics" (Полупроводы микроэлектроники), *Kommersant*, Feb. 25, 2022, <https://www.kommersant.ru/doc/5230512>; "Authorities will flood developers of Russian telecom equipment with money. They promise a sharp increase in salaries" (Власти зальют деньгами разработчиков российского телеком-оборудования. Обещан резкий рост зарплат), *CNews*, Feb. 28, 2022, https://www.cnews.ru/news/top/2022-02-28_vlasti_zavaljat_dengami.

¹⁴ "President of RUSSOFT on how the ban on the import of high-tech products threatens the IT industry" (Чем грозит IT-отрасли запрет на импорт высокотехнологичной продукции – президент РУССОФТ), *D-Russia.ru*, Feb. 24, 2022, <https://d-russia.ru/chem-grozit-it-otrasli-zapret-na-import-vysokotehnologichnoj-produkcii-prezident-russoft.html>.

¹⁵ Valeriy Kodachigov, "It's about technology: Russians will not be left without iPhones and Windows" (Дело в технике: россияне не останутся без iPhone и Windows), *Izvestiya*, Mar. 5, 2022, <https://iz.ru/1301152/valerii-kodachigov/delo-v-tekhnike-rociiiane-ne-ostanutsia-bez-iphone-i-windows>.

¹⁶ "There is potential to minimize damage: authorities and experts on Russia's readiness for sanctions" (Потенциал для минимизации ущерба есть: власти и эксперты о готовности России к санкциям), *TASS*, Feb. 28, 2022, <https://tass.ru/ekonomika/13892605>.

¹⁷ "Expert: Russian manufacturers of neuroprocessors will replace foreign ones within 3-4 years" (Эксперт: российские производители нейропроцессоров заменят зарубежных в течение 3-4 лет), *TASS*, Feb. 25, 2022, <https://tass.ru/ekonomika/13866497>.

¹⁸ "Rostelecom announced its readiness for anti-Russian sanctions" («Ростелеком» заявил о готовности к антироссийским санкциям), *D-Russia.ru*, Feb. 25, 2022, <https://d-russia.ru/rostelekom-zajavil-o-gotovnosti-k-antirossijskim-sankcijam.html>; "Yandex' warns of the risk of default after the suspension of trading in its securities" ("Яндекс" предупредил о риске дефолта после приостановки торгов его бумагами), *TASS*, Mar. 4, 2022, <https://tass.ru/ekonomika/13961127>.

Breakdown of international cooperation

After many years of expanding international cooperation in the field of technology, and especially in artificial intelligence, much of this cooperation infrastructure has rapidly dissolved over the course of the conflict thus far. Russian academics in the technology sphere are particularly dependent on ties with foreign partners. For this reason, the rapid severing of links between academic institutions is likely to result in a severe negative impact on Russian technology scholarship, including artificial intelligence. A number of Western journals have announced that they are banning publication of manuscripts by scholars working at Russian institutions. Russian scholars face the prospect of being published in only domestic or Asian journals. Foreign scholars are canceling their participation in Russian conferences and are disinviting their Russian colleagues from conferences abroad. Western entities are also canceling joint projects.¹⁹ The first was MIT, which announced that it was ending its decade-long collaboration with the Skolkovo Institute of Science and Technology (Skoltech) the day after Russia's invasion of Ukraine began. The program began in 2011 and was extended in 2019 for another five years. MIT and Skoltech currently have nine joint projects, which will be either canceled or pursued separately.²⁰ In the aftermath of MIT's announcement, the leadership of Skoltech—specifically, Rector Alexander Kuleshov and Vice-Rector Keith Stevenson—put out a statement arguing that the break with MIT will not have a noticeable impact on Skolkovo's research and educational activities. At the same time, they appealed to the scientific and educational community of Russia and the world, noting that the goal of the institute is “to develop and educate a new generation of Russian and international specialists, and not be an arena of political discourse and promotion of personal ambitions.” The statement was part of an effort by Skolkovo leadership to avoid a complete breakdown in its international cooperation relationships.²¹

Most major Western technology corporations have also announced that they were ending their cooperation with Russia. For NVIDIA, this means not just that it will join AMD and Intel in stopping sales of graphics cards and microprocessors, but also that it will end its AI partnerships.²² Yandex has temporarily halted its driverless vehicle tests in Ann Arbor and will shift this program to other locations.²³ Major East Asian companies are also departing the Russian market, with Samsung leading the way. In early March, Samsung announced that it is suspending exports of all of its products to Russia, though it is not clear whether the Samsung AI Center in Moscow will close.²⁴ Analysts fear that Chinese companies such as Huawei will take Samsung's place on the Russian market, and potentially also in the AI sphere, where Huawei already has a

¹⁹ Nataliya Mikhailchenko, Denis Gritsenko, “Scientific anxiety: how researchers from the Russian Federation are ‘cut off’ from world science” (Ученая тревога: как исследователей из РФ «отрезают» от мировой науки), *Izvestiya*, Mar. 2, 2022, <https://iz.ru/1298746/nataliia-mikhailchenko-denis-gritsenko/uchenaia-trevoga-kak-issledovatelei-iz-rf-otrezaiut-ot-mirovoi-nauki>.

²⁰ Carey Goldberg and Denise Pellegrini, “MIT Cuts Ties With Russia Tech Center in Protest of Invasion,” *Bloomberg News*, Feb. 26, 2022, <https://www.bloomberg.com/news/articles/2022-02-26/mit-cuts-ties-with-russian-tech-institute-in-protest-of-invasion>.

²¹ “Skoltech said they do not want to be an arena for politics” (В Сколтехе заявили, что не хотят быть ареной политики), *RIA-Novosti*, Mar. 2, 2022, <https://ria.ru/20220302/skoltekh-1776104556.html>.

²² Maksim Grigor'ev, “NVIDIA stops all deliveries to Russia due to the invasion of Ukraine” (NVIDIA прекращает все поставки в россию из-за вторжения в Украину), *ITC.ua*, Mar. 6, 2022, <https://itc.ua/news/nvidia-prekrashhaet-vse-postavki-v-rossiyu-iz-za-vtorzheniya-v-ukrainu/>.

²³ “Yandex’ has suspended road tests of unmanned vehicles in the United States” (“Яндекс” приостановил дорожные тесты беспилотных автомобилей в США), *TASS*, Mar. 5, 2022, <https://tass.ru/ekonomika/13974137>, 5, 2022, <https://tass.ru/ekonomika/13974137>.

²⁴ Sohee Kim, “Samsung Suspends Shipments of Phones, Chips to Russia,” *Bloomberg News*, Mar. 4, 2022, <https://www.bloomberg.com/news/articles/2022-03-04/samsung-suspends-shipments-of-phones-chips-to-russia>.

significant presence in Russia.²⁵ The Japanese government, like the governments of South Korea and Taiwan, has also decided to cut off exports of high-tech products and specifically semiconductors to Russia. Although Russia imports approximately 70 percent of its semiconductors from China, these are largely less advanced types that will work for appliances and cars but not for advanced weapons systems, cloud computing, or advanced data applications such as artificial intelligence and robotics.²⁶

China, on the other hand, plans to continue to cooperate with Russia in the IT sphere. Wang Jianwei, deputy head of the Information Technology Development Department of the Ministry of Industry and Informatization of the People's Republic of China, recently spoke at the Krasnoyarsk Economic Forum, indicating that China will continue cooperation with Russia in the field of information technology. He said that China was looking to strengthen cooperation with Russia in areas such as big data and cloud technologies and is ready to work together on standards for informatization of industries and the creation of common internet platforms.²⁷ Russia is hoping that other non-Western countries will also continue to cooperate with Russia in technology. To this end, it recently announced that the 13th International IT Forum will take place in Khanty-Mansiysk and virtually from June 7 to 9, with the participation of official representatives and members of the business and expert communities from the BRICS and SCO countries.²⁸

Governance and legal developments

The Russian government has responded to sanctions and the break in cooperation by announcing various efforts to support Russia's domestic IT industry. In the short term, the government is taking immediate measures to save Russian companies suffering from sanctions. Prime Minister Mishustin has announced that the Ministry of Finance will spend one trillion rubles to buy stocks in Russian companies, while temporarily prohibiting foreign investors from selling their Russian shares.²⁹ According to Vice-premier Andrey Belousov, the Russian government has prepared three scenarios for interactions with foreign partners, depending on their positions. The first scenario is that the company would remain in Russia, in which case the Russian government would attempt to provide it with all the necessary resources and materials for it to continue conducting its business. A second scenario would involve the company's temporary departure, with the foreign stockholders' shares being transferred for the time being to the control of Russian partners. This scenario would allow the company to return to Russian markets in the future. The third scenario would occur in cases where the foreign company wanted to close its facilities and lay off workers. This would be considered deliberate bankruptcy. The Russian government would get

²⁵ "Samsung facing risk of giving its Russian market share to Chinese firms, says expert," TASS, Mar. 5, 2022, <https://tass.com/economy/1417345>.

²⁶ Sebastian Moss, "US, Japan, Taiwan impose sanctions, restrict sales of semiconductors and telco equipment to Russia," Feb. 25, 2022, <https://www.datacenterdynamics.com/en/news/us-japan-taiwan-impose-sanctions-restrict-sales-of-semiconductors-and-telco-equipment-to-russia/>; "Japan plans to limit the export of advanced technologies to Russia within the framework of sanctions," (Япония в рамках санкций планирует ограничить экспорт в РФ передовых технологий), TASS, Feb. 21, 2022, <https://tass.ru/ekonomika/13795839>.

²⁷ "China plans to continue cooperation with Russia in the IT field" (Китай планирует продолжить сотрудничество с Россией в IT-сфере), TASS, Mar. 3, 2022, <https://tass.ru/ekonomika/13945187>.

²⁸ "International delegations will visit the IT forum in Khanty-Mansiysk" (Международные делегации посетят IT-форум в Ханты-Мансийске), TASS, Mar. 17, 2022, <https://tass.ru/obschestvo/14106395>.

²⁹ "The government will allocate a trillion rubles for the purchase of shares of Russian companies" (Правительство выделит триллион рублей на покупку акций российских компаний), RIA-Novosti, Mar. 1, 2022, <https://ria.ru/20220301/sanktsii-1775843804.html>.

involved to ensure that the business would continue to function so as to maintain continued employment of its citizens.³⁰

For the longer term, Russian president Vladimir Putin signed a decree on measures to accelerate the development of the IT industry in the country. These measures will simplify the procedure for companies to employ foreigners and to obtain a residence permit for them. It will also provide a number of benefits for domestic IT companies, such as a three-year exemption from inspections and paying income tax, as well as discounts on loan rates. Employees of such firms will also be able to obtain preferential mortgage rates and will be exempt from military conscription for the duration of their employment.³¹ The goal is to reduce the flight of Russian IT specialists abroad, a trend that has rapidly picked up speed. Russian specialists have set up channels on Telegram to exchange information on how to depart, with 5,000 people expressing interest in emigrating to places such as the United States, Turkey, Georgia, Cyprus, Lithuania, and Montenegro.³² Some IT software and hardware companies are already raising salaries, using funds from government subsidies in order to retain workers and prevent brain drain.

Mishustin also announced that import substitution will become the main focus of the government's economic policy, with an emphasis on accelerating the transition of the Russian economy from natural resource extraction to high-tech production.³³ According to Russian presidential spokesman Dmitry Peskov, these measures will restore rapid economic growth, encouraging international companies to "return to the [Russian] market again and [they] will be more than eager in catching up and reclaiming their positions."³⁴

As for the technology field specifically, the Ministry of Digital Development, Communications and Mass Media announced that it will take measures to encourage Russian businesses and individuals to shift to Russian software. These measures will include lower insurance tariffs and no taxes on profits.³⁵ Maksut Shadaev, the head of the ministry, drafted a letter to the ministry's employees laying out three primary goals for dealing with the crisis facing Russia's IT industry: increasing financing for Russian developers to produce domestic analogs of software that was previously purchased abroad; encouraging large Russian companies to buy software from Russian developers; and changing regulations to remove all administrative

³⁰ "The Cabinet of Ministers has prepared three options for relations with foreign companies when they leave the Russian Federation" (Кабмин подготовил три варианта взаимоотношений с зарубежными компаниями при их уходе из РФ), TASS, Mar. 4, 2022, <https://tass.ru/ekonomika/13960189>.

³¹ "What foreign IT products and services Russia has to substitute," TASS, Mar. 5, 2022, <https://tass.com/economy/1417381>.

³² Tatiana Isakova, Nikita Korolev, "Programmers will not be demobilized: the Ministry of Digital Development wants to stop the flight of IT specialists from Russia" (Программистам не светит дембель: Минцифры хочет остановить бегство IT-специалистов из России), *Kommersant*, Mar. 1, 2022, <https://www.kommersant.ru/doc/5238127>.

³³ "Mikhail Mishustin: "Import substitution should become the main focus of our activity" (Михаил Мишустин: «Импортозамещение должно стать основным направлением нашей деятельности»), D-Russia.ru, Mar. 1, 2022, <https://d-russia.ru/mihail-mishustin-importozameshhenie-dolzno-stat-osnovnym-napravleniem-nashej-deyatelnosti.html>.

³⁴ "Current situation will turn into rapid economic growth — Kremlin," TASS, Mar. 5, 2022, <https://tass.com/economy/1417333>.

³⁵ "Digital Ministry calls for stimulating the transition to domestic software" (Минцифры выступило за стимулирование перехода на отечественное ПО), *Izvestiya*, Mar. 5, 2022, <https://iz.ru/1301087/2022-03-05/mintcifry-vystupilo-za-stimulirovanie-perekhoda-na-otechestvennoe-po>.

barriers to working in the new environment.³⁶ The government announced that it will provide 1.9 billion rubles in credits to support companies in the field of artificial intelligence. An additional 1.5 billion rubles will go to support research centers in artificial intelligence, and 1.7 billion rubles to support companies that purchase domestic AI pilot products.³⁷

There is also a plan to create a domestic repository for open source software, analogous to the international GitHub repository. This is critical because Russian developers fear that they will lose access to GitHub, which would have a serious negative impact on efforts at import substitution in the software field. At the same time, experts in the field believe that it will be very difficult to create sufficiently good analogs for Western software even with access to open source repositories, especially since many state corporations use specialized modified software that is based on Western core products.³⁸

Conclusion

This paper has shown that the break in international cooperation in Russia's high-tech and artificial intelligence sectors that has resulted from Russia's invasion of Ukraine is far reaching and likely to be long lasting. Its most significant consequences include restrictions on the import of high-quality semiconductors and the use of Western software in Russia. In addition, the break in academic cooperation and the departure of many Russian IT specialists for foreign destinations is likely to slow intellectual advances in the technology sphere for years to come even if sanctions are lifted or import substitution measures bear fruit to some extent. While the Russian government is taking a number of actions to reduce the impact of the break in cooperation, these measures are unlikely to have a major impact on the worst consequences of Russia's sudden technological isolation.

³⁶ Kristina Kholupova, "The head of the Ministry of Digital Development wrote an 'uplifting' letter to his subordinates with new measures to save the IT industry," (Глава Минцифры написал подчиненным «духподъемное» письмо с новыми мерами спасения ИТ-отрасли), CNews, Mar. 7, 2022, https://www.cnews.ru/news/top/2022-03-07_glava_mintsifry_dlya_borby.

³⁷ "Enterprises in the field of artificial intelligence in 2022 will receive almost 2 billion rubles in grants." (Предприятия сферы искусственного интеллекта в 2022 г. получают почти 2 млрд рублей грантов), TASS, Mar. 3, 2022, <https://tass.ru/ekonomika/13959441>.

³⁸ Tatiana Isakova, Nikita Korolev, "Programmers will not be demobilized: the Ministry of Digital Development wants to stop the flight of IT specialists from Russia" (Программистам не светит дембель: Минцифры хочет остановить бегство ИТ-специалистов из России), *Kommersant*, Mar. 1, 2022, <https://www.kommersant.ru/doc/5238127>.

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