



# US Technology Policy Amid Rivalry With China

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# Introduction

Today, a new technological paradigm is emerging, shaped by artificial intelligence (AI), the Internet of Things, robotics, cloud technology, supercomputing systems, and various advanced forms of technology capable of automating numerous processes, boosting productivity, and creating fundamentally new products. Similar to past industrial revolutions that introduced labour saving appliances and widespread use of electric power and IT, the fourth industrial revolution (Industry 4.0) is poised to exert a profound influence on various social processes. The leader in this technological revolution will wield significant influence in global politics and the economy.

Not too long ago, a new industrial and innovation-driven powerhouse emerged on the technological map of the world. Now, China has started to challenge the technological dominance of the United States and is determined to vie for leadership in the technological race. Throughout history, each industrial revolution unfolded amid serious political tensions between competing entities, and Industry 4.0 is no exception.

Despite the unprecedented interdependence and interconnectedness of the world, the latest twist in the technological revolution has witnessed a decoupling between the United States and China. This separation is adversely affecting the entire global technological network that has been painstakingly built over the past several decades. In essence, the process of rupturing established production ties, reducing bilateral investments in high-tech manufacturing industries, and scaling back joint research activities was launched. The once-symbiotic project titled “Chimerica,” discussed by historian Niall Ferguson and economist Moritz Schularick in 2007, has begun to face serious difficulties.<sup>1</sup> Technonationalism<sup>2</sup> is resurging, and the contours of the techno-economic blocs are becoming increasingly discernible.

The technological war between the United States and China, unleashed at the peak of their interdependence, can be attributed to several underlying reasons.

**First**, the United States expected that it would be able to easily control its “junior partner.”<sup>3</sup> However, this failed to materialise, and its partner evolved to become a serious economic competitor and a strategic rival. A number of Chinese-made high-tech products became highly competitive on the international market, which, of course, the US did not like. The United States outright accuses China of capitalising on the openness of the global economy while restricting access to its domestic market. This increases the world’s dependence on China while reducing China’s dependence on the outside world.<sup>4</sup>

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<sup>1</sup> Ferguson N., Schularick M. ‘Chimerica’ and the Global Asset Market Boom // International Finance. Volume10, Issue3. Winter 2007. Pp. 215-239. URL: <https://onlinelibrary.wiley.com/doi/epdf/10.1111/j.1468-2362.2007.00210.x>

<sup>2</sup> Данилин И. Американо-китайская технологическая война через призму технонационализма // Пути к миру и безопасности. 2021. № 1(60). С.29-43.

<sup>3</sup> Заккрытие Чимерики // Коммерсантъ. 05.11.2018. URL: <https://www.kommersant.ru/doc/3786795>

<sup>4</sup> National Security Strategy // The White House. October 2022. URL: <https://www.whitehouse.gov/wp-content/uploads/2022/11/8-November-Combined-PDF-for-Upload.pdf>

**Second**, China's significant progress in high-tech industries has sparked serious concerns among US leadership regarding the integration of innovative technology into China's military capabilities. This makes it clear why the conflict was initiated by the US. Perceiving that its technological gap is critically narrowing between itself and China, the United States sought to prevent China from gaining any economic or military edge, however big or small

The goal of the United States is to to restrain the technological advancement of its primary competitor in the hi-tech industry, particularly since technology factor literally permeates the ongoing geopolitical standoff between the two countries.<sup>5</sup> The 2022 US National Security Strategy states that "technology is central to today's geopolitical competition and to the future of our national security, economy and democracy."<sup>6</sup>

As things stand, the United States maintains its lead in the technological race being at the pinnacle of competencies, technologies, and assets. However, the US needs to secure an undisputable victory over its primary geopolitical rival.<sup>7</sup> Washington sees the solution to this challenge in bolstering its own technological potential and restructuring global production chains to circumvent mainland China, applying sanction pressure, and consolidating alliances with its closest partners, primarily the EU, Japan, and South Korea, as well as with the Chinese province of Taiwan which is referred to as the "global strategic hub for next-generation technology."<sup>8</sup>

This report analyses the potential of the US technological platform, the specifics and problems of the current US technology policy,<sup>9</sup> Washington's strategies in dealing with its Chinese competitor, the risks associated with technological decoupling from China, and autonomy-related limitations of emerging techno-economic blocs. The following focuses on the hi-tech industry, encompassing AI, cloud technology, supercomputers, quantum computing, and microelectronics, to compare the respective

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<sup>5</sup> Сучков М. «Геополитика технологий»: международные отношения в эпоху Четвёртой промышленной революции. Санкт-Петербургский государственный университет, 2022. Вестник СПбГУ. Международные отношения. 2022. Т. 15. Вып. 2. С. 138-157. URL: <https://irjournal.spbu.ru/article/view/14022/9446>

<sup>6</sup> National Security Strategy // The White House. October 2022. URL: <https://www.whitehouse.gov/wp-content/uploads/2022/10/Biden-Harris-Administrations-National-Security-Strategy-10.2022.pdf>

<sup>7</sup> The Current State of U.S.-China Chip Competition // The Diplomat. 6.04.2023. URL: <https://thediplomat.com/2023/04/the-current-state-of-u-s-china-chip-competition/>

<sup>8</sup> Taiwan produces over 90 percent of the world's most advanced microchips. See: Chip Makers Turn Cutthroat in Fight for Share of Federal Money // The New York Times. 23.02.2023. URL: <https://www.nytimes.com/2023/02/23/business/economy/chip-makers-fight-federal-money.html>

<sup>9</sup> In this paper, the term "technology policy" is defined as intervention of the state in the technology sector of the economy to create a competitive advantage and improve the overall innovation capability of a country by supporting, improving and developing technology. Technology policy tools may include subsidizing R&D, providing financial assistance to private companies, for example, in order to expand their production capacity, providing tax breaks, regulating foreign direct investment, imposing export controls on certain products, establishing technological alliances with other countries, and more.

technological potential of both the US and China. It is worth noting that sectors such as biotechnology, the aerospace industry, the defence industry, and electric transport merit separate study and fall beyond the scope of this analysis.

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## Current Technological Achievements of the United States: An Overview of Key High-Tech Areas

As of today, the United States maintains its position at the forefront of the technological race. The country has a longstanding strength in research, development, design, and marketing, consistently ranking among the most innovation-driven nations globally.<sup>10</sup> It remains the world leader in R&D spending, which reached \$679.4 billion in 2022.<sup>11</sup> Notably, there is positive momentum in the proportion of R&D spending to GDP, increasing from 2.79 percent in 2016<sup>12</sup> to 3.40 percent in 2021.<sup>13</sup> The private sector, which is responsible for a significant proportion of experimental developments (72 percent), over half of applied research, and a substantial and growing share of fundamental research, stands as the primary sponsor of research and development in the United States.<sup>14</sup>

Let's delve into some segments of the IT industry where the United States demonstrates high performance.

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<sup>10</sup> In the Global Innovation Index 2022 rankings, the US ranks 2<sup>nd</sup> after Switzerland See: Глобальный инновационный индекс, 2022. URL: <https://globalstocks.ru/wp-content/uploads/2022/10/wipo-pub-2000-2022-exec-ru-global-innovation-index-2022-15th-edition.pdf>

<sup>11</sup> Gross expenditure on research and development (GERD) in the United States from 2020 to 2022 // Statista. URL: <https://www.statista.com/statistics/1345767/gross-research-development-expenditure-us/#:~:text=The%20gross%20expenditure%20of%20the,year%20%2D%20643.8%20billion%20U.S.%20dollars>

<sup>12</sup> Boroush M., Guci L. Research and Development: U.S. Trends and International Comparisons // NSF. 28.04.2022. URL: <https://nces.nsf.gov/pubs/nsb20225>

<sup>13</sup> Federally Funded R&D Declines as a Share of GDP and Total R&D // NSF. URL: <https://nces.nsf.gov/pubs/nsf23339#:~:text=The%20ratio%20of%20U.S.%20research,funding%20sources%20for%20domestic%20R%26D>.

<sup>14</sup> Boroush M., Guci L. Research and Development: U.S. Trends and International Comparisons // NSF. 28.04.2022. URL: <https://nces.nsf.gov/pubs/nsb20225>

## Artificial Intelligence

US authorities believe that dominance in AI technology will be crucial for the global military and economic competition.<sup>15</sup> The greatest achievements in AI primarily come from US tech giants such as Google and Microsoft, positioning them at the forefront of AI research and development.<sup>16</sup> Significant progress has been achieved in generative AI, exemplified by OpenAI's ChatGPT. Moreover, the United States has surpassed other countries in both the number of companies (as of 2020, US companies accounted for approximately 38 percent of global AI development companies) and corporate investment (from 2013 to 2021, US companies invested \$149 billion in AI development). Additionally, venture capital in this field reached \$42 billion in 2020, constituting 57 percent of the global total. Furthermore, the United States maintains a leading role in the quality of collected data, a critically important factor for refining AI algorithms, thanks to the well-structured and diverse data obtained through Western digital platforms with wide geographic coverage.<sup>17</sup>

## Microelectronics

America holds leading positions in key segments of the microelectronics industry, such as R&D, design, and manufacturing processes. Currently, US-based firms command the largest share of the semiconductor market, accounting for 46.3 percent.<sup>18</sup> Intel and AMD play pivotal roles in the global processor market, with market shares of 70.77 and 19.84 percent, respectively, as of the end of 2022. Nvidia dominates the graphics processing units (GPUs), with an 88 percent share of the global market as of the third quarter of 2022.<sup>19</sup> Additionally, according to Fubon Securities Investment Services, Nvidia's market share in the Chinese market is estimated at almost 95 percent.<sup>20</sup> Based on 2019

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<sup>15</sup> Allen G.C. Choking off China's Access to the Future of AI // CSIS. 11.10.2022. URL: <https://www.csis.org/analysis/choking-chinas-access-future-ai>

<sup>16</sup> Какие страны лидируют в гонке ИИ? // InvestGlass. 6.02.2023. URL: <https://www.investglass.com/ru/which-countries-are-leading-the-ai-race/>

<sup>17</sup> Матвеев К. Искусственный интеллект с китайской спецификой: станет ли Китай мировым лидером в сфере ИИ к 2030 году? // РСМД. 21.06.2022. URL: <https://russiancouncil.ru/analytics-and-comments/analytics/iskusstvennyy-intellekt-s-kitayskoy-spetsifikoy-stanet-li-kitay-mirovym/>

<sup>18</sup> SIA Factbook 2022 // SIA. URL: [https://www.semiconductors.org/wp-content/uploads/2022/05/SIA-2022-Factbook\\_May-2022.pdf](https://www.semiconductors.org/wp-content/uploads/2022/05/SIA-2022-Factbook_May-2022.pdf)

<sup>19</sup> NVIDIA захватила ещё большую долю рынка дискретной графики – на двоих у Intel и AMD осталось 12% // 3DNews. 24.11.2022. URL: <https://3dnews.ru/1077895/nvidia-pochti-polnostyu-zahvatila-rinok-diskretnoy-grafiki-na-dvoih-intel-i-amd-ostalos-12->

<sup>20</sup> US Deals Heavy Blow to China Tech Ambitions With Nvidia Chip Ban // Bloomberg. 2.09.2022. URL: <https://www.bloomberg.com/news/articles/2022-09-02/us-deals-heavy-blow-to-china-tech-ambitions-with-nvidia-chip-ban>



data, US companies like Intel, Micron,<sup>21</sup> Qualcomm, Broadcom, and Texas Instruments, are among the top 10 most profitable semiconductor companies.<sup>22</sup>

US companies play a crucial role in developing Electronic Design Automation, (EDA), software enabling the creation of complex chip designs.<sup>23</sup> All three leading global EDA companies (Mentor Graphics, Cadence Design Systems, and Synopsys) are headquartered in the United States, with the majority of their employees based there as well.<sup>24</sup> According to experts, Chinese software, led by Empyrean Technology in the development of Chinese EDA solutions, has so far been unable to compete successfully because it is not ready to develop next-generation solutions.<sup>25</sup>

Moreover, the United States holds strong positions in the production of advanced semiconductor equipment. Key players in this field include Lam Research (specialising in etching and deposition), Applied Materials (involved in all stages of production), and KLA Corporation (focused on production control and metrology).

## Cloud Technology

US companies are the largest providers of cloud services globally, including computing, data storage, data analysis, machine learning, and more. As of 2023, Amazon Web Services (AWS) is the most comprehensive and widely used cloud computing platform, with a 34 percent share of the global market. AWS offers over 175 fully functional services, serving clients in 190 countries. Following AWS, other key players in global cloud service market include Microsoft Azure (21 percent), Google Cloud

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<sup>21</sup> In 2022, Microsoft announced it was ready to begin mass production of DRAM RAM chips using the “world’s most advanced” process for these products 10 nm or 1β (1-beta). See: Микрон бросила вызов законам физики в техпроцессе 1β для DRAM +35 % к плотности и +15 % к энергоэффективности без EUV // 3DNews. 1.11.2022. URL: <https://3dnews.ru/1076706/micron-brosila-vizov-zakonam-fiziki-v-novom-tehprotsesse1-dlya-dram-35-k-plotnosti-i-15-k-energoeffektivnosti>

<sup>22</sup> Кто есть кто в мировой микроэлектронике // Хабр. 4.02.2020. URL: <https://habr.com/ru/articles/486326/>

<sup>23</sup> The US accounts for about 60 percent of the global sales of chip design companies. See: SIA Factbook 2021 // SIA. URL: <https://www.semiconductors.org/wp-content/uploads/2021/05/2021-SIA-Factbook-FINAL1.pdf>

<sup>24</sup> Allen G. C. Choking off China’s Access to the Future of AI // CSIS. 11.10.2022. URL: <https://www.csis.org/analysis/choking-chinas-access-future-ai>

<sup>25</sup> США поставили подножку китайской полупроводниковой промышленности: у Китая нет замены американскому софту // 3DNews. 15.08.2022. URL: <https://3dnews.ru/1072168/noviy-zapret-ssha-na-rasprostranenie-edasofta-negativno-skagetsya-na-vozmognosti-kitaya-razrabativat-sovremennie-mikroshemi>

(11 percent), IBM Cloud (3 percent), Salesforce (3 percent), Oracle Cloud (2 percent), and Dell Technologies Cloud (2 percent).<sup>26</sup>

In contrast, major Chinese cloud services providers, namely Huawei Cloud, Tencent Cloud, and Alibaba Cloud, appear more modest and collectively hold only 9 percent of the global market.<sup>27</sup>

## Supercomputers

The availability of high-performance computing systems, commonly known as supercomputers, is a crucial indicator of progress in advanced technology. These machines are used for real-time processing of big data and for research in various fields such as meteorology, physics, cryptography, artificial intelligence, and more.

Officially, the United States holds the lead in the race to develop the most powerful supercomputers. The Frontier HPE Cray EX surpassed its Japanese competitor, Fugaku (Fujitsu), in the 2022 Top500 supercomputer rankings, and maintained its dominance in 2023. An American machine powered by AMD processors and accelerators achieved the historic milestone of 1 exaflop (1 quintillion operations per second). The Frontier's performance stands at nearly 1.2 exaflops.

All other systems lag significantly behind, with Fugaku's performance being almost one-third of that of Frontier.<sup>28</sup> Chinese supercomputers Sunway Taihu Light and Tianhe-2A ranked 7 and 10, respectively, in the 2023 Top500 rankings.<sup>29</sup>

## Quantum Computing

The United States leads in quantum computing research and development,<sup>30</sup> with major contributions from industry leaders such as

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<sup>26</sup> Top 10 biggest cloud providers in the world in 2023 // Technology. 15.02.2023. URL: <https://technologymagazine.com/top10/top-10-biggest-cloud-providers-in-the-world-in-2023>

<sup>27</sup> Top 10 biggest cloud providers in the world in 2023 // Technology. 15.02.2023. URL: <https://technologymagazine.com/top10/top-10-biggest-cloud-providers-in-the-world-in-2023>

<sup>28</sup> Эксафлопс покорился пока только AMD. Суперкомпьютер Frontier остаётся недостижимым лидером в новом списке Top500 // ixbt.com. 22.05.2022. URL: <https://www.ixbt.com/news/2023/05/22/c-amd-frontier-top500.html>

<sup>29</sup> Top500. June. 2023. URL: <https://www.top500.org/lists/top500/2023/06/>

<sup>30</sup> Schmidt E. Innovation Power. Why Technology Will Define the Future of Geopolitics // Foreign Affairs. Vol 102, №2, 2023. URL: <https://www.foreignaffairs.com/issues/2023/102/2>

IBM, Microsoft, Intel, Amazon, and Alphabet.<sup>31</sup> Regular reports highlight the US companies' latest successes in this field. Notably, IBM made a significant breakthrough in 2023, addressing errors in quantum processors, as reported in the June issue of the *Nature* journal.<sup>32</sup> Also in June 2023, Microsoft announced its plan to build a quantum supercomputer within the next 10 years that will be capable of performing 1 million quantum operations per second.<sup>33</sup>

From 2011 to 2020, the United States produced the largest number of publications on quantum computing globally. The US companies engaged in quantum computing enjoy a substantial funding advantage, estimated to be 30 times greater than their privately-owned Chinese competitors.<sup>34</sup>

However, China's reports on overall government funding for research and development in quantum technology are highly contradictory, making it difficult to determine the actual amount of China's government funding, which may already exceed that of the United States.<sup>35</sup>

The US government aims to maintain the country's leadership in quantum computing primarily due to its potential military applications, such as communication security and, hypothetically, breaking encryptions. Moreover, recognising the potential of quantum technology and potential threats from competitors, the Biden administration issued a memorandum on national security in May 2022, requiring federal agencies to transition to post-quantum cryptography by 2035.<sup>36</sup> Implementing new encryption standards with quantum protection is expected to take more than 10 years and cost tens of billions of dollars.<sup>37</sup>

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<sup>31</sup> Witt S. The World-Changing Race to Develop the Quantum Computer // *The New Yorker*. 12.12.2022. URL: <https://www.newyorker.com/magazine/2022/12/19/the-world-changing-race-to-develop-the-quantum-computer>

<sup>32</sup> Quantum Computing Advance Begins New Era, IBM Says // *The New York Times*. 14.07.2023. URL: <https://www.nytimes.com/2023/06/14/science/ibm-quantum-computing.html>

<sup>33</sup> Microsoft пообещала создать квантовый суперкомпьютер через 10 лет // *D-Russia.ru*. 22.06.2023. URL: <https://d-russia.ru/microsoft-poobeshhala-sozdat-kvantovyyj-superkompjuter-cherez-10-let.html>

<sup>34</sup> The U.S. Wants to Make Sure China Can't Catch Up on Quantum Computing // *FP*. 31.03.2023. URL: <https://foreignpolicy.com/2023/03/31/us-china-competition-quantum-computing/>

<sup>35</sup> An Assessment of the U.S. and Chinese Industrial Bases in Quantum Technology // *RAND Corporation*. 2022. URL: [https://www.rand.org/pubs/research\\_reports/RRA869-1.html](https://www.rand.org/pubs/research_reports/RRA869-1.html)

<sup>36</sup> The U.S. Wants to Make Sure China Can't Catch Up on Quantum Computing // *FP*. 31.03.2023. URL: <https://foreignpolicy.com/2023/03/31/us-china-competition-quantum-computing/>

<sup>37</sup> Witt S. The World-Changing Race to Develop the Quantum Computer // *The New Yorker*. 12.12.2022. URL: <https://www.newyorker.com/magazine/2022/12/19/the-world-changing-race-to-develop-the-quantum-computer>

## Advantages

One of the main advantages of the United States is its immense gravitational pull for talent from around the world, attracting engineers, scientists, and entrepreneurs. For instance, approximately 77 percent of international students who completed their studies at American universities from 2000 to 2015 chose to stay and work in the United States. This figure rises to almost 90 percent for Chinese students who opted to stay in America.<sup>38</sup> Interestingly, between 40 and 60 percent of technology companies were founded by first or second-generation immigrants. Examples include Apple's Steve Jobs, whose father is from Syria, Google with Sergey Brin from Russia, Tesla with Elon Musk from South Africa, and Nvidia's Jensen Huang from Taiwan. This concentration of talent and innovators enables the United States to actively engage in R&D in high-tech industries and successfully commercialise promising innovations.

Another advantage lies in the fact that most countries depend on US technology, which is used around the world and is present in various hi-tech sectors in the form of US intellectual property, components, equipment, and software. This provides Washington with additional control and leverage through sanctions.<sup>39</sup>

Lastly, in the context of the technological race, the well-established coordination with allies such as the Netherlands, Japan, and others is a bonus for the United States. China primarily tackles its technological challenges on its own.

However, despite all technological successes and power, there is no reason to assume that US superiority is something that will last forever, especially as China is already winning some key technological battles.

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<sup>38</sup> Матвеенков К. Искусственный интеллект с китайской спецификой: станет ли Китай мировым лидером в сфере ИИ к 2030 году? // РСМД. 21.06.2022. URL: <https://russiancouncil.ru/analytics-and-comments/analytics/iskusstvennyy-intellekt-s-kitayskoy-spetsifikoy-stanet-li-kitay-mirovym/>

<sup>39</sup> Allen G. C. Choking off China's Access to the Future of AI // CSIS. 11.10.2022. URL: <https://www.csis.org/analysis/choking-chinas-access-future-ai>

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# China's Advanced Technology Challenge to the United States

Today, China is the main and sole rival of the United States that is eroding US technological hegemony, and this process is advancing at a fairly rapid pace.

According to Professor Barry Naughton of the University of California, China's industrial policy after 1978, "evolved from inconsistent planning to broad techno-industrial goals and then focused on industry-specific policies."<sup>40</sup> The transition from an economy based on cheap labour to an innovation-driven model in the early 2000s was designated as one of the country's priority development areas.

The launch of the Made in China 2025 strategy in 2015, which was aimed at augmenting the national economy on the basis of domestic innovation, reducing dependence on foreign technology and investment, and strengthening the country's position as a global leader in high-tech industries, was a pivotal event in China's technology policy.<sup>41</sup> In March 2021, the National People's Congress of China approved the 14<sup>th</sup> Five-Year Plan, covering the 2021-2025 period. It outlined several key areas that China seeks to develop, such as next-generation AI, quantum information, and semiconductors.<sup>42</sup>

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<sup>40</sup> Barry N. The Rise of China's industrial policy 1978 to 2020 // Universidad Nacional Autónoma de México. 2021. URL: [https://dusselpeters.com/CECHIMEX/Naughton2021\\_Industrial\\_Policy\\_in\\_China\\_CECHIMEX.pdf](https://dusselpeters.com/CECHIMEX/Naughton2021_Industrial_Policy_in_China_CECHIMEX.pdf)

<sup>41</sup> Перская В., Ревенко Н. «Сделано в Китае 2025»: китайский опыт обеспечения задач национального развития // Азия и Африка сегодня. 2020. № 7. С. 19-25.

<sup>42</sup> Глобальный политический обзор. Ключевые изменения в государственной политике во всем мире // Covington. 6.04.2021. URL: <https://www.globalpolicywatch.com/2021/04/chinas-14th-five-year-plan-2021-2025-signposts-for-doing-business-in-china/>

The Chinese government is investing heavily in science, technology, and innovation and promoting the development of the high-tech sector.<sup>43</sup> As a result, according to experts from The Information Technology and Innovation Foundation (ITIF), China has surpassed the United States in the overall volume of innovation. However, experts note that most of these innovations are of an imitative rather than a cutting-edge nature.<sup>44</sup>

In a relatively short period, Chinese companies have transitioned from assembling foreign components to manufacturing their own advanced products in the production of most industrial goods, moving China's position along the value chain significantly. Along with its domination in the production of equipment for renewable energy sources,<sup>45</sup> high-capacity batteries for electric vehicles,<sup>46</sup> and 5G networks,<sup>47</sup> China has demonstrated its capabilities in high-tech fields such as artificial intelligence and quantum communications.

## Artificial Intelligence

In 2017, Beijing announced plans to become the global AI leader by 2030. China is already ahead of the curve in the field of AI-based surveillance technology and the creation of e-commerce algorithms.<sup>48</sup> Not

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<sup>43</sup> Схватка за чипы: чем грозит борьба между США и Китаем за технологическое лидерство // Forbes. 30.04.2023. URL: <https://www.forbes.ru/tekhnologii/488480-shvatka-za-cipy-chem-grozit-bor-ba-mezdu-ssa-i-kitaem-za-tehnologiceskoe-liderstvo>

<sup>44</sup> Clay I., Atkinson R. D. Wake Up, America: China Is Overtaking the United States in Innovation Capacity // ITIF. 23.01. 2023. URL: <https://itif.org/publications/2023/01/23/wake-up-america-china-is-overtaking-the-united-states-in-innovation-capacity/>

<sup>45</sup> Chinese companies dominate almost every segment of the solar energy value chain, from processing polysilicon used in solar cells to assembling solar panels.

<sup>46</sup> CATL, a Chinese company founded in 2011, is now the world's largest battery manufacturer and works with major automotive companies such as BMW, Tesla and Volkswagen, among others. See: Dan Wang. China's Hidden Tech Revolution. How Beijing Threatens U.S. Dominance // Foreign Affairs. Vol 102, №2, 2023. URL: <https://www.foreignaffairs.com/issues/2023/102/2>

<sup>47</sup> China has rapidly captured the 5G network market, leading the way in building this modern infrastructure. Huawei holds most of the patents for this technology. See: What is the Chip 4 alliance? // TRT World. 9.09.2022. URL: <https://www.trtworld.com/business/what-is-the-chip-4-alliance-59586>

<sup>48</sup> The U.S. vs. China: Who Is Winning the Key Technology Battles? //WSJ. 12.04.2020. URL: <https://www.wsj.com/articles/the-u-s-vs-china-who-is-winning-the-key-technology-battles-11586548597>

only does China significantly surpass the United States in terms of the number of scientific papers it issues on AI, but it also almost equals its main competitor with regard to their importance and citation.<sup>49</sup> China never stops experimenting with innovative algorithms and business models that promise to overhaul the country's economy.<sup>50</sup> Several key factors contribute to the development of AI in China.

**First**, there is robust financial support for AI startups provided by venture investors, technology juggernauts and the government.<sup>51</sup> The volume of the Chinese government's investment in this industry is unknown, but estimates of state spending range from \$2 to \$8.4 billion in 2018.<sup>52</sup>

**Second**, due to China's larger population compared to that of the United States, the digital platforms owned by Chinese IT giants such as Baidu, Alibaba, Tencent and others generate a much larger volume of data compared to US digital platforms. In 2018, China surpassed the United States in terms of the volume of data generated in a year, with 7.6 zettabytes vs. 6.9 zettabytes. It is projected that by 2025, this gap will increase to 48.6 zettabytes vs. 30.6 zettabytes.<sup>53</sup>

**Third**, for cultural and social reasons, China has an edge over the United States in terms of access to public and personal data for further use. In Chinese society, security concerns traditionally take precedence over information confidentiality, as it is believed that public interests should prevail over individual interests.<sup>54</sup>

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<sup>49</sup> Матвеенков К. Искусственный интеллект с китайской спецификой: станет ли Китай мировым лидером в сфере ИИ к 2030 году? // РСМД. 21.06.2022. URL: <https://russiancouncil.ru/analytics-and-comments/analytics/iskusstvennyy-intellekt-s-kitayskoy-spetsifikoy-stanet-li-kitay-mirovym/>

<sup>50</sup> Кай-Фу Ли. Сверхдержавы искусственного интеллекта. Китай, Кремниевая долина и новый мировой порядок. М.: Манн, Иванов и Фербер, 2019. С. 12.

<sup>51</sup> Там же. С. 17.

<sup>52</sup> By comparison, between 2000 and 2021, the US government cumulatively allocated about \$8 billion for AI projects, most of which was military-related. See: Матвеенков К. Искусственный интеллект с китайской спецификой: станет ли Китай мировым лидером в сфере ИИ к 2030 году? // РСМД. 21.06.2022. URL: <https://russiancouncil.ru/analytics-and-comments/analytics/iskusstvennyy-intellekt-s-kitayskoy-spetsifikoy-stanet-li-kitay-mirovym/>

<sup>53</sup> Ibid.

<sup>54</sup> Ibid.

If the current trends remain in force, China has a chance to become the leader in AI research and development in the coming years.<sup>55</sup>

## Microelectronics

China is making rapid progress in microelectronics, which is the foundation of the IT industry, which, in turn, is essential for the AI and supercomputer industry. According to some experts, mainland has taken a prominent place in chip assembly, testing and packaging, but it lags behind with their independent development and production.<sup>56</sup> Most Chinese chip producers are involved in the market for older generation microchips that are used in consumer electronic appliances and telecommunications.<sup>57</sup>

China has set the ambitious goal of reducing dependence on foreign technology and becoming a leader in semiconductor production by 2030.<sup>58</sup> According to the Semiconductor Industry Association (SIA), in the period between 2014 and 2030, China's investment in the semiconductor industry will surpass \$150 billion.<sup>59</sup> From 2000 to 2022, mainland China increased its share of global semiconductor production from 1 to 15 percent.<sup>60</sup> As part of the Made in China 2025 strategy, the plan was to achieve a 40-percent self-sufficiency in semiconductor production level by 2020 and 70 percent by 2025.<sup>61</sup> However, by 2020, self-sufficiency in chips had only

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<sup>55</sup> Матвеенков К. Искусственный интеллект с китайской спецификой: станет ли Китай мировым лидером в сфере ИИ к 2030 году? // РСМД. 21.06.2022. URL: <https://russiancouncil.ru/analytics-and-comments/analytics/iskusstvennyy-intellekt-s-kitayskoy-spetsifikoy-stanet-li-kitay-mirovym/>

<sup>56</sup> Can China Become the World Leader in Semiconductors? // The Diplomat. 25.09.2020. URL: <https://thediplomat.com/2020/09/can-china-become-the-world-leader-in-semiconductors/>

<sup>57</sup> China's chip design industry in 2022: the dawn of living with US sanctions // Technode. 9.02.2023. URL: <https://technode.com/2023/02/09/silicon-chinas-chip-design-industry-in-2022-the-dawn-of-living-with-us-sanctions/>

<sup>58</sup> Schmidt E. Innovation Power. Why Technology Will Define the Future of Geopolitics // Foreign Affairs. Vol 102, №2, 2023. URL: <https://www.foreignaffairs.com/issues/2023/102/2>

<sup>59</sup> Схватка за чипы: чем грозит борьба между США и Китаем за технологическое лидерство // Forbes. 30.04.2023. URL: <https://www.forbes.ru/tekhnologii/488480-shvatka-za-cipy-chem-grozit-bor-ba-mezdu-ssa-i-kitaem-za-tehnologiceskoe-liderstvo>

<sup>60</sup> The Economics of Chip War: China's Struggle to Develop the Semiconductor Industry // Computer, 2023. URL: <https://www.computer.org/csdl/magazine/co/2023/06/10132020/1NnHezc8uqs>

<sup>61</sup> Схватка за чипы: чем грозит борьба между США и Китаем за технологическое лидерство // Forbes. 30.04.2023. URL: <https://www.forbes.ru/tekhnologii/488480-shvatka-za-cipy-chem-grozit-bor-ba-mezdu-ssa-i-kitaem-za-tehnologiceskoe-liderstvo>



reached 16 percent.<sup>62</sup> Nevertheless, according to the consulting company International Business Strategies, considering current industry sanctions, by 2030, Chinese companies are expected to meet up to 33 percent of the country's demand for chips.<sup>63</sup>

Regarding the production of the most advanced semiconductors, here too, mainland China has achieved considerable progress in a relatively short time. In 2016, China's largest chip maker, Semiconductor Manufacturing International Corporation (SMIC), started mass production of microchips using the 28nm technology platform.<sup>64</sup> In 2022, there were reports that mass production of chips using the 14nm platform had been established.<sup>65</sup> Additionally, according to some specialised sources, in 2021, SMIC started the production of chips on the 7nm platform<sup>66</sup> using the Advanced Semiconductor Materials Lithography (ASML) deep ultraviolet (DUV) lithography machines which are not the most advanced machines available. However, experts note that the price for such chips is approximately 10 times higher than the market price of a 7nm chip produced by Taiwan Semiconductor Manufacturing Co. Ltd. (TSMC).<sup>67</sup>

Bridging the gap between China and the United States in the semiconductor industry involves several factors.

**First**, China employs key Taiwanese specialists. In 2017, the SMIC Corporation hired engineer and top manager Liang Mong Song (referred to as the crucial figure behind SMIC's technological progress)<sup>68</sup> who had worked at TSMC for nearly 20 years. He was followed by a team of

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<sup>62</sup> Taiwan holds all the chips in US–China tech showdown // EastAsiaForum. 3.12.2022. URL: <https://www.eastasiaforum.org/2022/12/03/taiwan-holds-all-the-chips-in-us-china-tech-showdown/>

<sup>63</sup> America's commercial sanctions on China could get much worse // The Economist. 30.03.2023. URL: <https://www.economist.com/briefing/2023/03/30/americas-commercial-sanctions-on-china-could-get-much-worse>

<sup>64</sup> Производителем 28-нм процессоров Snapdragon 425 стал «китаец» // 3DNews. 25.06.2016. URL: <https://3dnews.ru/935154/proizvoditelem-28nm-protessorov-qualcomm-snapdragon-425-stal-kitaets>

<sup>65</sup> SMIC Mass Produces 14nm Nodes, Advances To 5nm, 7nm // Tom's Hardware. 16.09.2022. URL: <https://www.tomshardware.com/news/smhc-mass-produces-14nm-nodes-advances-to-5nm-7nm>

<sup>66</sup> Why China's big chip breakthrough has rattled the US // TRT World. 23.08.2022. URL: <https://www.trtworld.com/magazine/why-china-s-big-chip-breakthrough-has-rattled-the-us-60048>

<sup>67</sup> The truth about SMIC's 7-nm chip fabrication ordeal // EDN. 23.08.2022. URL: <https://www.edn.com/the-truth-about-smics-7-nm-chip-fabrication-ordeal/>

<sup>68</sup> Taiwan chip veteran calls working for China's top foundry SMIC a 'foolish' decision // South China Morning Post, 13.08.2022. URL: <https://www.scmp.com/tech/tech-war/article/3188738/taiwan-chip-veteran-calls-working-chinas-top-foundry-smic-foolish>

almost 200 Taiwanese engineers.<sup>69</sup> In all, over 3,000 engineers were transferred from Taiwan to mainland-based semiconductor companies in 2020, which is almost 10 percent of Taiwan's semiconductor R&D workforce.<sup>70</sup>

**Second**, the Chinese government supports local chip manufacturers and developers by providing tax breaks, administrative privileges, and direct subsidies.

**Third**, Chinese tech giants Alibaba and Tencent have joined the efforts to develop advanced chips as part of a consortium of high-tech giants and research institutes created by the Chinese government.<sup>71</sup> Huawei strives to create the most advanced extreme ultraviolet (EUV) lithography machines.<sup>72</sup>

China has succeeded in developing and making its own processors as well. Market experts highly rate the prospects of the processors manufactured by China's Loongson, which was developed by specialists from the Chinese Academy of Sciences. The head of Intel's Chinese office believes that Chinese processor developers are making quick progress and may become serious global players within the next three to five years.<sup>73</sup>

## Quantum Technology

Even though the United States has achieved significant success in quantum computing, China has an advantage in quantum communication and encryption.<sup>74</sup> Over the last decade, Beijing has invested about \$10 billion in this industry, approximately 10 times more than

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<sup>69</sup> Китай наладил техпроцесс 7 нм без доступа к западным технологиям // Хабр. 19.09.2022. URL: <https://habr.com/ru/companies/itsumma/articles/688932/>

<sup>70</sup> Can China Become the World Leader in Semiconductors? // The Diplomat. 25.09.2020. URL: <https://thediplomat.com/2020/09/can-china-become-the-world-leader-in-semiconductors/>

<sup>71</sup> Китай привлек Alibaba и Tencent для помощи в разработке чипов // РИА. 30.11.2022. URL: <https://ria.ru/20221130/chipy-1835346954.html>

<sup>72</sup> Huawei подала патентную заявку на EUV-сканер – он может открыть Китаю технологии менее 7 нм // 3DNews. 24.12.2022. URL: <https://3dnews.ru/1079361/huawei-podala-patentnuyu-zayavku-na-euvskaner-on-moget-otkrit-kitayu-tehnologii-menee-7-nm>

<sup>73</sup> Итоги 2022 года: процессоры для ПК // 3DNews. 10.01.2023. URL: <https://3dnews.ru/1079951/itogi-2022-goda-protseessori-dlya-pk>

<sup>74</sup> The U.S. vs. China: Who Is Winning the Key Technology Battles? //WSJ. 12.04.2020. URL: <https://www.wsj.com/articles/the-u-s-vs-china-who-is-winning-the-key-technology-battles-11586548597>

the US government.<sup>75</sup> China invests significant funds into quantum networks, which is a method for transmitting information using quantum bits.<sup>76</sup> In 2020, Chinese scientists achieved quantum-encrypted communication using a satellite, bringing the country closer to establishing unbreakable quantum communication.<sup>77</sup>

## Supercomputers

China ranks first worldwide in the number of supercomputers. According to the 2022 Top500 rankings, China has 173 systems, while the United States has 127. Thus, China and the United States together account for almost two-thirds of the world's most powerful supercomputers.<sup>78</sup>

According to Top500, the United States has created the most powerful supercomputer. However, according to some sources, in recent years, Beijing has been reluctant to disclose all information about its significant achievements in high-performance computing. Considering this, it is impossible to be certain that the United States is the undisputed leader in this race.

## Cloud Computing

China is expanding its presence in the cloud computing market. For example, in 2022, Huawei launched the Go Cloud, Go Global plan and announced its intention to cover 170 countries and regions worldwide.<sup>79</sup> Southeast Asia is of particular interest to Chinese tech giants in terms of developing cloud services, and they plan to invest hundreds of millions of

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<sup>75</sup> Under the 2018 National Quantum Initiative Act, the State Department will allocate \$1.2 billion over five years for research in quantum computing and artificial intelligence. See: США выделяют 625 млн долл. на исследования в области квантовой информации // 3DNews. 27.08. 2020. URL: <https://3dnews.ru/1019218/ssha-videlyat-625-mln-na-issledovaniya-v-oblasti-kvantovoy-informatsii/>

<sup>76</sup> Schmidt E. Innovation Power. Why Technology Will Define the Future of Geopolitics // Foreign Affairs. Vol 102, №2, 2023. URL: <https://www.foreignaffairs.com/issues/2023/102/2>

<sup>77</sup> Dan Wang. China's Hidden Tech Revolution. How Beijing reatens U.S. Dominance // Foreign Affairs. Vol 102, №2, 2023. URL: <https://www.foreignaffairs.com/issues/2023/102/2>

<sup>78</sup> В мировом топе суперкомпьютерных держав Россия поднялась с десятого на восьмое место // Cnews. 30.05. 2022. URL: [https://www.cnews.ru/news/top/2022-05-30\\_v\\_mirovom\\_tope\\_superkompyuternyh](https://www.cnews.ru/news/top/2022-05-30_v_mirovom_tope_superkompyuternyh)

<sup>79</sup> Top 10 biggest cloud providers in the world in 2023 // Technology. 15.02.2023. URL: <https://technologymagazine.com/top10/top-10-biggest-cloud-providers-in-the-world-in-2023>

dollars in it.<sup>80</sup> Today, US cloud companies that hold a dominant position globally face increasing competition from Chinese competitors in this region. Alibaba Group Holding Ltd., Huawei Technologies Co., and Tencent Holdings Ltd. have accessed the developing markets of Thailand and Indonesia earlier than their US competitors, and are luring cloud product customers with prices that are 20 to 40 percent lower. Moreover, in terms of the number of availability zones or data centre clusters, Chinese companies take the lead in the region.<sup>81</sup>

## Advantages

China is developing its scientific, technological, and innovative potential at a fast pace, thus strengthening its position in the race for technological leadership. The country has made its way up through the international innovation rankings, such as the Global Innovation Index, where it climbed from 25<sup>th</sup> place in 2016<sup>82</sup> to 11<sup>th</sup> place in 2022.<sup>83</sup> China has also become the global leader in the number of patent applications,<sup>84</sup> research papers, and STEM graduates.<sup>85</sup> According to the Australian Strategic Policy Institute (ASPI), China ranks first in scientific development in many key technological areas, and leads in 37 out of 44 research areas from the creation of nanomaterials and robotics to advanced radio frequency communications, defence, and space technology.<sup>86</sup> According to 2010-2019 statistics and despite the fact that the United States remains the global leader in R&D spending, the average annual growth rate of R&D spending in China is nearly twice that of the United States.<sup>87</sup> Since China aims to become one of the most innovation-driven economies globally by 2035, the Chinese National People's Congress decided in 2021 to increase spending on fundamental research by more than 7 percent each year for a period of

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<sup>80</sup> American Cloud Companies Face Challenge from China in Southeast Asia // WSJ. 13.02.2023. URL: <https://www.wsj.com/articles/amazon-microsoft-google-pressured-by-chinese-cloud-rivals-in-southeast-asia-2c8d98b4>

<sup>81</sup> Ibid.

<sup>82</sup> Global Innovation Index 2016. URL: <https://tind.wipo.int/record/28216>

<sup>83</sup> Глобальный инновационный индекс – 2022. URL: <https://globalstocks.ru/wp-content/uploads/2022/10/wipo-pub-2000-2022-exec-ru-global-innovation-index-2022-15th-edition.pdf>

<sup>84</sup> Китай обошёл США и стал лидером по числу действующих патентов // Наш портал. 21.03.2023. URL: <https://npr.by/kitaj-lider-po-chislu-dejstvujushih-patentov/>

<sup>85</sup> Macovei M. There Are No Winners in the US-China “Tech War” // Mises Institute. 28.07.2020. URL: <https://mises.org/wire/there-are-no-winners-us-china-tech-war-0>

<sup>86</sup> Китай обгоняет США и западные демократии в технологической гонке // Коммерсантъ. 04.03.2023. URL: <https://www.kommersant.ru/doc/5861101>

<sup>87</sup> Boroush M., Guci L. Research and Development: U.S. Trends and International Comparisons // NSF. 28.04.2022. URL: <https://nces.nsf.gov/pubs/nsb20225>

five years.<sup>88</sup> Overall, China's investment in research and development has increased from \$106 billion in 2010 to \$463 billion in 2022<sup>89</sup> (about 2.4 percent of GDP).<sup>90</sup>

One of China's main advantages over the United States lies in its powerful manufacturing ecosystem allowing for the massive implementation of innovations. Over the past two decades, China, with substantial state support, has created an unparalleled manufacturing capacity for science-intensive industries with advanced production capabilities and a large labour reserve. China's focus on stimulating production has provided it with practical experience, specifically expertise and skills in various manufacturing processes, which is something the United States cannot boast of. America placed an emphasis on research, development, design, and marketing, and paid little attention to the value of physical production, which is now threatening its technological superiority.

According to some experts, the creation of an extensive and highly skilled workforce that can be adapted as needed for most high-tech industries has been China's most significant achievement over the past two decades. For example, Shenzhen has secured leading positions in the production of consumer drones, virtual reality headsets, and other cutting-edge electronics.<sup>91</sup>

China's advantages include the possession of rare earth metals that are widely used in microelectronics and other industries, and the ability to produce them on an industrial scale. Chinese companies control up to 90 percent of rare earth metal production,<sup>92</sup> which, according to some experts, could give them a significant leverage over their competitors.<sup>93</sup>

Finally, China boasts a massive domestic market, allowing it to maintain stability in the economy and industrial production in the face of

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<sup>88</sup> В Китае одобрили амбициозный план технологического прорыва // РБК. 11.03.2021. URL: <https://www.rbc.ru/politics/11/03/2021/604a2c5e9a7947bc907a7920>

<sup>89</sup> Схватка за чипы: чем грозит борьба между США и Китаем за технологическое лидерство // Forbes. 30.04.2023. URL: <https://www.forbes.ru/tekhnologii/488480-shvatka-za-cipy-chem-grozit-bor-ba-mezdu-ssa-i-kitaem-za-tehnologiceskoe-liderstvo>

<sup>90</sup> Китай повышает госрасходы на науку и технологические исследования // Коммерсантъ. 05.03.2021. URL: <https://www.kommersant.ru/doc/4713803>

<sup>91</sup> Dan Wang. China's Hidden Tech Revolution. How Beijing reatens U.S. Dominance // Foreign Affairs. Vol 102, №2, 2023. URL: <https://www.foreignaffairs.com/issues/2023/102/2>

<sup>92</sup> A Transatlantic Approach to Digital Sovereignty // ISPI. 16.06.2022. URL: <https://www.ispionline.it/en/publicazione/transatlantic-approach-digital-sovereignty-35455>

<sup>93</sup> Schmidt E. Innovation Power. Why Technology Will Define the Future of Geopolitics // Foreign Affairs. Vol 102, №2, 2023. URL: <https://www.foreignaffairs.com/issues/2023/102/2>

external shocks, such as sanctions. This factor is crucial, since blacklisted Chinese companies can temporarily switch to the domestic market, as Huawei did recently.<sup>94</sup>

## Challenges

Despite breakthroughs in advanced technology, China is exposed to serious vulnerabilities. According to experts from Mises University, most of China's success primarily reflects its efforts, while the efficiency and quality of some Chinese innovations raise questions. It is argued that China has rapidly ascended the value chain, but in many cases, the high-tech products it exports are assembled - even though on its territory - by foreign transnational corporations such as Intel, Foxconn, Cisco, and Samsung.

Leading Chinese tech giants, including Huawei, Alibaba, Baidu and Tencent, are technologically dependent and rely on foreign suppliers.<sup>95</sup> By all accounts, the country is still significantly dependent on imports of many key microelectronics components, including advanced manufacturing equipment and software. Chinese companies predominantly rely on imports from Japan, the United States, and Europe, which control over 90 percent of the global market for equipment and semiconductor manufacturing.<sup>96</sup> Moreover, with regard to the production of logic chips, Chinese companies lag behind by 5 to 10 years.<sup>97</sup>

However, the problems plaguing the Chinese technological sector do not appear insurmountable in the long term. It is clear why the United States is so concerned about China's rapid technology progress. Any claims to victory in the technological race are perceived in the United States as a threat to national security.

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<sup>94</sup> Huawei нарастила продажи третий квартал подряд – чистая прибыль почти утроилась // 3DNews.11.08.2023. URL: <https://3dnews.ru/1091362/huawei-narastila-prodagi-tretiy-kvartal-podryad>

<sup>95</sup> Macovei M. There Are No Winners in the US-China "Tech War" // Mises Institute. 28.07.2020. URL: <https://mises.org/wire/there-are-no-winners-us-china-tech-war-0>

<sup>96</sup> См.: Dan Wang. China's Hidden Tech Revolution. How Beijing Threatens U.S. Dominance // Foreign Affairs. Vol 102, №2, 2023. URL: <https://www.foreignaffairs.com/issues/2023/102/2>; Scharre P. Decoupling wastes U.S. leverage on China keeping Chinese firms dependent on Western chips is a better strategy // Foreign Policy. 2023. URL: <https://foreignpolicy.com/2023/01/13/china-decoupling-chips-america/>

<sup>97</sup> The Economics of Chip War: China's Struggle to Develop the Semiconductor Industry // Computer.2023. URL: <https://www.computer.org/csdl/magazine/co/2023/06/10132020/1NnHezc8uqs>

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# America's New Technology Policy

The United States has long been involved in science and technology policy. In his report “Science, the endless frontier,” published in 1945, Science Advisor Vannevar Bush advised President Franklin Delano Roosevelt on how to sustain US leadership in science and technology. He suggested creating a powerful system of higher education with university laboratories, a system for educating top-grade researchers and a centre for attracting the best scientists from all over the world. Today, this report is praised for cementing the US lead in science and technology.<sup>98</sup>

In the second half of the 20<sup>th</sup> century, US technology policy was primarily oriented toward the defence industry rather than the private sector – the federal budget allocated substantial funds for the development of military technology, established specialised institutes and so on. It would be appropriate to mention at this point the formation of the US Defense Advanced Research Projects Agency (DARPA) in 1958. For the most part, it focused on military research rather than the commercial sector.<sup>99</sup> However, later on, military technology spun off useful innovations to the commercial sector. Professor of Harvard University Lewis Branscomb noted that military R&D and procurement were critical in the early development of the electronics, computer, and aerospace industries.<sup>100</sup>

For decades, the US Government preferred not to interfere in the affairs of private high-tech companies. Of course, there were cases when Washington tried to support critical high-tech industries with trade or financial policies as was the case during the US-Japanese “semi-conductor

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<sup>98</sup> Егоров С.Е., Пястолов С.М. Стратегии инновационного развития США // ИНИОН РАН. 2021. URL: [http://inion.ru/site/assets/files/6625/2021\\_ao\\_strategii\\_innovatcionnogo\\_razvitiia\\_ssha.pdf](http://inion.ru/site/assets/files/6625/2021_ao_strategii_innovatcionnogo_razvitiia_ssha.pdf)

<sup>99</sup> Hufbauer G.C., Jung Euijin. Scoring 50 Years of US Industrial Policy, 1970–2020 // PIIE. November 2021. URL: <https://www.piie.com/sites/default/files/documents/piieb21-5.pdf>

<sup>100</sup> Branscomb L. M. Does America Need a Technology Policy? // Harvard Business Review. 1992. URL: <https://hbr.org/1992/03/does-america-need-a-technology-policy>

battle” in the 1980s.<sup>101</sup> However, in general, the US leadership tried to give the utmost freedom to businesses with a light regulatory touch and lower taxes. The culture of Silicon Valley flourished, as expressed in the values of venture capital and freedom of corporate and industrial strategies.

In the meantime, American companies were steadily losing their share of the market in high-tech strategic sectors because they were not competitive enough. This caused in the US a wave of discussions on the need to intensify its technology policy. In the 1990s, national debates focused on the ability and necessity of the government playing an active role in encouraging commercial technical innovations. The advocates of technology policy insisted on the absolute need for state support in critical R&D. Its critics claimed that innovations were naturally becoming global in the global economy where capital, technology and people were mobile and trade barriers were disappearing. In this context, any attempts by the government to choose winners or otherwise control technological progress inside the country were doomed to fail.<sup>102</sup> These debates did not yield any substantial changes in US technology policy.

However, the rapidly shrinking gap between China and the US, which became particularly pronounced since the 2010s, again revived the debate in the US professional, scientific and government circles. It became clear that the state should be more active in national technological development. All that remained to decide was how best to achieve this.

In January 2020, the National Science and Technology Council submitted a report entitled “Science and engineering indicators” to the President and Congress. It reads: “Increasingly, the United States is seen globally as an important leader rather than the uncontested leader.”<sup>103</sup>

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<sup>101</sup> By the middle of the 1980s, Japanese companies managed to seize more than half of the world market of Dynamic random-access memory (DRAM) chips. The US Government decided to help American semi-conductor companies to fight their Japanese rivals by holding an anti-dumping campaign (the Japanese promised not to set prices on semi-conductors below a “fair market price.” To help the semi-conductor industry, it also established a public-private consortium Sematech that DARPA funded from 1987 to 1997. Sematech helped reduce R&D costs. См.: Hufbauer G.C., Jung Euijin. Scoring 50 Years of US Industrial Policy, 1970–2020 // PIIE. November 2021. URL: <https://www.piie.com/sites/default/files/documents/piieb21-5.pdf>

<sup>102</sup> Branscomb L. M.. Does America Need a Technology Policy? // Harvard Business Review. 1992. URL: <https://hbr.org/1992/03/does-america-need-a-technology-policy>

<sup>103</sup> Егоров С.Е., Пястолов С.М. Стратегии инновационного развития США // ИНИОН РАН. 2021. URL: [http://inion.ru/site/assets/files/6625/2021\\_ao\\_strategii\\_innovatcionnogo\\_razvitiia\\_ssha.pdf](http://inion.ru/site/assets/files/6625/2021_ao_strategii_innovatcionnogo_razvitiia_ssha.pdf)



In the same year, President of the Massachusetts Institute of Technology (MIT), Leo Rafael Reif spoke about the threat to the US position as global technological leader because the US had no advanced communications. He said the US was barely ahead in machine learning and artificial intelligence while lagging behind others in several similar areas. He noted the threat of greater competition from China to Europe and blamed the US for failing to insist on a coordinated response by universities, industry and the government.<sup>104</sup>

The United States began the process of revising its technology policy.

**First**, it acknowledged that investment in science and research were decisive for economic welfare. Federal investment in R&D dropped from 1.2 percent of GDP in the late 1970s to less than 0.8 percent in recent years,<sup>105</sup> adversely affecting the development of the national technological and industrial bases. A number of experts believe that technological research “that seems outlandish now may prove critical in the not-too-distant future.”<sup>106</sup>

**Second**, analysts believe that in the past few decades, high-tech growth in the US was limited, feeble and geographically unequal,<sup>107</sup> while Silicon Valley failed to develop and commercialise the types of technology and innovation that could ensure economic growth in the broadest sense.<sup>108</sup> Experience showed that the growth of venture capital helped speed up introduction and commercialisation but did little to resolve scientific problems of a higher order. Last but not least, the bulk

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<sup>104</sup> Егевев С.Е., Пястолов С.М. Стратегии инновационного развития США // ИНИОН РАН. 2021. URL: [http://inion.ru/site/assets/files/6625/2021\\_ao\\_strategii\\_innovatcionnogo\\_razvitiia\\_ssha.pdf](http://inion.ru/site/assets/files/6625/2021_ao_strategii_innovatcionnogo_razvitiia_ssha.pdf)

<sup>105</sup> Rotman D. 2022's seismic shift in US tech policy will change how we innovate // MIT. 9.01.2023. URL: <https://www.technologyreview.com/2023/01/09/1064735/us-tech-policy-changing-innovation/>

<sup>106</sup> Schmidt E. Innovation Power. Why Technology Will Define the Future of Geopolitics // Foreign Affairs. Vol 102, №2, 2023. URL: <https://www.foreignaffairs.com/issues/2023/102/2>

<sup>107</sup> In expert estimate, the economic growth and social benefits produced by the Silicon Valley were relatively narrow, while most most of the beneficiaries were the young and technically skilled workers on the West Coast. См.: Uncle Sam Is Disrupting the Venture Capital World // Bloomberg. 2.03.2023. URL: <https://www.bloomberg.com/opinion/articles/2023-03-02/chips-act-is-disrupting-the-venture-capital-world>

<sup>108</sup> Rotman D. 2022's seismic shift in US tech policy will change how we innovate // MIT. 9.01.2023. URL: <https://www.technologyreview.com/2023/01/09/1064735/us-tech-policy-changing-innovation/>

of US talent went into finance and software because of mass layoffs and other reasons. As a result, a significant amount of technological skill and knowledge was lost.<sup>109</sup>

**Third**, in the past few years, American experts have talked about the shortage of production capacities on US territory, which held back innovation. Analyst Dan Wang admitted that the “crooked smile” concept was fraught with serious consequences. According to this concept, most of the profit in high-tech industries is produced in the beginning of the value-creating chain (during design, research and development) and then in the marketing of a product, bypassing the least profitable real production stage. This concept will make it difficult for the US to sustain its long-term technological dominance.<sup>110</sup> Wang believes that the withdrawal of companies from many production segments is seriously weakening US positions. How can engineers design automation systems if they are not familiar with production, he wondered.<sup>111</sup> In their special reports for 2021, the NSCAI and the White House also noted that the shortage of production capacities negatively affected the country’s innovation potential and was impeding the growth of the US semiconductor industry.<sup>112</sup>

In response to the question of why China is winning, many analysts say that China is focused not only on scientific breakthroughs. It is working on innovating in production and building up its industrial expertise. Thus, China ensured its success in solar energy because in the last decade it managed to reduce the cost of solar panels. In China’s case, “Solar has plunged in price not through innovation in panel technology, but by innovation that reduces the cost of \*manufacturing\* the panels.” Moreover, experts emphasise that “insights derived from the solar industry’s learning-by-doing continue to spill-over into new ideas for basic research.”<sup>113</sup>

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<sup>109</sup> Dan Wang. China’s Hidden Tech Revolution. How Beijing Threatens U.S. Dominance // Foreign Affairs. Vol 102, №2, 2023. URL: <https://www.foreignaffairs.com/issues/2023/102/2>

<sup>110</sup> Ibid.

<sup>111</sup> Hammond S. How Congress Ruined the Endless Frontier Act // Niskanen Center. 20.05.2021. URL: <https://www.niskanencenter.org/how-congress-ruined-the-endless-frontier-act/>

<sup>112</sup> Building Resilient Supply Chains, Revitalizing American Manufacturing, And Fostering Broad-Based Growth // The White House. June 2021. URL: <https://www.whitehouse.gov/wp-content/uploads/2021/06/100-day-supply-chain-review-report.pdf> ; The final report. National Security Commission on Artificial Intelligence // Washington, DC, USA, Mar. 2021. URL: <https://www.nsc.gov/2021-final-report/>

<sup>113</sup> Hammond S. How Congress Ruined the Endless Frontier Act // Niskanen Center. 20.05.2021. URL: <https://www.niskanencenter.org/how-congress-ruined-the-endless-frontier-act/>

**Fourth**, American experts and politicians are seriously worried about the fragility of critical industries due to the structure of supply chains. This mostly applies to the semiconductor industry. The economic argument that the production location does not matter is no longer valid. John Verway, an advisor to the Pacific Northwest National Laboratory, PNNL, believes the concentration of high-tech production lines in Taiwan (that hosts the single company producing 90 percent of the most innovative chips) is a big strategic risk.<sup>114</sup> Any accidental or deliberate political or other form of destabilisation may undermine the work of supply chains, threatening the industry with real disaster. Considering this risk, in 2021 the White House issued the Executive Order on America's Supply Chains. It was designed to review the main risks to the supply of required products, materials and services.<sup>115</sup>

The United States realised that, **first**, it could no longer be sure of having adequate production and innovation capacities inside the country, and, **second**, that it could no longer fully rely on the global supply chains to make up for all domestic production shortages with relative ease.<sup>116</sup> Even US allies are striving to obtain their own competitive advantage in key high-tech industries and strengthen their technological sovereignty. The US-dominated global production system was very appealing to America but proved to be unviable.

Starting in about 2019, the trend of intensifying technology policy in the US picked up speed. Now it has become a national priority. The US began to move from debate to action. As early as under the Donald Trump administration, it started returning American companies from China to its own territory.<sup>117</sup> In turn, the Biden administration focused on strengthening supply chains (semi-conductors, critical materials, etc.), restoring high-tech production in the US and promoting its high-tech development. According

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<sup>114</sup> Вервей Д. «Мозги» для искусственного интеллекта // Открытые системы. №1. 2022. URL: <https://www.osp.ru/os/2022/01/13056118>

<sup>115</sup> Executive Order on America's Supply Chains // The White House. 24.02.2021. URL: <https://www.whitehouse.gov/briefing-room/presidential-actions/2021/02/24/executive-order-on-americas-supply-chains/>

<sup>116</sup> Atkinson R. D. Computer Chips vs. Potato Chips: The Case for a U.S. Strategic-Industry Policy // ITIF. 3.01.2022. URL: <https://itif.org/publications/2022/01/03/computer-chips-vs-potato-chips-case-us-strategic-industry-policy/>

<sup>117</sup> Трамп призвал американские компании вернуть производство из Китая в США // ТАСС. 23.08.2023. URL: <https://tass.ru/ekonomika/6793298>

to MIT experts, in 2022, there was a real “seismic shift” in US technology policy because US leaders decided on deliberate state intervention, including financial incentives and investments facilitating the growth of certain industries and technologies.<sup>118</sup> “It’s critically important to ensure that industries of the future start, grow and remain in the U.S.,” Assistant Secretary of Commerce for Economic Development Alejandra Y. Castillo said in a press release.<sup>119</sup> It was necessary to promote technological and industrial development of the country’s whole regions at the expense of state subsidies and to launch high-tech production there, which was supposed to create jobs.

In October 2022, the Subcommittee on Advanced Manufacturing (SAM) launched a National Strategy for Advanced Manufacturing, outlining the goals, priorities and recommendations for the next four years. According to the document, in order to address global competition, the US must “(1) Develop and implement advanced manufacturing technologies; (2) Grow the advanced manufacturing workforce; and (3) Build resilience into manufacturing supply chains.”<sup>120</sup>

In the past few decades, US leaders did not try to allocate additional funds for applied research and even reduced the funding of fundamental research.<sup>121</sup> Obviously, now the US is focused on enhancing the technological role of the state and intensifying cooperation between the government, the private sector and the scientific community. Judging by everything, the status of Silicon Valley is also changing. It is starting to lose its position of the main innovation centre and economic growth driver despite its impressive achievements in artificial intelligence and other high-tech areas. America now needs technological centres oriented toward high-tech production.<sup>122</sup>

However, the United States is unlikely to adopt a tough command-and-control model or opt for autarky. Rather, it will restore the trinity of

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<sup>118</sup> Rotman D. 2022’s seismic shift in US tech policy will change how we innovate // MIT. 9.01.2023. URL: <https://www.technologyreview.com/2023/01/09/1064735/us-tech-policy-changing-innovation/>

<sup>119</sup> With the CHIPS and Science Act moving forward, help the EDA define ‘tech hubs’// Technical.ly. 15.02.2023. URL: <https://technical.ly/civic-news/eda-tech-hubs-chips-science-act/>

<sup>120</sup> National Strategy for Advanced Manufacturing // The Subcommittee on Advanced Manufacturing. October 2022. URL: <https://www.whitehouse.gov/wp-content/uploads/2022/10/National-Strategy-for-Advanced-Manufacturing-10072022.pdf>

<sup>121</sup> Schmidt E. Innovation Power. Why Technology Will Define the Future of Geopolitics // Foreign Affairs. Vol 102, №2, 2023. URL: <https://www.foreignaffairs.com/issues/2023/102/2>

<sup>122</sup> With the CHIPS and Science Act moving forward, help the EDA define ‘tech hubs’// Technical.ly. 15.02.2023. URL: <https://technical.ly/civic-news/eda-tech-hubs-chips-science-act/>

government, private companies and universities, which existed at the peak of the Cold War. It is already drafting its strategic industrial policy to determine the industries and technology that are critical for its security, including microelectronics. ITIF experts suggest combining market policy for most of the economy and strategic industrial policy for individual sectors (aerospace, semiconductors and quantum computing).<sup>123</sup>

The US National Security Strategy reads: “The private sector and open markets have been, and continue to be, a vital source of our national strength and a key driver of innovation.”<sup>124</sup> The US will also increase its strategic public investment that “is the backbone of a strong industrial and innovation base in the 21st century global economy.”<sup>125</sup> It will encourage talented Americans to work on specific areas of research and production. The US may undergo a structural overhaul that will shift the balance in its economic sectors – the manufacturing sector will receive a bigger role, which will increase the share of high-tech and science-intensive industries in the economy. As for enhancing the resilience of supply chains, the US leadership is now striving to ensure permanent access to critical products by expanding its domestic production capacities and diversifying foreign suppliers.

America intends to invest “in key areas where private industry, on its own, has not mobilised...”<sup>126</sup> while also “countering intellectual property theft, forced technology transfer, and other attempts to degrade our technological advantages by enhancing investment screening, export controls, and counterintelligence resources.”<sup>127</sup>

Long-term strategic competition with China is motivating the United States to adjust its approaches on the foreign track of technology policy. We are seeing this on the example of revived techno-nationalism. Thus, the US Government is assuming a leading role in creating an American technological platform, thereby simultaneously reducing mutual dependence with China by pursuing a policy of partial technological decoupling. In addition, it

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<sup>123</sup> Atkinson R. D. Computer Chips vs. Potato Chips: The Case for a U.S. Strategic-Industry Policy // ITIF. 3.01.2022. URL: <https://itif.org/publications/2022/01/03/computer-chips-vs-potato-chips-case-us-strategic-industry-policy/>

<sup>124</sup> National Security Strategy // The White House. October 2022. URL: <https://www.whitehouse.gov/wp-content/uploads/2022/11/8-November-Combined-PDF-for-Upload.pdf>

<sup>125</sup> Ibid.

<sup>126</sup> National Security Strategy // The White House. October 2022. URL: <https://www.whitehouse.gov/wp-content/uploads/2022/11/8-November-Combined-PDF-for-Upload.pdf>

<sup>127</sup> Ibid.

is paying significant attention to strengthening its ties with allies and associates because the US mainly projects its geopolitical power via technological spheres of influence.<sup>128</sup>

National security is becoming the most important issue for Washington. However, while economic benefits are becoming a secondary consideration, political decisions ultimately pursue economic goals as well, such as preventing the economic balance of power from shifting in China's favour. The United States does not want to lose its dominance in any area. This is why the US leadership is forcing its allies to rethink their ties with China as well.

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## Strategies for Countering the Chinese Competitor

The US government seeks to limit China's access to crucial Western technologies as much as possible, to diversify and build supply chains in circumvention of China, and to partner up with allies and partners in order to explore and scale innovative technology, as well as to strengthen its own traditions of scientific innovation and manufacturing. Let's look into US technology policy in greater detail.

### Creating a Sustainable Technological Ecosystem

After taking office, President Biden started reshaping the national technological landscape. According to analysts, the country had not seen such extensive federal funding for science and technology in decades.<sup>129</sup> In August 2022, the CHIPS and Science Act became law. The act provides for tax credits until 2026 and funds to incentivise manufacturers to build plants in the United States in order to increase domestic semiconductor production. It also includes multibillion-dollar investment in the microelectronics

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<sup>128</sup> Lippert B., Perthes V. Strategic Rivalry between United States and China // SWP. 6.04.2020. URL: <https://www.swp-berlin.org/en/publication/strategic-rivalry-between-united-states-and-china/>

<sup>129</sup> RotmanD. 2022's seismic shift in US tech policy will change how we innovate // MIT. 9.01.2023. URL: <https://www.technologyreview.com/2023/01/09/1064735/us-tech-policy-changing-innovation/>

industry. Over five years, approximately \$170 billion will be set aside to promote scientific research, \$52 billion in government subsidies for semiconductor manufacturing, and \$24 billion in investment tax credits for chip production plants.<sup>130</sup> According to experts from the Peterson Institute for International Economics (PIIE), semiconductors have become a “centrepiece of President Biden’s industrial policy.”<sup>131</sup>

The US authorities intend the CHIPS and Science Act to serve as an incentive for the construction of new chip manufacturing plants. The goal is to restore the US share in chip production, which fell from 37 percent in 1990 to 12 percent in 2022.<sup>132</sup> Most American semiconductor companies focused on developing advanced products and outsourced expensive production to Asian foundries. However, the technological strategy has now changed, with America making chip production one of its top priorities in accord with both its economic and national security goals.

The nation has started to greatly increase its production capacity. In September 2022, *Intel* started the construction of two \$20 billion chip manufacturing plants in Ohio (due to various factors, primarily inflation,<sup>133</sup> construction costs may increase to \$100 billion). Production is scheduled to begin in 2025. Additionally, over the next 10 years, Intel plans to allocate around \$50 million to conduct dedicated research and training programmes which will involve over 80 institutions in the state.<sup>134</sup> About 9,000 graduates will be trained under this programme within the next three years.<sup>135</sup>

In October 2022, US semiconductor manufacturer Micron Technology announced its plans to invest up to \$100 billion over the next 20-plus years in building the world’s largest computer chip manufacturing complex

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<sup>130</sup> Majority of U.S. Senate backs bill boosting chipmakers, to compete with China // Reuters. 27.07.2022. URL: <https://www.nasdaq.com/articles/majority-of-u.s.-senate-backs-bill-boosting-chipmakers-to-compete-with-china>

<sup>131</sup> Hufbauer G.C., Jung Euijin. Scoring 50 Years of US Industrial Policy, 1970–2020 // PIIE. November 2021. URL: <https://www.piie.com/sites/default/files/documents/piieb21-5.pdf>

<sup>132</sup> SIA Factbook 2022 // SIA. URL: [https://www.semiconductors.org/wp-content/uploads/2022/05/SIA-2022-Factbook\\_May-2022.pdf](https://www.semiconductors.org/wp-content/uploads/2022/05/SIA-2022-Factbook_May-2022.pdf)

<sup>133</sup> Exclusive: Samsung’s new Texas chip plant cost rises above \$25 billion // Reuters. 16.03.2023. URL: <https://www.reuters.com/technology/samsungs-new-texas-chip-plant-cost-rises-above-25-billion-sources-2023-03-15/>

<sup>134</sup> Intel торжественно начала строительство двух заводов в Огайо – к 2025 году они начнут производить передовые чипы // 3DNews. 9.09.2022. URL: <https://3dnews.ru/1073876/intel-torgestvenno-nachala-stroitelstvo-dvuh-predpriyatij-v-ogayo-kotorie-k-2025-godu-nachnut-vidavat-peredovuyu-produktsiyu>

<sup>135</sup> Ibid.

in upstate New York. The new factory is expected to create around 50,000 new jobs.<sup>136</sup>

One of the main goals of the US leadership is to spread the funds widely across the country in order to create several thriving ecosystems, capable of integrating raw materials, research, and manufacturing capacities.<sup>137</sup> Washington is fully aware of the fact that in the face of tough competition with China, the production capacity of domestic companies alone will not be enough. So, to ensure reliable supply chains, the goal is to relocate a significant portion of foreign-based factories capable of making the most advanced chips to the United States. This is a fairly costly undertaking, but America spares no expense when it comes to reshoring, since semiconductor shortages could undermine the country's security.

Following persistent invitations from Washington, TSMC agreed to build two semiconductor manufacturing plants in Arizona.<sup>138</sup> With the costs totalling \$40 billion, this is one of the largest foreign direct investments in the history of the United States.<sup>139</sup> Chip production using 4nm technology is expected to become operational by 2024, and production with the most advanced 3nm technology will go live by 2026.<sup>140</sup> The factories will employ around 4,500 people. TSMC has already sent about 600 engineers, who will work at the new facilities in the United States, to Taiwan for on-site training.<sup>141</sup>

In addition to TSMC, the United States plans to localise Samsung semiconductor production. In 2022, the construction of a Samsung plant, at an estimated cost of \$25 billion, began in Texas.<sup>142</sup> Furthermore,

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<sup>136</sup> Micron to invest up to \$100 bln in semiconductor factory in New York // Reuters. 4.10.2022. URL: <https://www.reuters.com/technology/micron-plans-invest-up-100-bln-semiconductor-factory-new-york-nyt-2022-10-04/>

<sup>137</sup> Chip Makers Turn Cutthroat in Fight for Share of Federal Money // The New York Times. 23.02.2023. URL: <https://www.nytimes.com/2023/02/23/business/economy/chip-makers-fight-federal-money.html>

<sup>138</sup> How Arizona Is Positioning Itself for \$52 Billion to the Chips Industry // The New York Times. 22.02.2023. URL: <https://www.nytimes.com/2023/02/22/technology/arizona-chips-act-semiconductor.html>

<sup>139</sup> US-led 'Fab 4' chip alliance meets to coordinate supply chain resilience // Computer world. 27.02.2023. URL: <https://www.computerworld.com/article/3689157/us-led-fab-4-chip-alliance-meets-to-coordinate-supply-chain-resilience.html>

<sup>140</sup> Через два года у Apple, AMD и NVIDIA появятся чипы "MadeinUSA": их будет выпускать TSMC на новых заводах в Аризоне // 3DNews. 07.12.2022. URL: <https://3dnews.ru/1078457/dva-amerikanskih-predpriyatiya-tsmc-smogut-vidavat-produktsii-na-10-mlrd-v-god>

<sup>141</sup> Ibid.

<sup>142</sup> Exclusive: Samsung's new Texas chip plant cost rises above \$25 billion // Reuters. 16.03.2023. URL: <https://www.reuters.com/technology/samsungs-new-texas-chip-plant-cost-rises-above-25-billion-sources-2023-03-15/>



Samsung has submitted applications in connection with the construction of another 11 semiconductor manufacturing plants over the next decade, with a total investment of \$192 billion. Nine of these plants will be built in Taylor, and two others in Austin (Samsung already operates two plants in Austin).<sup>143</sup> However, even though the initiatives took off at a fairly fast pace, the construction has somewhat slowed down amid a general drop in demand for PCs, smartphones, and, accordingly, semiconductors.

However, according to most experts, no amount of government subsidies can create fully operational domestic industries. According to Boston Consulting Group and SIA, creating fully domestic semiconductor production supply chains would cost at least \$1 trillion, which is more than double the value of the global semiconductor market.<sup>144</sup> And this is just the initial investment. Furthermore, this initiative is economically impractical, as it would lead to a general increase in semiconductor prices by 35 to 65 percent and affect the cost of end electronic products.<sup>145</sup>

The Biden administration has acknowledged that the United States is not capable of recreating the fully integrated production of high-tech products within its borders. Considering this, the goal is to expand cooperation with its allies and partners to establish a collective and sustainable supply chain.<sup>146</sup> The US leadership has decided to complement reshoring with friendshoring, which involves deploying high-tech production facilities in the countries that share the “Western values.”<sup>147</sup> According to Washington, friendshoring will make the West less vulnerable to geopolitical and other shocks, such as pandemics, cyberattacks, or natural disasters. Essentially, it involves replacing China with trade partners from like-minded countries. Friendshoring is strongly promoted by US Treasury Secretary Janet Yellen. According

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<sup>143</sup> Samsung планирует вложить \$192 миллиарда в строительство 11 полупроводниковых заводов в Техасе // TechInsider. 25.07.2022. URL: <https://www.techinsider.ru/technologies/news-1549831-samsung-planiruet-vlozhit-192-milliarda-v-stroitelstvo-11-poluprovodnikovyh-zavodov-v-tehase/>

<sup>144</sup> «Манхэттенский проект» для IT // Ведомости. 30.11.2022. URL: <https://www.vedomosti.ru/technology/articles/2022/11/30/952737-manhattenskii-proekt-dlya-it>

<sup>145</sup> Strengthening the Global Semiconductor Supply Chain in an Uncertain Era // SIA/BCG Report. April 2021. URL: <https://www.semiconductors.org/strengthening-the-global-semiconductor-supply-chain-in-an-uncertain-era/>

<sup>146</sup> Friendshoring: what is it and can it solve our supply problems? // The Guardian. 6.08.2022. URL: <https://www.theguardian.com/business/2022/aug/06/friendshoring-what-is-it-and-can-it-solve-our-supply-problems>

<sup>147</sup> Rebuilding America's economy and foreign policy with ally-shoring // Brookings. 8.06.2021. URL: <https://www.brookings.edu/blog/the-avenue/2021/06/08/rebuilding-americas-economy-and-foreign-policy-with-ally-shoring/>

to her, companies should be discouraged from concentrating too many manufacturing sites in an unreliable country like China.<sup>148</sup>

Traditionally, the strategy for building supply chains has been influenced by factors such as price, quality and shipment. Now, security and compliance with state policies and rules are part of these considerations as well, forcing companies to rethink their production development arrangements.<sup>149</sup>

In 2022, the CSIS released a special report titled “Semiconductor supply chains” which identified the following candidates to support semiconductor supply chains in the United States:

- **The Netherlands:** The country is the world’s largest supplier of the most advanced photolithography systems<sup>150</sup> that are critical for the production of modern chips. The Netherlands conducts applied research and engages in the design and production of microchips.
- **Belgium:** The country is known for its strong fundamental and applied research in the semiconductor field. Belgium boasts a ramified R&D ecosystem and a well-developed transport network while enjoying a central geographical location in the EU.
- **Germany:** The country is the world’s fourth-largest exporter of semiconductors and a key producer of various materials that are critical for chip production. Germany has large research and development centres.
- **Japan:** Ranking fourth in the world in semiconductor production and equipment sales, Japan has extensive experience in manufacturing materials that are used in the semiconductor industry.<sup>151</sup>

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<sup>148</sup> Friendshoring makes sense if done in the right way // Reuters. 5.12.2022. URL: <https://www.reuters.com/breakingviews/friendshoring-makes-sense-if-done-right-way-2022-12-05/>

<sup>149</sup> Reinsch W.A., Benson E., Arasasingham A. Securing Semiconductor Supply Chains // CSIS. August 2022. URL: [https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/220802\\_Reinsch\\_Semiconductors.pdf?VersionId=WMGKge29KFMOBw9Bkvwzkomj4mUtsr](https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/220802_Reinsch_Semiconductors.pdf?VersionId=WMGKge29KFMOBw9Bkvwzkomj4mUtsr).

<sup>150</sup> Dutch ASML is the only supplier of extreme ultraviolet (EUV) lithography machines, which are used to produce the most advanced chips (e.g. 3, 5 and 7 nm).

<sup>151</sup> Reinsch W. A., Benson E., Arasasingham A. Securing Semiconductor Supply Chains // CSIS. August 2022. URL: [https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/220802\\_Reinsch\\_Semiconductors.pdf?VersionId=WMGKge29KFMOBw9Bkvwzkomj4mUtsr](https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/220802_Reinsch_Semiconductors.pdf?VersionId=WMGKge29KFMOBw9Bkvwzkomj4mUtsr).

Various sources also mention **Indonesia, Malaysia, Vietnam,**<sup>152</sup> **Mexico, and India,** to name a few, as possible destinations for the production facilities and workforce relocated from China.<sup>153</sup>

Some large US technology companies started moving their production sites from China to other countries long before the idea of friendshoring became popular.<sup>154</sup> The relocation of manufacturing facilities was driven by economic considerations (cheap labour<sup>155</sup> and rent, tax incentives, etc.) and changing global political dynamics.

The number of Apple factories in Vietnam rapidly increased from 14 in 2018 to 23 in 2022. In India, production has been expanding more slowly, increasing from 7 factories in 2018 to 9 in 2022. However, India was selected to accommodate the most critical Apple production lines. Since 2020, the iPhone 11, 12, and 13 have been manufactured there.<sup>156</sup> Even though India currently accounts for only 5 percent of iPhone assembly, analysts estimate that by 2025, this figure could grow to 25 percent.<sup>157</sup> India is attractive to US companies<sup>158</sup> for several reasons: English is the second official language, there is a growing middle class, and the country has a vast internal market, and a more skilled workforce than other countries, such as Vietnam. Several major semiconductor companies (Micron, Intel,

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<sup>152</sup> Friendshoring: what is it and can it solve our supply problems? // The Guardian. 6.08.2022. URL: <https://www.theguardian.com/business/2022/aug/06/friendshoring-what-is-it-and-can-it-solve-our-supply-problems>

<sup>153</sup> Rebuilding America's economy and foreign policy with ally-shoring // Brookings. 8.06.2021. URL: <https://www.brookings.edu/blog/the-avenue/2021/06/08/rebuilding-americas-economy-and-foreign-policy-with-ally-shoring/>

<sup>154</sup> Apple began revising the geographical location of its production sites in 2014. See: What it would take for Apple to disentangle itself from China // Financial Times. 17.01.2023. URL: <https://www.ft.com/content/74f7e284-c047-4cc4-9b7a-408d40611bfa>

<sup>155</sup> Wages in Vietnam today are less than half of what they are in China. See: What it would take for Apple to disentangle itself from China // Financial Times. 17.01.2023. URL: <https://www.ft.com/content/74f7e284-c047-4cc4-9b7a-408d40611bfa>

<sup>156</sup> Vietnam mainly produces AirPods and a small number of iPads. See: Vietnam or India: which one will be the new "world's factory"? // Ginger River Review. 9.06.2022. URL: [https://www.gingerriver.com/p/vietnam-or-india-which-one-will-be?utm\\_source=substack&utm\\_medium=email](https://www.gingerriver.com/p/vietnam-or-india-which-one-will-be?utm_source=substack&utm_medium=email)

<sup>157</sup> What it would take for Apple to disentangle itself from China // Financial Times. 17.01.2023. URL: <https://www.ft.com/content/74f7e284-c047-4cc4-9b7a-408d40611bfa>

<sup>158</sup> However, some experts are somewhat sceptical about India, as it does not support anti-Russian sanctions and pursues an independent policy. See: Reinsch W. A., Benson E., Arasasingham A. Securing Semiconductor Supply Chains // CSIS. August 2022. URL: [https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/220802\\_Reinsch\\_Semiconductors.pdf?VersionId=WMGKge29KFMObw9Bkvwzkkomj4mUtsr](https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/220802_Reinsch_Semiconductors.pdf?VersionId=WMGKge29KFMObw9Bkvwzkkomj4mUtsr).

Texas Instruments) operate research centres in Bangalore.<sup>159</sup> Indian Prime Minister Narendra Modi's state visit to the United States in June 2023 prompted some major US technology companies to promise to locate their production facilities in India. In particular, Micron plans to build a \$2.75 billion assembly and testing complex for DRAM and NAND memory chips in the state of Gujarat. Applied Materials also announced its plans to invest \$400 million in a new engineering centre in Bangalore.<sup>160</sup>

The US government is forcing businesses to speed up relocation. For example, Apple is facing political, strategic and investment pressure, compelling it to sharply reduce its production-related dependence on China.<sup>161</sup> The company is attacked by both Democrats and Republicans for being "so dependent on China that it can no longer express basic American values."<sup>162</sup> There are other reasons for relocating as well. During the pandemic, China's strict policies led to major disruptions in the supply chain<sup>163</sup> which was a painful experience. Now, Apple is concerned that escalating tensions between Washington and Beijing could hamper its carefully organised supply chain. In view of this, Apple is exploring production options outside China and gradually diversifying the geography of its manufacturing base. According to experts, the company is currently going through a rough patch, with a 40.5 percent decline in the Apple Inc. personal computer market in the first quarter of 2023, sluggish demand, and an excess of products in the industry. In the context of unfavourable economic circumstances, Apple sees a window of opportunity for relocating its manufacturing sites.<sup>164</sup>

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<sup>159</sup> Reinsch W. A., Benson E., Arasasingham A. Securing Semiconductor Supply Chains // CSIS. August 2022. URL: [https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/220802\\_Reinsch\\_Semiconductors.pdf?VersionId=WMGKge29KFMOBw9Bkvwzcxomj4mUtsr](https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/220802_Reinsch_Semiconductors.pdf?VersionId=WMGKge29KFMOBw9Bkvwzcxomj4mUtsr)

<sup>160</sup> Щедров И. Учитель йоги в поисках технологий: итоги визита Моды в США // ИМЭМО РАН. 28.06.2023. URL: <https://www.imemo.ru/publications/policy-briefs/text/uchitely-yogi-v-poiskah-tehnologiy-itogi-vizita-modi-v-ssha>

<sup>161</sup> What it would take for Apple to disentangle itself from China // Financial Times. 18.01.2023. URL: <https://www.ft.com/content/74f7e284-c047-4cc4-9b7a-408d40611bfa>

<sup>162</sup> Ibid.

<sup>163</sup> In December 2022, thousands of workers were forced to flee the Zhengzhou megafactory known as iPhoneCity, operated by Foxconn (a manufacturing partner of Apple).

<sup>164</sup> Apple's 40% Plunge in PC Shipments Is Steepest Among Major Computer Makers // BNN Bloomberg. 10.04.2023. URL: <https://www.bnnbloomberg.ca/apple-s-40-plunge-in-pc-shipments-is-steepest-among-major-computer-makers-1.1905817>

Intel has encountered similar pressure. At the end of 2021, the company planned to ramp up chip production in China, but the White House rejected this plan. As a result, Intel sold its semiconductor wafer production plant in Dalian to the South Korean SK Hynix Inc. However, Intel still operates chip packaging and testing centres in China.<sup>165</sup>

The US government is also concerned about the country's serious dependence on China for the supply of raw materials that are used in the production of high-tech products. China dominates the global supply chain in terms of certain critical minerals and rare elements that are used in defence and electronics. China has dominant positions in the production of yttrium (99 percent), gallium (94 percent), metallic magnesium (87 percent), tungsten (82 percent), bismuth (80 percent) and others.<sup>166</sup> The United States lacks domestic production of 14 out of 35 critical raw materials, and the country relies on imports for more than 50 percent of its supplies of 31 elements.<sup>167</sup> In recent years, there has been a discussion in the United States about diversifying supply chains for critical minerals. Diversification implies domestic production and collaboration with allies (the EU, Australia, Canada, and Japan). This goal is outlined in the Department of Energy's 2021-2031 strategy to support domestic supply chains for critical minerals and materials.<sup>168</sup> Additionally, the Brookings Institution suggested that some African countries could be considered as potential external alternative suppliers of raw materials.<sup>169</sup>

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<sup>165</sup> US to Stop TSMC, Intel From Adding Advanced Chip Fabs in China // Bloomberg. 2.08.2022. URL: <https://www.bloomberg.com/news/articles/2022-08-02/us-to-stop-tsmc-intel-from-adding-advanced-chip-fabs-in-china?sref=Y0jVLCFo>

<sup>166</sup> The US policy in dealing with critical minerals // ISE. October 2019. URL: <https://ru.institut-seltene-erden.de/die-us-politik-im-umgang-mit-kritischen-mineralien/>

<sup>167</sup> Critical Minerals and Materials: U.S. Department of Energy's Strategy to Support Domestic Critical Mineral and Material Supply Chains (FY 2021-FY 2031) // U.S. Department of Energy's Strategy to Support Domestic Critical Mineral and Material Supply Chains. 2021. URL: [https://www.energy.gov/sites/prod/files/2021/01/f82/DOE%20Critical%20Minerals%20and%20Materials%20Strategy\\_0.pdf](https://www.energy.gov/sites/prod/files/2021/01/f82/DOE%20Critical%20Minerals%20and%20Materials%20Strategy_0.pdf)

<sup>168</sup> Ibid.

<sup>169</sup> Could Africa replace China as the world's source of rare earth elements? // Brookings. 29.12.2022. URL: <https://www.brookings.edu/articles/could-africa-replace-china-as-the-worlds-source-of-rare-earth-elements/#:~:text=In%202021%2C%20global%20demand%20for,and%2085%25%20of%20processing%20capacity.>

## Ousting China From Global Markets by Sectoral Sanctions

The United States has been waging an economic war against China for several years now. During this time, the two countries raised tariffs on various goods, adopted new rules limiting investment in each other's economies, introduced export controls on sensitive technology, limited access to research and university exchanges,<sup>170</sup> and toughened visa procedures, to name a few.

US sanctions policy dealt a heavy blow to Chinese companies. Here are some illustrative examples:

- In 2018, Fujian Jinhua Integrated Circuit Co., was one of the first to be blacklisted. Sponsored by the Chinese authorities, it was developing DRAM domestic chips and cooperating with Taiwan's United Microelectronics Corporation (UMC). Due to US sanctions, UMC refused to continue cooperation with Fujian Jinhua, forcing the manufacturer to cease production.<sup>171</sup>
- In 2018, the US imposed sanctions on China's second largest telecommunications company ZTE. It was banned from buying US technological components for seven years for violating US sanctions against Iran and North Korea. After this decision was announced, ZTE suspended most of its production.<sup>172</sup> However, the company managed to avoid bankruptcy by swiftly signing a deal with the US – ZTE was compelled to pay a fee of \$1.3 billion, appoint US specialists to monitor compliance with sanctions and change its top management.<sup>173</sup>
- In 2019, the United States considered Huawei a threat to its national security. The Chinese company was accused of industrial espionage, violation of Western sanctions against Iran and technology theft. Washington banned the sale of US-made components, including

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<sup>170</sup> Macovei M. There Are No Winners in the US-China "Tech War" // Mises Institute. 28.07.2020. URL: <https://mises.org/wire/there-are-no-winners-us-china-tech-war-0>

<sup>171</sup> The greatest challenge facing China's chip drive? It's neither funding nor talent, but resource allocation // South China Morning Post. 17.01.2023. URL: <https://www.scmp.com/comment/opinion/article/3206470/greatest-challenge-facing-chinas-chip-drive-its-neither-funding-nor-talent-resource-allocation>

<sup>172</sup> U.S. reaches deal to keep China's ZTE in business: congressional aide // Reuters. 25.05.2018. URL: <https://www.reuters.com/article/us-usa-trade-china-zte-idUSKCN1IQ2JY>

<sup>173</sup> Ibid.

semiconductors, to the Chinese telecommunications giant in a bid to deprive it of access to advanced technology.<sup>174</sup> Later, in 2020, using America's central position in the global chip value chain, the US Bureau of Industry and Security (BIS) compelled developers and producers from third countries to limit sales to Huawei.<sup>175</sup> In addition, the US set itself the aim of blocking the company's telecommunications development. The Americans persuaded their allies to renounce or reduce the use of 5G equipment for security considerations. In 2020, sanctions pressure reduced Huawei's share in the global wireless network equipment market by 2 percent.<sup>176</sup> Its smartphone sales dropped by 42 percent compared to the previous year.<sup>177</sup> US restrictions reduced Huawei's presence in the global market, increasing its dependence on the Chinese market. The US dealt a massive sanctions blow to the Chinese company because it had claimed to control the enormous market by creating a comprehensive digital ecosystem, developing both 5G infrastructure and new generation smartphones supporting new telecom standards.

Contrary to the predictions of many analysts, sanctions pressure increased with the advent of the Joe Biden administration. The export control policy was expanded. Technocrats, who believe that the benefits of continued US interaction with China exceed the strategic risks, have ceased to have any influence on decision-making. Centrists are highly influential in the Biden administration, implementing the small-yard-high-fence approach of former Defence Secretary Robert Gates.<sup>178</sup> This entails technological separation in the most strategically sensitive areas with the preservation of bilateral economic ties in other spheres (for instance, non-critical or obsolete technologies). However, centrists are finding it increasingly difficult to find a balance between economic

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<sup>174</sup> Схватка за чипы: чем грозит борьба между США и Китаем за технологическое лидерство // Forbes. 30.04.2023. URL: <https://www.forbes.ru/tekhnologii/488480-shvatka-za-cipy-chem-grozit-bor-ba-mezdu-ssa-i-kitaem-za-tehnologiceskoe-liderstvo>

<sup>175</sup> США расширили санкции против Huawei // Коммерсантъ. 17.08.2020. URL: <https://www.kommersant.ru/doc/4458187>

<sup>176</sup> U.S. campaign against Huawei appears to be working, as Chinese tech giant loses sales outside its home market // The Washington Post. 31.03.2021. URL: <https://www.washingtonpost.com/technology/2021/03/31/impact-us-campaign-against-huawei/>

<sup>177</sup> Ibid.

<sup>178</sup> The Debate to Decouple // CSIS. 16.11.2022. URL: <https://www.csis.org/blogs/new-perspectives-asia/debate-decouple>

openness and protection of national interests. In reality, they are drifting towards a third influential restrictionist political camp, which is more radical, advocating a rupture in economic ties with China (retaining only deals facilitating US domination).<sup>179</sup> Apparently, under the impact of these political forces, the Biden administration has set itself the aim of impeding China's technological upsurge at any price.

The United States is directing its main attack against the heart of IT industry – semiconductors. What has it done so far?

**First**, in August 2022, the US introduced restrictions on exports of high-tech chips to China and Russia. Restrictions were imposed, for example, on graphics processing units (GPU) that are critical for developing artificial intelligence. The ban affected the leading American companies in this area – Nvidia and AMD.<sup>180</sup>

**Second**, in October 2022, the Biden administration decided to totally sever China's access to the most advanced microchips produced with the use of American equipment or technology in any part of the world.<sup>181</sup> Thus, it limited exports of logic chips with non-planar transistor architectures of 16nm or 14nm, or below; DRAM memory chips of 18nm half-pitch or less; NAND flash memory chips with 128 layers or more.<sup>182</sup> Besides this, the US introduced extraterritorial restrictions on supplies of equipment and software to China, to prevent it from producing its own versions of advanced chips. The strategy of deterring Huawei was scaled up with success.

The US is continuously revising its Entity List. It has blacklisted, among others, key Chinese semiconductor producers – Yangtze Memory Technologies Corporation (YMTC), SMIC, Cambricon Technologies, PXW Semiconductor.<sup>183</sup> As of 2022, the Entity List contained about 600 Chinese

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<sup>179</sup> The Debate to Decouple // CSIS. 16.11.2022. URL: <https://www.csis.org/blogs/new-perspectives-asia/debate-decouple>

<sup>180</sup> Схватка за чипы: чем грозит борьба между США и Китаем за технологическое лидерство // Forbes. 30.04.2023. URL: <https://www.forbes.ru/tekhnologii/488480-shvatka-za-cipy-chem-grozit-bor-ba-mezdu-ssa-i-kitaem-za-tehnologiceskoe-liderstvo>

<sup>181</sup> Export restrictions became extraterritorial after the introduction of the *Foreign Direct Product Rule (FDPR)*. This measure bans supplies of equipment and components to China from third countries, if they contain US technology.

<sup>182</sup> Commerce Implements New Export Controls on Advanced Computing and Semiconductor Manufacturing Items to the People's Republic of China (PRC) // BIS. 07.10.2022. URL: <https://www.bis.doc.gov/index.php/documents/about-bis/newsroom/press-releases/3158-2022-10-07-bis-press-release-advanced-computing-and-semiconductor-manufacturing-controls-final/file>

<sup>183</sup> US adds 36 Chinese entities into Entity List, including YMTC // DigiTimes. 16.12.2022. URL: <https://www.digitimes.com/news/a20221216VL204/us-china-chip-ban-ymtc.html>



companies. Their access to US technology, commodities and software was strictly limited.<sup>184</sup>

**Third**, in March 2023, the US updated its Chips Act – companies that received state grants were banned from increasing their production of high-tech chips (less than 28 nm) by more than 5 percent at plants located in the PRC, and from conducting joint research.<sup>185</sup>

**Fourth**, in August 2023, Joe Biden signed an executive order limiting the possibility of China attracting US investment in high-tech industries (microelectronics, artificial intelligence and so on).<sup>186</sup> The White House fears that US investment may help China to develop technology for upgrading its armed forces.<sup>187</sup>

**Fifth**, the Biden administration prohibited American engineers and Chinese citizens with US green cards from working at Chinese chip factories.<sup>188</sup>

American companies found themselves in a difficult situation and some of them are resorting to tricks to keep their profits. Unwilling to lose the profitable Chinese market, Nvidia reduced the capabilities of its A100 and H100 GPUs and offered customers in China the alternative, less powerful A800 and H800.<sup>189</sup> Indicatively, fearing new export restrictions by the Biden administration, the Chinese technical giants (Baidu, ByteDance, Tencent and Alibaba) immediately accepted this alternative version

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<sup>184</sup> Commerce Adds Seven Chinese Entities to Entity List for supporting China's Military Modernization Efforts // BIS. 23.09.2022. URL: <https://www.bis.doc.gov/index.php/documents/about-bis/newsroom/press-releases/3121-2022-08-23-press-release-seven-entity-list-additions/file>

<sup>185</sup> Схватка за чипы: чем грозит борьба между США и Китаем за технологическое лидерство // Forbes. 30.04.2023. URL: <https://www.forbes.ru/tehnologii/488480-shvatka-za-cipy-chem-grozit-bor-ba-mezdu-ssa-i-kitaem-za-tehnologiceskoe-liderstvo>

<sup>186</sup> Executive Order on Addressing United States Investments in Certain National Security Technologies and Products in Countries of Concern // The White House. 9.08.2023. URL: <https://www.whitehouse.gov/briefing-room/presidential-actions/2023/08/09/executive-order-on-addressing-united-states-investments-in-certain-national-security-technologies-and-products-in-countries-of-concern/>

<sup>187</sup> Ibid.

<sup>188</sup> America's commercial sanctions on China could get much worse // The Economist. 30.03.2023. URL: <https://www.economist.com/briefing/2023/03/30/americas-commercial-sanctions-on-china-could-get-much-worse>

<sup>189</sup> Nvidia graphic processors are used to process big data, and to study language models, autonomous transport and complicated calculations, to name a few. See.: China's internet giants order \$5bn of Nvidia chips to power AI ambitions // The Financial Times. 9.08.2023. URL: <https://www.ft.com/content/9dfce156-4870-4ca4-b67d-bb5a285d855c>

and ordered tens of thousands of processors.<sup>190</sup> Owing to the high demand, However, in October 2023, new US sanctions followed, this time banning the supply of H800 and A800 GPUs to China. Nvidia is again planning to develop special versions that would not be subject to sanctions. Nvidia is reported to be preparing three GPU models: HGX H20, L20 PCIe, and L2 PCIe<sup>191</sup>.

The American leadership admits that unilateral action may undermine the long-term efficiency of sanctions policy on China.<sup>192</sup> This is why it has been making efforts recently to gain the support of its allies and partners. The Americans are compelling key semiconductor producers from Japan, the Netherlands, Taiwan and South Korea to support their sanctions policy that threatens mainland China with a multilateral boycott in sensitive technologies. It is worth noting that the US Government has achieved a certain amount of success in this respect. Since 2019, the Dutch ASML stopped its exports to China of EUV-machines (most advanced extreme ultraviolet photolithography) that produce chips with nodes as small as 7, 5 and 3nm.<sup>193</sup> On January 27, 2023, Japan and the Netherlands signed a deal limiting China's access to cutting-edge semiconductor producing equipment.<sup>194</sup> On July 23, 2023, Japan announced its decision to limit exports of 23 types of semiconductor producing equipment.<sup>195</sup> From September 1, 2023, ASML also introduced export controls on some less advanced models of deep ultraviolet photolithography equipment (DUV)<sup>196</sup>. US partners display this kind of loyalty because all technology contains a high proportion of American intellectual property or components. For example, ASML depends on supplies of laser systems that are manufactured

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<sup>190</sup> China's internet giants order \$5bn of Nvidia chips to power AI ambitions // The Financial Times. 9.08.2023. URL: <https://www.ft.com/content/9dfee156-4870-4ca4-b67d-bb5a285d855c>

<sup>191</sup> США запретили поставки в Китай ускорителей Nvidia, созданных специально для Китая, поэтому Nvidia создаст новые. Модели HGX H20, L20 PCIe и L2 PCIe ожидаются в ближайшее время // industry-hunter. 10.11.2023. URL: <https://industry-hunter.com/ssa-zapretili-postavki-v-kitaj-uskoritelej-nvidia-sozdannyh-specialno-dla-kitaa-poetomu-nvidia-sozdast-novye-modeli-hgx-h20-l20-pcie-i-l2-pcie-ozidautsa-v-blizajsee-vrema>

<sup>192</sup> The Current State of U.S.-China Chip Competition // The Diplomat. 6.04.2023. URL: <https://thediplomat.com/2023/04/the-current-state-of-u-s-china-chip-competition/>

<sup>193</sup> China voices opposition to new Dutch rules restricting chip equipment exports // Global Times. 1.06.2023. URL: <https://www.globaltimes.cn/page/202307/1293512.shtml>

<sup>194</sup> Ibid.

<sup>195</sup> Japan's export curbs on chip-making equipment to China take effect // The Japan Times. 23.07.2023. URL: <https://www.japantimes.co.jp/news/2023/07/23/business/chip-export-curbs-begin/>

<sup>196</sup> The Netherlands has started limiting chip gear exports to China // TechWire. 4.09.2023. URL: <https://techwireasia.com/2023/09/when-do-chinese-chip-gear-export-curbs-hit-the-netherlands/>

by Cymer<sup>197</sup> in the US. This is why the Dutch company has to coordinate its activities with the new US legislation in many respects. Moreover, foreign companies prefer to accommodate US restrictions because otherwise they can lose a big share of their profits. For example, TSMC receives about 60 percent of its revenue from US customers and a mere 20 percent from mainland China.<sup>198</sup> Nonetheless, for a number of companies – ASML, Samsung, TSMC and some others – the loss of the growing Chinese market is very painful and is not in their interests.

Naturally, the Biden administration cannot completely ignore the aspirations of its foreign partners and it is trying to be flexible towards them. Thus, in October 2022, South Korean and Taiwanese companies with plants in mainland China<sup>199</sup> were allowed to maintain production of semiconductors with the use of US equipment and technology for one more year without additional licencing requirements.<sup>200</sup> In June 2023, Under Secretary of Commerce for Industry and Security Alan Estevez announced a decision to extend the waivers<sup>201</sup> but it is unknown for how long. In all probability, Washington is afraid to scare its partners off with its aggressive export controls policy. It is trying to keep a certain balance, realising that overhasty actions may cause a serious disruption in the global semiconductor supply chain.

It seems America wants to get a quick result by pursuing its large-scale sanctions policy and to crush China's technological success by pulling the emergency brake. Although overall, export controls have already had a negative effect on China's semiconductor industry (according to Bloomberg, its chips industry underwent a serious decline in 2022),<sup>202</sup> the

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<sup>197</sup> ASML // ASML official website. URL: <https://www.asml.com/en/company/about-asml/cymer>

<sup>198</sup> Can China Become the World Leader in Semiconductors? // The Diplomat. 25.09.2020. URL: <https://thediplomat.com/2020/09/can-china-become-the-world-leader-in-semiconductors/>

<sup>199</sup> TSMC has a factory in mainland China, in Nanjing, while Samsung Electronics has one in Xi'an, and SK Hynix has two big plants in Wuxi and Dalian.

<sup>200</sup> Samsung and SK Hynix face China dilemma from U.S. export controls // Nikkei Asia. 25.10.2022. URL: <https://asia.nikkei.com/Business/Tech/Semiconductors/Samsung-and-SK-Hynix-face-China-dilemma-from-U.S.-export-controls>

<sup>201</sup> U.S. to Allow South Korean, Taiwan Chip Makers to Keep Operations in China // WSJ. 12.06.2023. URL: <https://www.wsj.com/articles/u-s-to-allow-south-korean-taiwan-chip-makers-to-keep-operations-in-china-5d7d72cc>

<sup>202</sup> US to Stop TSMC, Intel From Adding Advanced Chip Fabs in China // Bloomberg. 2.08.2022. URL: <https://www.bloomberg.com/news/articles/2022-08-02/us-to-stop-tsmc-intel-from-adding-advanced-chip-fabs-in-china?sref=Y0jVLCFo>

Biden administration is considering possibilities for a further toughening of restrictions.<sup>203</sup> For example, the White House is thinking about restricting the rent of cloud services used by Chinese companies due to the shortage of high-tech chips.<sup>204</sup> Quantum technology may be the next victim. Chinese companies may face restrictions on the supply of equipment for quantum computing, error correction software and cloud access to quantum computers.<sup>205</sup>

## Consolidation With Allies, Partners and Like-Minded States

Alliances or “force multipliers” traditionally play a big role in US policy. To strengthen its positions in the technological race, the Biden administration is resorting to ad-hoc practice in cooperation. It is consolidating its relations with its allies and adherents by establishing various technological partnerships (TTC, Chip 4 and others). The technological ecosystem, especially microelectronics, is largely globalised. It embraces East Asia, Europe and the US. In this context, the Americans intend to pool their efforts primarily with the EU and its individual members, as well as with Japan, South Korea and Taiwan.

### TTC

The Trade and Technology Council (TTC) is an example of Western technological consolidation. It is a trans-Atlantic partnership of the US and the EU, launched in 2021. This alliance is largely asymmetrical because the technological weight of its members is unequal.<sup>206</sup> The TTC is designed to maintain regular contacts between American and European officials and experts on a broad range of issues, ranging from the elaboration of technical standards to the deployment of 5G/6G networks, and ensuring

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<sup>203</sup> Reuters узнал о встречах производителей чипов с чиновниками Белого дома из-за Китая // Forbes. 18.07.2023. URL: <https://www.forbes.ru/tekhnologii/492998-reuters-uznal-o-vstrecah-proizvoditelej-cipov-s-cinovnikami-belogo-doma-iz-za-kitaa>

<sup>204</sup> U.S. Considers New Curbs on AI Chip Exports to China // WSJ. 27.06.2023. URL: <https://www.wsj.com/amp/articles/u-s-considers-new-curbs-on-ai-chip-exports-to-china-56b17feb>

<sup>205</sup> However, some scientists believe that as distinct from the semiconductor industry, quantum computing is a young and still experimental sector. Export controls are unlikely to be effective because this industry still has to develop a single approach to the creation of a quantum computer, and supply chains require improvement. См.: The U.S. Wants to Make Sure China Can't Catch Up on Quantum Computing // FP. 31.03.2023. URL: <https://foreignpolicy.com/2023/03/31/us-china-competition-quantum-computing/>

<sup>206</sup> Some researchers believe that it is easier to establish asymmetrical alliances and they are more sustainable and long lasting. См.: Morrow J. D. Alliances and Asymmetry: An Alternative to the Capability Aggregation Model of Alliances // American Journal of Political Science, Nov., 1991, Vol. 35, No. 4 (Nov., 1991), pp. 904-933.

sustainable semiconductor supply chains and cybersecurity. The stated goal of the TTC is to draft international technological rules and standards for promoting Western values and interests. However, at present the alliance is more focused on unifying standards than coordinating policy at a time of heightened geopolitical risks. Therefore, its main goal today is to retain the Western lead in conditions of strategic competition with China and the conflict with Russia. As some experts note, the TTC is becoming a “central support” for the trans-Atlantic partnership, and is indispensable for coordinating sanctions and export controls.<sup>207</sup> Those participating in this platform are also working on a mechanism for monitoring the creation of value chains to identify and prepare for potential supply disruptions, as well as to enhance transparency and exchange information.

### **Chip 4**

In Asia, the United States is trying to unite the largest technology players around itself with the goal of creating a mega semiconductor supply chain, without China’s participation.<sup>208</sup> In March 2022, US President Joe Biden suggested establishing a technological alliance Chip 4 (or Fab 4). Apart from the US, it includes Japan, South Korea and the Chinese province of Taiwan.

The officially stated aim of the alliance is to ensure the security of the global semiconductor supply chain, coordinate policy, grant subsidies and conduct joint R&D. However, Washington is obviously trying to use the alliance to expand its access to vital chips and make it more difficult for China to obtain advanced semiconductor technology. For the US, Chip 4 may act as a foundation for technological breakthroughs.<sup>209</sup>

The choice of participants is easy to explain – they account for a large part of capabilities for designing, producing and testing microchip components. For example, the South Korean companies Samsung and SK Hynix are the world leaders in memory chips. TSMC dominates in terms of the manufacture of the most advanced semiconductor wafers with 5 and 3nm process nodes. Taiwan is the centre for assembly, test, mark and pack (ATMP) via Foxconn and Wistron.<sup>210</sup> In addition, the world’s most advanced

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<sup>207</sup> Толстухина А. Технологический суверенитет Евросоюза и его границы // Международный дискуссионный клуб «Валдай». Валдайская записка №119. 07.10.2022. URL: <https://ru.valdaiclub.com/a/valdai-papers/valdayskaya-zapiska-119/>

<sup>208</sup> What is the Chip 4 alliance? // TRT World. 9.09.2022. URL: <https://www.trtworld.com/business/what-is-the-chip-4-alliance-59586>

<sup>209</sup> Is there really a Chip 4 Alliance? Officially, it’s still a proposal // TECHWIRE Asia. 10.01.2023. URL: <https://techwireasia.com/2023/01/is-there-really-a-chip-4-alliance-officially-its-still-a-proposal/>

<sup>210</sup> Ibid.

semiconductor manufacturing capacities with process technologies of less than 10nm are now located in Taiwan (92 percent) and South Korea (8 percent).<sup>211</sup> Japan dominates the manufacture of critical production equipment and materials, in particular, photoresists (two Japanese companies – JSR and Shin-Etsu Chemical – control about 90 percent of this market.)<sup>212</sup>

Thus, Chip 4 embraces almost all the main areas involved in creating a value chain: Taiwan and South Korea produce chips; Japan manufactures materials and equipment, and the US designs chips, develops software and makes equipment. However, some important links are missing – raw materials (China) and photolithographic equipment (the Netherlands), to name a few.

Although the United States is trying hard to mobilise its East Asian alliance, no agreements or treaties have been signed in the year since its foundation. At its only online meeting on February 16, 2023, its high-ranking officials discussed ways of creating an early warning system and ensuring a more sustainable global chain of semiconductor supplies.<sup>213</sup> At the same meeting, which was not attended by a single technological company, Taiwan proposed exchanging information on different aspects of the supply chain as soon as possible.<sup>214</sup> The participants expressed their intention of informing each other officially with regard to the problems that might arise in the global supply chain but “postponed the discussion” of export controls, which are a bigger concern for the US.

### ***Quad and the Indo-Pacific Economic Framework (IPEF)***

In Asia, Washington is also planning to use Quad and the Indo-Pacific Economic Framework (IPEF) to strengthen the supply chains of semiconductors and their critical components.

Overall, the United States is demonstrating an aggressive approach in these alliances by compelling its partners to join the sanctions policy contrary to economic expediency.

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<sup>211</sup> Strengthening the Global Semiconductor Supply Chain in an Uncertain Era // SIA/BCG Report. April 2021. URL: <https://www.semiconductors.org/strengthening-the-global-semiconductor-supply-chain-in-an-uncertain-era/>

<sup>212</sup> Производителей фоторезиста для EUV-литографии станет больше. Но этот рынок монополизировала Япония // 3DNews. 10.10.2020. URL: <https://3dnews.ru/1022646/proizvoditeley-fotorezista-dlya-euvlitografii-stanet-bolshe-no-etot-rinok-monopolizirovala-yaponiya>

<sup>213</sup> US-led ‘Fab 4’ chip alliance meets to coordinate supply chain resilience // COMPUTERWORLD. 27.02.2023. URL: <https://www.computerworld.com/article/3689157/us-led-fab-4-chip-alliance-meets-to-coordinate-supply-chain-resilience.html>

<sup>214</sup> Ibid.

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# Vulnerabilities in the US Technology Policy

## Issues With New Legislation

The CHIPS and Science Act does not address the supply of raw materials, components, or equipment, implying that the United States underestimates the danger of its semiconductor sector's dependence on a vast number of the second- and third-tier suppliers worldwide, which produce industrial equipment, specialty chemicals, and equipment for crystal growth, as well as a wide range of other critical components.

The CHIPS and Science Act raises questions and criticism with external players, particularly TSMC, Samsung, and SK Hynix. This document stipulates the payment of subsidies to companies from the partner countries. However, to receive the subsidy, companies must disclose information about their management decisions and manufacturing processes, which entails business risks. Furthermore, subsidised companies come under obligation to share a portion of their profits with the US government.<sup>215</sup>

Additionally, according to this act, companies receiving federal funding are not to increase the production of advanced microchips on mainland China with a technology platform under 28 nm.<sup>216</sup> This is how the White House is trying to put a cap on investment in China. Major industry players are fighting off such attempts, as without the ability to upgrade or expand existing capacities, they effectively lose growth opportunities on the world's largest semiconductor market.<sup>217</sup> The South Korean government and companies are urging the US leadership to reconsider these restrictions. Some Korean companies are concerned to the point where they are considering rejecting assistance from the US

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<sup>215</sup> South Korea says US Chips Act subsidies have too many requirements // Fox Business. 7.03.2023. URL: <https://www.foxbusiness.com/markets/south-korea-us-chips-act-subsidies-requirements>

<sup>216</sup> US to Stop TSMC, Intel From Adding Advanced Chip Fabs in China // Bloomberg. 2.08.2022. URL: <https://www.bloomberg.com/news/articles/2022-08-02/us-to-stop-tsmc-intel-from-adding-advanced-chip-fabs-in-china?sref=Y0jVLCFo>

<sup>217</sup> Ibid.

federal government, a move that could damage the image of the US government programmes.<sup>218</sup>

Moreover, some Western analysts fear that the adoption of new legislation will spark a subsidy race and competition between the United States and its own allies and partners. South Korea, the EU and Taiwan – the key players on the technology field – are already responding to US legislation by increasing subsidies and introducing tax incentives in the semiconductor industry.<sup>219</sup> Market competition does not align with America's interests, as the country strives for dominance amid close cooperation with its allies and partners.

## Lack of Skilled Labour

When deploying the manufacturing ecosystem, the United States has run into shortages of highly skilled labour. The labour force is crucial, since engineers, managers, factory workers, and technicians represent the main force and value of an enterprise. US technology companies find it hard to attract employees to the manufacturing sector, as the talented mostly gravitate towards the financial sector, consulting, and the internet industry. This is further compounded by the issues haunting US immigration policy, which creates difficulties in obtaining work visas and bringing specialists to the country.<sup>220</sup> According to a Deloitte report, the US semiconductor industry may face a shortage of 70,000 to 90,000 workers in the next few years. McKinsey predicts a shortage of around 300,000 engineers and 90,000 skilled technical specialists in the United States by 2030.<sup>221</sup> Authorities and companies are facing the complex task of making the public interested in the industry.

## Expensive Production

According to analysts, the production of high-tech products, particularly semiconductors, in the United States will be very expensive. The operation of TSMC's factory in Washington has shown that semiconductor

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<sup>218</sup> U.S. to Allow South Korean, Taiwan Chip Makers to Keep Operations in China // WSJ. 12.06.2023. URL: <https://www.wsj.com/articles/u-s-to-allow-south-korean-taiwan-chip-makers-to-keep-operations-in-china-5d7d72cc>

<sup>219</sup> KaminD., KysarR. The Perils of the New Industrial Policy. How to Stop a Global Race to the Bottom // Foreign Affairs. 2023. URL: <https://www.foreignaffairs.com/united-states/industrial-policy-china-perils>

<sup>220</sup> Semiconductors and National Security: The CHIPS Challenge // Aspen Security Forum. 2023. URL: <https://www.youtube.com/live/grp93s6QVOg?si=ehsWcrpOCUVAevJD>

<sup>221</sup> America's Semiconductor Boom Faces a Challenge: Not Enough Workers // The New York Times. 19.05.2023. URL: <https://www.nytimes.com/2023/05/19/us/politics/semiconductor-worker-shortage.html>



production at that factory is 50 percent more expensive than in Taiwan.<sup>222</sup> Interestingly, Morris Chang, the founder of TSMC, was sceptical about US efforts to increase local chip production. According to Chang, America's attempt to boost local chip production will be a "wasteful, expensive exercise in futility." Similar assessments are common in the US expert community as well. For instance, CSIS analysts believe that in the long term, reshoring will increase prices, reduce efficiency and weaken the competitiveness of the United States.<sup>223</sup>

## Government Subsidies Do Not Boost Competition

As shown by the PIIE study "Scoring 50 Years of US industrial policy, 1970–2020," federal subsidies to one or two companies fail to boost their innovative efforts because they do not create a healthy competitive environment. The competitive pressure is either weakened, or eliminated entirely.<sup>224</sup> If, for example, Intel<sup>225</sup> were to receive the bulk of subsidies from the federal budget, this would not lead to significant breakthroughs in the semiconductor industry. According to some analysts, the future of the industry will depend on the proper distribution of funding.<sup>226</sup>

## Dependency on Imports of the Most Advanced Chips Will Persist

According to the Biden administration's plan, the TSMC factories being built in Arizona will make the United States self-sufficient in the production of cutting-edge semiconductors. However, analysts are doubtful. Despite TSMC's decision to invest \$40 billion in their construction, this amount is insufficient to create production that would be comparable to that in Taiwan. For example, it is anticipated that TSMC's

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<sup>222</sup> Can semiconductor manufacturing return to the US? // Brookings, CSIS. 19.04.2022. URL: <https://www.youtube.com/watch?v=NwCWYcag5RE&t=5s>

<sup>223</sup> Reinsch W. A., Benson E., Arasasingham A. Securing Semiconductor Supply Chains // CSIS. August 2022. URL: [https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/220802\\_Reinsch\\_Semiconductors.pdf?WMGKge29KFMOBw9Bkvwzcxomj4mUtsr](https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/220802_Reinsch_Semiconductors.pdf?WMGKge29KFMOBw9Bkvwzcxomj4mUtsr).

<sup>224</sup> Hufbauer G.C., Jung Euijin. Scoring 50 Years of US Industrial Policy, 1970–2020 // PIIE. November 2021. URL: <https://www.piie.com/sites/default/files/documents/piieb21-5.pdf>

<sup>225</sup> The U.S. Department of Commerce says about two-thirds of the federal subsidies earmarked for the semiconductor industry through the Chip Act will go to advanced semiconductor makers TSMC, Samsung and Intel. See.: Chip Makers Turn Cutthroat in Fight for Share of Federal Money // The New York Times. 23.02.2023. URL: <https://www.nytimes.com/2023/02/23/business/economy/chip-makers-fight-federal-money.html>

<sup>226</sup> Ibid.

factories in Arizona will produce 600,000 wafers per year. Meanwhile, in 2021 alone, the Taiwanese factory produced 14.2 million wafers, and this figure is growing every year. According to analysts, Arizona's share in TSMC's global output will amount to a meagre 2.85 percent by 2026. TSMC will need to spend about \$1 trillion to fully meet the demand of Apple, AMD, Nvidia, and Qualcomm for the US-made chips.<sup>227</sup>

Moreover, American factories will lag behind Taiwanese ones by two to three generations because research and development will remain in Taiwan. For example, 3nm process chips are already being produced in Taiwan, while production in Arizona will not begin until 2026.

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## Challenges Posed by the Decoupling Policy and the Flip Side of Sanctions

The technological decoupling between China and the United States is unprecedented and disrupts the architecture of market and production processes in the high-tech sector. Let's explore the main risks posed by the decoupling policy and the ongoing export control programme for the United States.

### Loss of Control

The US government risks losing control over the situation since there is no clearly articulated national strategy for technological decoupling from China. Also, predicting China's technological progress becomes a challenge given these circumstances. According to analysts, the further the United States distances itself from China, including in terms of scientific exchange and joint research, the more challenging it will be for it to understand its competitor's current and future technological capabilities.<sup>228</sup>

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<sup>227</sup> Sorry, USA, \$40 Billion Won't Buy Chip Independence // The Washington Post. 7.12.2022. URL: [https://www.washingtonpost.com/business/sorry-usa-40-billion-wont-buy-chip-independence/2022/12/07/997ab18e-75f6-11ed-a199-927b334b939f\\_story.html](https://www.washingtonpost.com/business/sorry-usa-40-billion-wont-buy-chip-independence/2022/12/07/997ab18e-75f6-11ed-a199-927b334b939f_story.html)

<sup>228</sup> The Right Time for Chip Export Controls // Lawfare. 13.12.2022. URL: <https://www.lawfaremedia.org/article/right-time-chip-export-controls>

## Consequences for Economic Health and Political Stability

The Quincy Institute for Responsible Statecraft acknowledges that globalisation has been a wealth generator over the past few decades, despite its uneven distribution. Engaging in a competitive face-off with China amid unwinding globalisation could have serious consequences for the economic health and political stability of the United States.<sup>229</sup> America's resilience is not infinite, as evidenced by the fragility of the US financial system (bankruptcies of major American banks,<sup>230</sup> the raising of the US debt ceiling in June 2023,<sup>231</sup> etc.), and the widening societal divide. In an article for *The New York Times*, historian Niall Ferguson noted that "one of the biggest sources of political and social strife in the Cold War era was a war against communism that the United States failed to win - against Vietnam."<sup>232</sup> Drawing out economic confrontation with China may lead to a similar outcome.

## Impact on US Companies and Innovation

Considering the US dependence on the vast and rapidly expanding Chinese market, which provides both production and consumption for the US technology companies, the unprecedented export controls may be utterly painful for them. In recent years, exports to China accounted for about 30 percent of revenue of the US companies like KLA, Applied Materials, and Lam Research which engage in making semiconductor manufacturing equipment.<sup>233</sup> Additionally, about one-fifth of Nvidia's global revenue, about a quarter of Intel's income, and about 60 percent of Qualcomm's income come from China.<sup>234</sup>

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<sup>229</sup> Managed Competition: A U.S. Grand Strategy for a Multipolar World // QUINCY BRIEF. No. 30. 1.09.2022. URL: <https://quincyinst.org/report/managed-competition-a-u-s-grand-strategy-for-a-multipolar-world/>

<sup>230</sup> GlobBaro HSE: Барометр мировой экономики // ВШЭ. Выпуск 13. 2023. URL: [https://arb.ru/banks/analytics/globbaro\\_hs\\_barometr\\_mirovoy\\_ekonomiki\\_aprel\\_nachalo\\_maya\\_2023\\_g-10632691/](https://arb.ru/banks/analytics/globbaro_hs_barometr_mirovoy_ekonomiki_aprel_nachalo_maya_2023_g-10632691/)

<sup>231</sup> Байден подписал закон об увеличении потолка госдолга США выше \$31,4 трлн // РБК. 3.06.2023. URL: <https://www.rbc.ru/economics/03/06/2023/647b805e9a7947622e575b1d>

<sup>232</sup> Ferguson N. The New Cold War? It's With China, and It Has Already Begun // The New York Times. 2.12.2019. URL: <https://www.nytimes.com/2019/12/02/opinion/china-cold-war.html>

<sup>233</sup> Эффект бумеранга: антикитайские санкции США ударили по мировой полупроводниковой отрасли // Открытый журнал. 19.10.2022. URL: <https://journal.open-broker.ru/radar/effekt-bumeranga/>

<sup>234</sup> Chip players are urging the US to relook into curbs against China // Techwire. 25.06.2023. URL: <https://techwireasia.com/2023/07/china-chip-curbs-should-be-relooked-into/>

In 2020, the Boston Consulting Group (BCG) conducted a study showing that if the United States were to prohibit US companies from exporting chips and related technology to China, US companies could lose 18 percent of the global market share, 37 percent of revenue, and between 15,000 to 40,000 high-skilled jobs in the semiconductor industry.<sup>235</sup>

After Washington had imposed severe sanctions on the Chinese microelectronics and supercomputing sector, chip companies lost over \$240 billion stock valuation.<sup>236</sup> US companies, including electronic design automation developers, chip designers, semiconductor manufacturing equipment producers, and chip makers found themselves on the receiving end. In July 2023, SIA once again urged the Biden administration to refrain from imposing further restrictions on chip sales to China and to allow the industry constant access to the Chinese market.<sup>237</sup>

US companies in other high-tech sectors are seriously concerned about the sanctions being scaled up. For example, the possibility of banning cloud access to quantum computers for Chinese organisations is seen as an existential threat by the start-up companies IonQ and Rigetti, as they derive a significant portion of their revenue from providing cloud services.<sup>238</sup>

Export controls can go beyond significantly reducing corporate revenues and affect private research and innovation. The traditional US leadership in the semiconductor industry was based on an effective innovation cycle that relied on US companies' access to global markets which made it possible to invest heavily in research and development.<sup>239</sup> US companies earned billions of dollars annually by selling technologies and licences to China. According to SIA, China purchased semiconductors worth \$378 billion in 2020 alone.<sup>240</sup> Export restrictions will reduce the revenue and disincentivise companies from engaging in innovation.

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<sup>235</sup> VarasA., VaradarajanR. How Restricting Trade with China Could End US Semiconductor Leadership // BCG. 9.03.2020. URL: <https://www.bcg.com/publications/2020/restricting-trade-with-china-could-end-united-states-semiconductor-leadership>

<sup>236</sup> Производители чипов из США признали, что технологические санкции против Китая ударят и по ним // 3Dnews. 30.01.2023. URL: <https://3dnews.ru/1081074/v-ssha-nachinayut-osoznavat-vred-ot-tehnologicheskikh-sanktsiy-protiv-kitaya-dlya-svoey-mestnoy-industrii>

<sup>237</sup> Reuters узнал о встречах производителей чипов с чиновниками Белого дома из-за Китая // Forbes. 18.07.2023. URL: <https://www.forbes.ru/tehnologii/492998-reuters-uznal-o-vstrecah-proizvoditelej-cipov-s-cinovnikami-belogo-doma-iz-za-kitaa>

<sup>238</sup> The U.S. Wants to Make Sure China Can't Catch Up on Quantum Computing // FP. 31.03.2023. URL: <https://foreignpolicy.com/2023/03/31/us-china-competition-quantum-computing/>

<sup>239</sup> Varas A., Varadarajan R. How Restricting Trade with China Could End US Semiconductor Leadership // BCG. 9.03.2020. URL: <https://www.bcg.com/publications/2020/restricting-trade-with-china-could-end-united-states-semiconductor-leadership>

<sup>240</sup> Taking Stock of China's Semiconductor Industry // SIA. 13.06.2021. URL: <https://www.semiconductors.org/taking-stock-of-chinas-semiconductor-industry/>

CSIS noted that excessive control of technology in the name of national security could strip US high-tech companies of revenue and profits that are needed for innovation and growth, especially for investment in research and development of next-generation products.<sup>241</sup> Semiconductor sector companies typically spend over 15 percent of their annual revenue on research and development.<sup>242</sup> It is important to consider the pace at which the semiconductor business is operating to explain this kind of spending on further research. Each generation of advanced technology typically has a service life of two to four years before it is replaced by more advanced technology.<sup>243</sup>

BCG also warned that the escalation of tension between the United States and China was fraught with the loss of competitiveness for US companies, with South Korea likely to surpass the United States in the near future as a global leader in semiconductors. In turn, cutting investment in R&D will obstruct the US semiconductor industry efforts to achieve breakthroughs that are necessary to maintain global leadership, upon which the US technology and defence sectors heavily rely. It is anticipated that cutting investment in R&D would increase dependence on foreign semiconductor suppliers.<sup>244</sup>

The US technology business itself (Intel, NVIDIA, Qualcomm, and others) expresses strong concerns about export controls, complaining that the current policy ties the hands of companies, depriving them of the opportunity of competing and leading in one of the world's largest markets.<sup>245</sup>

Corporations warn regulators that sectoral sanctions undermine President Biden's long-term goals of encouraging chip manufacturing in the United States, as the lack of orders from Chinese clients will eliminate the need to implement projects such as Intel's manufacturing complex in Ohio.<sup>246</sup>

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<sup>241</sup> Reinsch W. A., Benson E., Arasasingham A. Securing Semiconductor Supply Chains // CSIS. August 2022. URL: [https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/220802\\_Reinsch\\_Semiconductors.pdf?VersionId=WMGKge29KFMObw9BkvwzKxomj4mUtsr](https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/220802_Reinsch_Semiconductors.pdf?VersionId=WMGKge29KFMObw9BkvwzKxomj4mUtsr).

<sup>242</sup> Can China Become the World Leader in Semiconductors? // The Diplomat. 25.09.2020. URL: <https://thediplomat.com/2020/09/can-china-become-the-world-leader-in-semiconductors/>

<sup>243</sup> Ibid.

<sup>244</sup> Varas A., Varadarajan R. How Restricting Trade with China Could End US Semiconductor Leadership // BCG. 9.03.2020. URL: <https://www.bcg.com/publications/2020/restricting-trade-with-china-could-end-united-states-semiconductor-leadership>

<sup>245</sup> US considers tougher restrictions on AI chip exports to China // Financial Times. 28.07.2023. URL: <https://www.ft.com/content/a6c6b769-349e-440f-a55b-c92371d00dd9>; Semiconductors and National Security: The CHIPS Challenge // Aspen Security Forum. 2023. URL: <https://www.youtube.com/live/grp93s6QVOg?si=ehsWcrpOCUVAevJD>

<sup>246</sup> Chip players are urging the US to relook into curbs against China // Techwire. 25.06.2023. URL: <https://techwireasia.com/2023/07/china-chip-curbs-should-be-relooked-into/>

## Slower PC Market May Play Into China's Hands

Some people believe that the difficulty in accessing crucial knowledge, technology, and production sites due to lagging behind in key technologies could significantly weaken China's digital advancement especially as the high dynamism of innovation in the ICT sector does not allow for pauses in innovation.<sup>247</sup>

However, China might benefit from the slowdown in the PC and processor market caused by global economic instability. Many US processor companies, such as AMD and Intel, have been hit by a significant drop in sales. According to analysts from Mercury Research, 2022 was the worst year for the processor market in the 30 years of the market research company's studies, with mobile processor sales plummeting by 30 percent for the year. Intel reported an enormous net loss of over \$600 million in the last quarter of 2022.<sup>248</sup> In these challenging circumstances, the US corporations are forced to cut capital spending on innovation, which leads to a lengthening of the life cycle of old products. Amid this slowdown, China may have the opportunity to level the risks of its innovation pause.

## Challenges of Production Relocation From China to Third Countries

Many economists are warning that the cost of friendshoring, which is seen as part of the deglobalisation process, could be high. The restructuring of production supply chains to bypass China may lead to short-term price hikes and long-term growth rate reductions.<sup>249</sup> The Semiconductor Industry Association, representing 99 percent of chip manufacturers in America, notes that losing access to production in China will decrease the international competitiveness of the United States in the high value-added end of the supply chain.<sup>250</sup>

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<sup>247</sup> Данилин И.В. Американо-китайская технологическая война: риски и возможности для КНР и глобального технологического сектора. Сравнительная политика. 2020;11(4):160-176.

<sup>h</sup><https://comparativepolitics.elpub.ru/jour/article/view/1246/768>

<sup>248</sup> AMD заняла рекордную долю рынка процессоров. Intel в большой опасности // Cnews. 10.02.2023. URL: [https://www.cnews.ru/news/top/2023-02-10\\_amd\\_zanyala\\_rekordnyuyu\\_dolyu](https://www.cnews.ru/news/top/2023-02-10_amd_zanyala_rekordnyuyu_dolyu)

<sup>249</sup> Friendshoring: what is it and can it solve our supply problems? // The Guardian. 6.08.2022. URL: <https://www.theguardian.com/business/2022/aug/06/friendshoring-what-is-it-and-can-it-solve-our-supply-problems>

<sup>250</sup> Macovei M. There Are No Winners in the US-China "Tech War" // Mises Institute. 28.07.2020. URL: <https://mises.org/wire/there-are-no-winners-us-china-tech-war-0>

The risk of relocating production to third countries is associated not only with a decrease in the competitiveness of US companies. India, Vietnam, Thailand and other Asian countries are currently incomparable to mainland China in terms of the completeness of the production supply chain, logistics infrastructure, manufacturing skills, quality of labour resources, and government support.<sup>251</sup> According to analysts, it will take these countries decades to create conditions as favourable as those in China.<sup>252</sup>

No doubt, Vietnam and India have factories run by major manufacturers such as Samsung or Foxconn, among others, but they cannot operate without supplies of materials and components from China. Steven Tseng, senior technology analyst at Bloomberg Intelligence notes: “Foxconn may be moving there, but their suppliers are not. There is no supply chain in India. They have to import pretty much everything from China.”<sup>253</sup>

Also, importantly, building an entire production system from scratch in another country is impossible without initial capital, staff training (including language), adaptation to local conditions, and overcoming numerous other complex and specific challenges.<sup>254</sup> Apple spent about two decades and billions of dollars creating an extraordinarily complex supply chain in China. Currently, over 95 percent of iPhones, AirPods, Macs, and iPads are produced there, and it is impossible to abruptly abandon such a well-established ecosystem.<sup>255</sup> According to some former Apple employees, “the company cannot diversify, because China will dominate in labour and technology production for another 20 years.”<sup>256</sup>

This is not to say that industrial clusters won’t eventually grow in other countries. This process will evolve over time and likely lead to the formation of a complex industrial ecosystem, but not without

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<sup>251</sup> What it would take for Apple to disentangle itself from China // Financial Times. 17.01.2023. URL: <https://www.ft.com/content/74f7e284-c047-4cc4-9b7a-408d40611bfa>

<sup>252</sup> Vietnam or India: which one will be the new “world’s factory”? // GRR. 9.06.2022. URL: [https://www.gingerriver.com/p/vietnam-or-india-which-one-will-be?utm\\_source=substack&utm\\_medium=email](https://www.gingerriver.com/p/vietnam-or-india-which-one-will-be?utm_source=substack&utm_medium=email)

<sup>253</sup> What it would take for Apple to disentangle itself from China // Financial Times. 18.01.2023. URL: <https://www.ft.com/content/74f7e284-c047-4cc4-9b7a-408d40611bfa>

<sup>254</sup> Vietnam or India: which one will be the new “world’s factory”? // GRR. 9.06.2022. URL: [https://www.gingerriver.com/p/vietnam-or-india-which-one-will-be?utm\\_source=substack&utm\\_medium=email](https://www.gingerriver.com/p/vietnam-or-india-which-one-will-be?utm_source=substack&utm_medium=email)

<sup>255</sup> How Apple tied its fortunes to China // Financial Times. 16.01.2023. URL: <https://www.ft.com/content/d5a80891-b27d-4110-90c9-561b7836f11b>

<sup>256</sup> What it would take for Apple to disentangle itself from China // Financial Times. 18.01.2023. URL: <https://www.ft.com/content/74f7e284-c047-4cc4-9b7a-408d40611bfa>

China's involvement.<sup>257</sup> Even with the relocation of production supply chains to third countries, the dependency on China will not disappear in the foreseeable future. This is evident from US tech giants, which, contrary to sanctions, continue to expand business ties with China. For instance, in the summer of 2023, Intel opened a new innovation centre in Shenzhen, which will focus on AI and edge computing.<sup>258</sup>

## Consolidation Challenges

The United States has raised the stakes in order to slow down China's technological development, but there is no guarantee that allies and partners will fully side with America and turn away from the lucrative Chinese market. The challenges of multilateral coordination can be seen from the inertia of the Chip 4 alliance. There are several reasons behind the lack of significant progress in its work. **First**, potential alliance participants in many areas of the microelectronics industry are direct competitors and are hesitant to share technologies, developments, and specific know-how with each other. For example, Samsung is concerned that its materials or transistor designs could be used by TSMC or Intel.<sup>259</sup> **Second**, the Chinese market's strength plays a great role. Mainland China and Hong Kong account for about 60 percent of South Korea's semiconductor exports. As for Taiwan, despite a 31.3 percent drop in exports of integrated circuits to China and Hong Kong compared to the previous year, and a 22.3 percent<sup>260</sup> increase in exports to the United States in February 2023, the country's overall trade with mainland China is higher than that with the United States. In 2021, mainland China and Hong Kong accounted for 42 percent of Taiwan's exports, while the United States accounted for 15 percent.<sup>261</sup> Moreover, as mentioned above, foreign factories producing advanced chips are located in mainland China: Samsung makes up to 40 percent

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<sup>257</sup> Vietnam or India: which one will be the new "world's factory"? // GRR. 9.06.2022. URL: [https://www.gingerriver.com/p/vietnam-or-india-which-one-will-be?utm\\_source=substack&utm\\_medium=email](https://www.gingerriver.com/p/vietnam-or-india-which-one-will-be?utm_source=substack&utm_medium=email)

<sup>258</sup> Intel aumentai proprilegami con la Cina, nonostante le tensioni con Washington sui chip // ScenariEconomici. 3.08.2023. URL: <https://scenarieconomici.it/intel-aumenta-i-propri-legami-con-la-cina-nonostante-le-tensioni-con-washington-sui-chip-foto/>

<sup>259</sup> U.S.-Proposed Chip 4 Alliance Faces Opposition from Partners // Tom's Hardware. 14.09.2022. URL: <https://www.tomshardware.com/news/us-proposed-chip-4-alliance-faces-opposition-from-partners>

<sup>260</sup> В феврале тайваньский экспорт чипов в Китай упал на 31,3 % // 3DNews. 20.03.2023. URL: <https://3dnews.ru/1083658/v-fevrale-tayvanskiy-eksport-chipov-v-materikoviy-kitay-upal-na-313->

<sup>261</sup> Is there really a Chip 4 Alliance? Officially, it's still a proposal // TECHWIRE Asia. 10.01.2023. URL: <https://techwireasia.com/2023/01/is-there-really-a-chip-4-alliance-officially-its-still-a-proposal/>



of its NAND memory chips there, and SK Hynix produces approximately the same number of DRAM chips,<sup>262</sup> which means that any disruptions in bilateral relations will jeopardise the production process.

South Korea is most opposed to the US initiative, since China is its largest export market. Restricting the sales of advanced technology will inevitably affect South Korean companies' revenues and growth plans. Japan, on the other hand, appears to be more loyal to the United States in the alliance. In May 2022, Washington and Tokyo announced cooperation in diversifying semiconductor production, increasing transparency, coordinating responses to chip shortages, and conducting joint research and development in the field of next-generation semiconductors.<sup>263</sup> In addition, reportedly, the United States has concluded some kind of agreement with Japan to limit exports of Canon, Nikon, and Tokyo Electron products to China.<sup>264</sup> However, it seems that close interaction between Washington and Tokyo in the field of microelectronics will not make much sense without the participation of South Korea and Taiwan, which are the key suppliers of advanced semiconductors. Overall, potential participants in the Chip 4 alliance have many reasons to be concerned, casting doubt on its effectiveness.

Interestingly, consolidation difficulties are also observed within the TTC. Washington and Brussels have so far been unable to agree on how hard they should resist China's growth in various areas ranging from global trade to semiconductors and generative AI.<sup>265</sup>

## China's Response Measures

After Washington toughened its sanctions pressure, there were apprehensions that the restrictions might push China to take response measures in areas where it had levers. For example, China could use

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<sup>262</sup> Samsung and SK Hynix face China dilemma from U.S. export controls // Nikkei Asia. 25.10.2022. URL: <https://asia.nikkei.com/Business/Tech/Semiconductors/Samsung-and-SK-Hynix-face-China-dilemma-from-U.S.-export-controls>

<sup>263</sup> Japan and U.S. reaffirm chip partnership, but impact seen as limited // The Japan Times. 23.05.2023. URL: <https://www.japantimes.co.jp/news/2022/05/23/business/us-japan-semiconductor-partnership/>

<sup>264</sup> US Government Stops Export Licenses to Huawei // Tom's Hardware. 31.01.2023. URL: <https://www.tomshardware.com/news/us-govt-ceases-to-grant-export-licenses-to-huawei>

<sup>265</sup> Specter of China looms over EU-US summit // Politico. 26.05.2023. URL: <https://www.politico.eu/article/china-eu-us-trade-technology-council-summit/>

its dominant position in mining and rare earth mineral processing.<sup>266</sup> These apprehensions were justified – on August 1, 2023, China decided to limit the export of gallium and germanium, which are crucial for the production of semiconductors and other high-tech products.<sup>267</sup> Analysts believe that the restrictions on the export of these metals may increase the production costs of chips and subsequently reduce the growth potential for the entire industry.<sup>268</sup> Other retaliatory measures included denying certain American technology companies access to the Chinese market. For instance, operators of critical infrastructure in China were banned from buying chips from the American company Micron. On May 21, 2023, the Chinese authorities announced that these products were a threat to national security. In the opinion of some analysts, Micron became China's target because Beijing could easily buy chips from the American company's South Korean competitors – Samsung and SK Hynix.<sup>269</sup>

Beijing's reaction to export restrictions has been relatively restrained for the time being but this does not mean that it will remain so.

## Sanctions Are Working but Not Well Enough

The US campaign against China's semiconductor sector is aimed at gaining time and breaking away from China in terms of technological development. Practice shows that this strategy works but only for a limited time.

Obviously, Western export controls are a real trial for China. At present, China does not have the domestic equipment and software required for the mass production of the most advanced chips.<sup>270</sup>

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<sup>266</sup> Specter of China looms over EU-US summit // Politico. 26.05.2023. URL: <https://www.politico.eu/article/china-eu-us-trade-technology-council-summit/>

<sup>267</sup> Китай контролирует 94% поставок галлия и 83% – германия. См.: Korea Chip 4 Alliance Member Most Vulnerable to China Tech Materials Restrictions // Sino NK. 18.07.2023. URL: <https://sinonk.com/2023/07/18/korea-chip-4-alliance-member-most-vulnerable-to-china-tech-materials-restrictions/>

<sup>268</sup> Китай ограничил экспорт необходимых для производства чипов металлов // РБК. 4.07.2023. URL: <https://www.rbc.ru/economics/04/07/2023/64a352db9a7947b60e85e0f9?from=newsfeed>

<sup>269</sup> В США посчитали беспочвенным запрет Китая на продукцию Micron // РБК. 22.05.2023. URL: <https://www.rbc.ru/rbcfreenews/646ae07b9a794776f2e8a901>

<sup>270</sup> Ковачич Л. Битва за полупроводники: будут ли победители? // РСМД. 29.08.2023. URL: <https://russiancouncil.ru/analytics-and-comments/analytics/bitva-za-poluprovodniki-budut-li-pobediteli/>

An illustrative example of the effect of the new export controls is provided by YMTC, a large Chinese producer of memory chips. According to analysts, sanctions prevented this company from completing the drafting of its business plan for 2023. It can no longer build production lines with foreign components. In January 2023, it started reducing its workforce. Former employees claim that the company is desperately trying to save money<sup>271</sup>. Biren Tech, a well-known Chinese developer of chips, is also dismissing its workers and simplifying its product to survive.<sup>272</sup>

However, the Chinese companies are not going to give up and are trying to move forward despite all the restrictions. In August 2023, Huawei launched its flagship smartphone Mate 60 Pro running on the HarmonyOS 4.0. operating system. This smartphone has a new processor – HiSilicon Kirin 9000s with a 7nm chip (N+2) made by SMIC.<sup>273</sup> Expert opinion varies on the origin of this processor.<sup>274</sup> The US also has questions about the smartphone being equipped with SK Hynix memory microchips, as current restrictions prohibit their export to Huawei<sup>275</sup>. Nonetheless, the appearance of this new device shows that China has a serious technological background and is able to cope with a storm of sanctions. Chris Miller, a professor at Tufts University said: “This shows that Chinese companies like Huawei still have plenty of capability to innovate.”<sup>276</sup>

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<sup>271</sup> America's commercial sanctions on China could get much worse // The Economist. 30.03.2023. URL: <https://www.economist.com/briefing/2023/03/30/americas-commercial-sanctions-on-china-could-get-much-worse>

<sup>272</sup> China's chip design industry in 2022: the dawn of living with US sanctions // Technode. 9.02.2023. URL: <https://technode.com/2023/02/09/silicon-chinas-chip-design-industry-in-2022-the-dawn-of-living-with-us-sanctions/>

<sup>273</sup> В новых смартфонах *Huawei* действительно нашли 7-нм чипы, которые Китай научился делать в условиях санкций // 3DNews. 04.09.2023. URL: <https://3dnews.ru/1092474/vipuskom-mobilnogo-protссора-dlya-huawei-mate-60-pro-predpologitelno-zanimaetsya-smic-s-ispolzovaniem-7nm-tehprotssessa>

<sup>274</sup> В новых смартфонах *Huawei* действительно нашли 7-нм чипы, которые Китай научился делать в условиях санкций // 3DNews. 04.09.2023. URL: <https://3dnews.ru/1092474/vipuskom-mobilnogo-protссора-dlya-huawei-mate-60-pro-predpologitelno-zanimaetsya-smic-s-ispolzovaniem-7nm-tehprotssessa>

<sup>275</sup> SK hynix Investigates Sanctions-Breaking 'Ghost RAM' In Huawei Phone // Tom's Hardware. 7.09.2023. URL: <https://www.tomshardware.com/news/sk-hynix-digs-deep-into-sanctions-breaking-ghost-ram-in-huawei-phone>

<sup>276</sup> New phone sparks worry China has found a way around U.S. tech limits // The Washington Post. 2.09.2023. URL: <https://www.washingtonpost.com/technology/2023/09/02/huawei-raimondo-phone-chip-sanctions/>

## Encouraging Beijing to Develop Its Own Advanced Technology

Ousting foreign companies from Chinese territory, America is simultaneously removing the industry's monopolists from it. China will have its own competitive players – this is only a question of time.

Sanctions slow down but do not stop China's technological progress. They are encouraging it to redouble efforts to develop its own advanced production of high-tech goods. The Chinese Shanghai Micro Electronics Equipment Group (SMEE) is developing a 28nm photolithographic machine and plans to put it on the market by the end of 2023.<sup>277</sup> There have been reports that Chinese firms have successfully developed electronic design automation (EDA) tools for chips produced at and above 14nm.<sup>278</sup>

ASML CEO Peter Wennink cautioned that the US campaign may have unexpected repercussions. He forecast that in the future “China will develop the technology domestically rather than import it.”<sup>279</sup> CSIS experts also fear that tougher export controls may inspire China to build up its own technological potential, making it a more serious competitor to the West in the long-term perspective.<sup>280</sup> SIA experts expressed the following opinion: “While there remains a long way to go for China to catch up with existing industry leaders – especially in advanced node foundry production, equipment, and materials – the gap is expected to narrow over the next decade as Beijing sharpens its focus on semiconductor self-reliance...”<sup>281</sup>

China may be lagging behind by several generations in the semiconductor industry but it has not been ousted from the relevant market. Microchips with a less advanced technical processor remain in demand (in the production of household equipment, cars, etc). By scaling their manufacture, Chinese producers may edge out their Western rivals in this sector.

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<sup>277</sup> Chinese firm expected to deliver 28nm chip machine at year-end: media report // Global Times. 1.08.2023. URL: <https://www.globaltimes.cn/page/202308/1295484.shtml>

<sup>278</sup> Huawei achieves breakthrough in EDA tools for chips // China Daily. 24. 03.2023. URL: <https://www.chinadaily.com.cn/a/202303/24/WS641d36a4a31057c47ebb65fb.html>

<sup>279</sup> Biden Wins Deal with Netherlands, Japan on China Chip Export Limit // Bloomberg. 27.01.2023. URL: <https://www.bloomberg.com/news/articles/2023-01-27/biden-wins-deal-with-dutch-japan-on-china-chip-export-controls>

<sup>280</sup> Allen G. C. Choking off China's Access to the Future of AI // CSIS. 11.10.2022. URL: <https://www.csis.org/analysis/choking-chinas-access-future-ai>

<sup>281</sup> China's Share of Global Chip Sales Now Surpasses Taiwan's, Closing in on Europe's and Japan's // SIA 10.01.2022. URL: <https://www.semiconductors.org/chinas-share-of-global-chip-sales-now-surpasses-taiwan-closing-in-on-europe-and-japan/>

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# Forecast

Practice shows that the stronger the turbulence the shorter the forecasting horizon. That said, let's try to imagine what will take place in the technological arena in the next decade.

**First**, the world will hardly be rigidly divided into two mutually exclusive techno-economic blocs. Their autonomy will be limited by the deep integration of the US and Chinese economic systems. This thesis is buttressed by numerous statements by US leaders, saying that “a full separation of our economies would be disastrous for both countries. It would be destabilising for the rest of the world.”<sup>282</sup> US businesses do not want to give up the profitable Chinese market either and are striving to keep it accessible. This is clear from numerous visits to Beijing by heads of US technological corporations in the spring and summer of 2023.<sup>283</sup> In addition, figures also show that a deep split of the world economy into competing blocs is impossible for the time being. In 2022, overall US-China trade was growing, reaching a record \$690 billion.<sup>284</sup>

**Second**, although the economic systems of the two countries are most likely to remain largely interdependent and most commercial sectors will remain open and global, some critical industries may be affected by regional fragmentation. This trend is dangerous for both the United States and China. Although US National Security Advisor Jake Sullivan described the Biden administration's approach as “small yard, high fence,” it may have big repercussions because the US is primarily hitting at the heart of the IT sector – microelectronics. This is bound to affect the development of all related technologies (AI, supercomputers, etc.) Fragmentation may lead to serious economic costs for semiconductor companies. Some experts believe this may slow down the growth rates of the technological capabilities of both sides.<sup>285</sup>

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<sup>282</sup> Remarks by Secretary of the Treasury Janet L. Yellen on the U.S. - China Economic Relationship at Johns Hopkins School of Advanced International Studies // U.S. Department of the Treasury. 20.04.2023. URL: <https://home.treasury.gov/news/press-releases/jy1425>

<sup>283</sup> In March, Apple CEO Tim Cook and Qualcomm CEO Cristiano Amon visited Beijing. In April, Intel CEO Pat Gelsinger visited, while Tesla co-founder Elon Musk was in the Chinese capital in May. Microsoft co-founder Bill Gates met Chinese leader Xi Jinping during his visit to Beijing in June. См.: U.S. big tech won't shake its China addiction // Asia Nikkei. 12.07.2023. URL: <https://asia.nikkei.com/Spotlight/The-Big-Story/U.S.-big-tech-won-t-shake-its-China-addiction>

<sup>284</sup> Объем торговли США и Китая достиг рекордных 690,59 млрд долл. по итогам 2022 года // Рамблер. 10.02.2023. URL: <https://finance.rambler.ru/markets/50176733-obem-torgovli-ssha-i-kitaya-dostig-rekordnyh-690-59-mlrd-po-itogam-2022-goda/>

<sup>285</sup> Ковачич Л. Битва за полупроводники: будут ли победители? // РСМД. 29.08.2023. URL: <https://russiancouncil.ru/analytics-and-comments/analytics/bitva-za-poluprovodniki-budut-li-pobediteli/>

**Third**, despite the complexity of reassembling the system of connections in the Hi-Tech sector, in the next ten or twenty years, we may see a considerable reorganisation in the production chains of various high-tech products when many of them are transferred from China to third countries (India, Vietnam and others).

**Fourth**, tougher export controls will stimulate China to develop greater technological autonomy. China is most likely to provide itself with the required equipment, components and software. Initially, they may be inferior to their Western counterparts but they will serve as a foundation for further technological progress.

**Fifth**, the current US policy on China's technological containment may exacerbate bilateral relations. Considering the weight of the competing actors, this poses a threat to the security of the entire world. It is already obvious today that the implementation of "industry 4.0" will increase the likelihood of conflict.

It is very difficult to predict who will win the race for technological leadership and how the world will be reformatted. Apparently, we will see a more or less clear picture in the next 10 or 15 years. Both the US and China have their strong points. China has advantages in its powerful production infrastructure, workforce, production knowledge and skills and very strong government support. The US is superior in innovation, knowledge, developments, talent attraction and marketing. In addition, America is cooperating with key technological players – the EU, Japan and South Korea, to name a few, whereas China mostly relies on itself, thereby enhancing its technological sovereignty.

In any case, "industry 4.0" has not yet reached the end of history. Quantum computers are still experimental equipment. Scientists have not yet developed AI comparable with or even close to the human intellect and there are hard problems requiring breakthroughs in microelectronics. So, it is too early to make predictions about who will win the tech race.

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