
Compete, Contest and Collaborate: How to Win the Technology Race with China

A Proposal Developed for the Technology and Public Policy Project¹

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Summary

China systematically extracts advanced technology from the West. It does so legally, by mining open source databases, investing in our most advanced companies, and compelling technology transfer as a condition for doing business in China, as well as illicitly, through cybertheft and industrial espionage.

How we choose to react will define whether the United States continues to lead in—and reap the benefits of—technical innovation and whether we will be able to set the global norms and standards for technology development and use. Previous U.S. presidents of both parties engaged China in dialogue on IP theft and market access for U.S. firms, among other issues. They were unable to correct China’s behavior. So far, the Trump Administration has focused on trade negotiations and on “defensive” measures: from Congress reforming CFIUS in 2018 and a proposed tightening of export controls, to scrutinizing and slowing cross-border collaboration, and discussing restricting Chinese student visas to the United States.¹ Yet instead of closing the U.S. system, as we are beginning to do, we can and must compete with China, and in some cases, find ways to collaborate.

Defense is important but it alone will not solve the problem. While the government is erecting barriers to cross-border trade, investment and knowledge flows, U.S. technology companies see the world as mostly global, integrated and stateless. These companies innovate globally

¹ Disclaimer: The views and opinions expressed in this paper are solely those of the authors and do not necessarily reflect those of Stanford University, the Geopolitics, Technology and Governance Program, or the Technology and Public Policy Project.

and cooperate across borders, and they do not necessarily share the government’s view that U.S. national security is at stake, and that ending collaboration is the best way to protect it.

This paper is designed to give the administration, Congress and/or the incoming President a firm grasp on the tools that are available to win the technology race with China. It proposes a three-prong approach to addressing China’s rise—contest, compete, and collaborate—with concrete recommended policy actions under each prong.

We support continued engagement with China; that engagement cannot succeed if China pays no costs for bad behavior. We outline a narrowly tailored set of defensive measures below. Offensively, we must augment the U.S. innovation system so that we can compete with China or any other challenger nation. We propose doing so via substantially increased investment in talent and R&D, and in diplomacy to proactively set the international norms and standards that govern technology development. Finally, where possible, we should collaborate with China on technologies—such as clean tech and specific healthcare technologies—that do not implicate U.S. national security and where technical advancements would help humanity as a whole.

The Challenge

What’s at stake?

There is nothing wrong with China’s desire to grow, and in fact, the U.S. and its allies should welcome the contributions China can make to future technological innovations. But China does not play fair. Chinese mercantilism undermines the norms and basic trust that support the global economic order.

If the United States does not act, we risk ceding technological leadership and influence to set the norms, values and standards for technology, with three potentially disastrous consequences.

First, rapid technological advances could give China’s military an edge in future conflicts (especially in AI and anti-satellite technology), thus destabilizing the Asia-Pacific region.

Second, the spread of China’s Orwellian AI-enabled social control system to other countries poses deep risks. China already scans its citizens’ faces and tracks what people say online through artificial intelligence—to stop jaywalking, but also make sure they are not criticizing their government.ⁱⁱ China is already exporting these surveillance systems to dictators around the world.ⁱⁱⁱ Likewise, China’s ability to bend the private sector to its will means turning ostensibly “private” companies like Huawei and others into tools the Chinese Communist Party can use to spy, or, for example, control power plants and other critical infrastructure in western countries—a threat that grows as Chinese exports increase.

Third, we risk a world with increased cyber war and unregulated military use of autonomous systems, because the United States has not led in setting the global norms for such conflict.

To recommend effective solutions, we must first understand China's goals, how China is executing against those goals, and where that leaves the United States and West in the technology race.

What Are China's Goals?

After spending decades striving to catch up economically and technologically, China is now the world's largest economy (by purchasing power parity) and explicitly aspires to lead across advanced technology sectors. China's most assertive policy pronouncement, "Made in China 2025," creates state-sponsored programs and specific targets for China to lead the world in ten strategic technology sectors, including semiconductors, aviation, agriculture, electronics, cleantech, and biomedicine.^{iv} China aspires by 2035 to be a global leader in innovation, and by 2049, China wants to lead in "national strength and international influence" with a military that can "fight and win."^v President Xi has publicly stated that technology constitutes China's "core combat capability."^{vi}

How China Acquires Technology: Through Licit and Illicit Means

To achieve the goals described above, China has engaged in aggressive behaviors to acquire advanced technologies, including:^{vii}

- Encouraging some Chinese students and researchers at U.S. universities to spy on its behalf^{viii}
- Engaging in protectionism that blocks American internet firms from the Chinese market, and thus insulates Chinese "national champions" like Tencent and Baidu from competition
- Sponsoring economic espionage of private and public sector IP, which the IP Commission recently estimated costs American companies between \$180 billion and \$540 billion each year^{ix}

Simultaneously, China has used legal means that nevertheless pose a challenge to America's technological leadership, including:

- State subsidies to develop competitors in strategic technology sectors^x
- Forcing western companies to transfer their technology as a condition of doing business in the Chinese market—in 2013 and 2017 approximately one-third of U.S. companies cited technology transfer as a concern^{xi}

- Investments and acquisitions in U.S. companies with strategic technologies, including, but not limited to, venture capital investments that alone reached \$72 billion in 2015, representing 16% of all U.S. venture investment that year^{xii}
- Real innovation by Chinese companies that have scale, capital, and excellent researchers, such as Tencent, Huawei, or DJI, a Chinese drone company now supplying 75% - 85% of the global market^{xiii}
- Mining western open source databases of academic and corporate R&D to utilize and deploy the latest developments in global AI^{xiv}
- Research partnerships with companies like Baidu in Silicon Valley and Microsoft in China, and until recently with universities like Berkeley and MIT^{xv}
- Recruiting U.S. talent and enticing many of the hundreds of thousands of Chinese students in the United States—representing 25% of all US STEM graduate students—back to China with prestigious academic positions or outsized compensation packages^{xvixvii}

Critical Technologies China is Focused On

While “Made in China 2025” identifies ten priority sectors, we believe that if China dominates the following three critical technology sectors, it could have an enormous negative impact on our military and economic security.

Artificial Intelligence: AI is a “general purpose technology,” akin to the steam engine or electricity, with the potential to revolutionize a wide range of sectors. China has a whole-of-government approach to achieve dominance in AI, investing in key areas of talent, data, hardware, ensuring its top AI firms do not compete with each other, while sharing their innovations with the government. It also provides regulatory support, including loose privacy and data protection regulations.^{xviii} Thirty-five Chinese universities will have AI majors starting in fall 2019, and initiatives like the “Thousand Talents” campaign recruit AI researchers and engineers from the United States (mostly Chinese nationals) to return to China.^{xix} China’s tech giants like Tencent, Alibaba and Baidu hold data at rare scale and diversity due to the reach of these companies across sectors, the sheer size of China’s 800-million-user internet ecosystem, and to the lack of privacy controls.

Semiconductors: Semiconductors are the most crucial building block of the information economy. American companies currently hold a competitive advantage. China consumes one half of the world’s semiconductors, but currently produces only about 3%.^{xxi} Its goal is to produce 70% of the world’s semiconductors in China by 2025.^{xxii} China has massive public-private funding vehicles pursuing mergers and acquisitions throughout the world, aggressive forced transfer of western technology, espionage efforts directed at leading American companies like Micron, and strategic partnerships with leaders like Intel.^{xxiii} It is imperative that the United States maintain its technological edge in semiconductors as it will have ripple effects in all military and commercial technology, in particular compute-heavy AI.

5G: 5G will be the backbone of the new economy, providing the antennas and routing infrastructure on which everything from cellphones to the entire “internet of things” will rely, including electricity grids, smart cities and autonomous vehicles. Our economy is growing highly dependent on 5G, and thus more vulnerable to sabotage.^{xxiv} China has an advantage because its national champion, Huawei, is both genuinely innovative and has benefited tremendously from state subsidies and industrial espionage against western companies.^{xxv} China is several years ahead of the US in deploying the technology, and Huawei is building 5G networks in many countries at materially cheaper rates (up to 35% less) and equivalent quality compared with alternatives like Ericsson and Nokia.^{xxvi} Due to China’s authoritarian system, Huawei, or any other Chinese company, can be marshalled for illicit action by the state—either spying or remotely controlling the internet of things—thus creating unacceptable risk for infrastructure that the U.S. economy and security will rely on so heavily.

Other Technologies: In addition to AI, semiconductors, and 5G, China’s “Internet Plus” and “Made in China 2025” call for the government to invest in and push innovation in sectors including robotics, aerospace, autonomous vehicles, cleantech, quantum computing, and biomedicine. In some of these sectors, the US and China could usefully cooperate, while in others the potential for dual-use military applications is too great.

The Proposal

This paper outlines a three-prong approach of contesting (“defense”), competing with (“offense”), and collaborating with China to ensure the U.S. maintains its leadership position in global technology. The proposal aims to reduce the severity of China’s illicit behaviors, compel China’s adherence to norms and rules in development and trade of technology, and ensure America’s continued leadership in next generation technologies.

“Defensive” Measures: Contesting Chinese Efforts

“Defensive” measures—like some the Trump administration and Congress have taken already—are a crucial way to protect the United States from cyber-espionage and other “leakage” of key technology secrets. Thus far, the administration has pressured Congress to reform CFIUS in 2018, proposed tightening of export controls, scrutinized and slowed cross-border collaboration, and publicly aired consideration of restricting Chinese student visas. However, the administration has applied these defensive tools inconsistently and does not appear to have clear strategic vision for which technologies it wants to protect and why. This paper proposes a clear, purposeful application of these tools to reduce China’s transgressions.

Prevent IP leaks via Foreign Transactions (Investment, M&A, Joint Ventures and Partnerships): In 2018, Congress substantially—and rightfully—reformed the law that governs foreign investment to make it more difficult for Chinese companies (and those from other

nations) to invest in cutting edge technology here in the United States. This was a commendable start, although the new law (called “FIRRMA”) is in some ways over-broad: it defines “critical technologies” very broadly and requires reviews of investment into the United States by all countries, even NATO allies that do not present security concerns. FIRRMA and the companion export control reforms currently under development must be carefully tailored to address dual use technology, but not so broad as to shut down valuable international cooperation. For example, we believe the Administration should create a scientific and private sector advisory panel that defines—on an ongoing and evolving basis—which “critical technologies” we need to protect. Such an advisory committee can help strike the right balance between ensuring security while not stifling innovation.

Exact Costs for Transgressions: China and Chinese firms should incur consequences when they break the rules. In addition to pursuing WTO actions against China, the United States should narrowly exercise available executive investigative and sanctioning powers as appropriate under the International Emergency Economic Powers Act (IEEPA), the “Entity List” of the Commerce Department’s Bureau of Industry and Security (BIS), and Section 337 (1930 Tariff Act) actions to punish specific Chinese firms or industry sectors for forced technology transfer, economic espionage and market protectionism. The WTO has not been an effective venue for technology-related issues between the United States and China under the last two administrations, in part because of the lack of willingness of U.S. companies to push for government action on their behalf, as well as government complacency in the face of that reluctance.^{xxvii}

The Trump Administration has used the “Entity List” to punish firms like ZTE and Huawei. Both do engage in problematic behavior, but the “Entity List” is a powerful tool that can generate unintended consequences and we believe it should be used in a narrowly tailored and measured way. For example, when Huawei was listed in May 2019, it lost access not just to the U.S. 5G market, which is a legitimate concern, but also to Intel’s chips, and to Google’s Android operating system, which does not implicate national security and harms our companies in the process.

Don’t Got it Alone: Defensive actions will carry even more weight if we do them jointly with like-minded nations. This will encourage the norms of behavior the United States and allies expect in a global technology economy moving forward.^{xxviii} *Please see our proposal for a “Tech 10” below.*

Sanction Support for China’s Techno-Authoritarianism: The United States should take a clear stand against China’s increasingly brazen use of technology to create an advanced surveillance state that abuses human rights.^{xxix} The Uighurs, a Turkic Muslim group of Chinese citizens, have been the most prominent and hard-hit victims of this techno-authoritarianism to date, and China has shown a willingness to export its methods.^{xxx} To send a message against abuses such as those against the Uighurs, the United States could, at the very least, use the

Global Magnitsky Act to sanction specific government officials in China in charge of implementing abuses against the Uighurs, and possibly add to the Entity List firms that directly and materially support these abuses through financial, services, or technical support. The Senate’s Uyghur Human Rights Policy Act of 2019 (S. 178) is a good start.^{xxx}

“Offensive” Measures: Competing with China

While we must take basic precautions to protect our technology, pulling up the drawbridge and digging a moat around U.S. technology is impossible and will not alone help us win this high-stakes race. Instead, we must once again set global norms and values for technology and reinforce our own ability to innovate.

Global Diplomacy: Shape the Global Norms for Technology

After World War II, a remarkable group of people came together and created the international order as we know it today—including the United Nations, the World Health Organization and the International Atomic Energy Agency—to establish norms for peaceful economic relations and technology standards. It was an enormous effort, and it paid off. It is time for a comparable effort to form a robust international innovation ecosystem among countries that share the same values in technology development: a proposal we call the “Tech 10.”

Through the Tech 10, the United States should join with other technology powers with shared values to coordinate national postures on technology development, use, and access. The inaugural members would include the United States, the United Kingdom, Australia, Canada, France, Germany, India, Israel, Japan, and South Korea. Others could apply to join as long as they agree to adhere to the same high standards.

From the defensive perspective, these countries should share information and coordinate on narrowly tailored export controls, investment restrictions and cyber-security. The Tech 10 will share best practices and intelligence and shape shared perspectives and norms related to deterrence policy tools (e.g., CFIUS, export controls), supply chain security, and investment in and licensing of critical infrastructure and dual-use technologies, among other relevant topics. This would help solve the problem that, for example, Chinese investment in Indian technology companies has spiked since the United States made it more difficult for China to invest.^{xxxii} The same pattern held true for Germany until Germany tightened its investment restrictions in late 2018.

The affirmative agenda could include dialogue on coordinating research and pooling resources and talent to tackle key basic science such as advanced AI, semiconductor research and quantum computing. They could also form working groups with other stakeholders – in particular the private sector and academia – to begin to define norms to govern safe uses of AI and other advanced technology.

Regular meetings of the Tech 10 and working groups could be co-led by ministries of technology, defense and intelligence, with representation, as needed, from trade, commerce, and foreign ministries.^{xxxiii} Tech 10 working groups could commission research in coordination with private and public sector experts to inform evolving issues across domains.

U.S. Government Actions

Federal R&D: Since the post-World War II era, the United States has been the preeminent leader in science and technology and a principal source of commercial innovation. Many of the fundamental breakthroughs underlying the U.S. economy today benefited from federally-sponsored research through the military, national labs, or corporate labs such as the transistor, microprocessor, sequencing the human genome, the Internet, GPS, and many others.^{xxxiv} Federally-funded research rose rapidly in the 1950s and early 1960s, reaching a peak of almost two percent of GDP in 1964, coinciding with the acceleration of the U.S. space program.^{xxxv} Today, that figure has declined to 0.7% and the US is falling behind partners and competitors in terms of government-sponsored research.^{xxxvi} Much of the slack has been filled by private industry funding. Total U.S. R&D remains relatively constant at roughly 2.7% of GDP, representing a marginal increase of less than 1% from 2011-2015. Yet the private sector is not necessarily working on basic science, or R&D that strengthens US competitiveness in the three key sectors we outline above. To create the preconditions for a pipeline of breakthroughs for tomorrow's economy, the United States must commit to a generational national investment in science and technology.

Over time, we believe the U.S. should aspire to grow federal R&D to 1% of GDP or higher, an increase of approximately \$200 billion.^{xxxvii} This approach could include the following recommendations:

- Increase funding at ARPA-E, DARPA, National Laboratories, universities and FFRDCs; establish competitive frameworks for this funding such that those labs which produce results get more funding;
- Coordinate this increase in funding with strategic national priorities for innovation;
- Fund research in areas where the venture capital market is not investing so that more capital-intensive and riskier ideas can be pursued, e.g., in materials science, advanced semiconductors, aerospace, etc.;
- Reorient the Small Business Innovation Research program so that federal agencies provide more money for seed and pre-seed ideas with a streamlined application process; and
- Form a U.S. government investment fund which matches funds invested by private capital (venture or private equity) going into sectors of national interest that are underfunded, such as semiconductors, advanced materials, etc.

Another paper in this series will explore this issue in more detail.

Moonshots: The United States should identify a handful of “moonshots” for public-private cooperation—aligned to the priority technology sectors identified above—and provide economic incentives for academic institutions, labs, and private firms to partner and strive toward ambitious goals. Examples might include artificial general intelligence (AGI) or a quantum supercomputer operating at a reach goal of qubits. Moonshots serve not only to focus efforts and resource allocation behind national priorities, but also have greater potential to override public concerns that can arise from public setbacks.

Talent & Workforce Development

Science and technology talent are the foundations of America’s success, and we are falling behind. The United States must make a generational investment in the nation’s technological talent base by improving the STEM education system, recruiting more tech-savvy talent into the federal government, and reforming our immigration policy.

STEM Education: In the recent OECD PISA worldwide ranking of student math, science and reading scores in 2015-2016, China ranked tenth, while the US came in a measly thirty-first.^{xxxviii} The United States must reverse this trend by building the pipeline of STEM talent starting in K-12. The federal government should provide funding for school districts that establish computer science (CS) as a core, non-elective curriculum offering, and establish loan forgiveness for CS graduates who teach K-12 CS courses.

Several other papers in this series will address specifically the challenge of building a workforce that can win the tech race with China. We agree with their recommendations.

Technical Chops in Government Service: We need more competence among U.S. policymakers on issues of technology. The Congressional questioning of Mark Zuckerberg at hearings in April 2018 showed that some Members of Congress are terrifyingly unprepared to govern on issues of advanced technology. We need a far broader and deeper pipeline of career talent. Similar to the public interest law movement in American legal education, which reduces financial burdens on law students interested in public service, the federal government should support technologists who want to do less lucrative but invaluable service in the government.^{xxxix} Programs to build the talent pipeline across government could include establishing additional fellowships, expanding loan forgiveness, asking tech companies to fund some of their employees doing short secondments in government, or even ROTC-like programs to recruit students with critical STEM training into public service.^{xl}

Finally, we should reestablish the Office of Technology Assessment (OTA). As a neutral research agency within the U.S. Congress staffed by scientists and technologists, OTA used to provide non-partisan advice to Members of Congress on science and technology issues. It was unwisely defunded during the “Gingrich Revolution” in 1994.

Attract and Retain the Best Global Talent: The United States must embrace perhaps our deepest advantage over China—that the best and brightest STEM talents across the world aspire to study at American universities and work for US companies. As of just two years ago, the United States had 26 of the top 50 universities in the world (compared to China’s two), and eight of the ten top technology companies.^{xli} Expanding U.S. educational advantage could include increasing the annual allocation of H1-B visas, and—instead of forcing talented foreign graduate students to leave the United States after just one year—extend post-graduate work visas to them.

The United States should not block Chinese students from studying or working in U.S. technology sectors. Not only is China a leading contributor of top AI talent to American companies, but data suggests most want to stay in the United States.^{xlixliii} To protect against espionage, the United States should set narrowly tailored federal guidelines on research topics that students from “countries of concern” may not participate in, strictly punish students or employees caught spying, and proactively educate Chinese students and employees on China’s state blackmail efforts targeting overseas Chinese. Moreover, we should find ways to punish the Chinese government, not the students, when such theft occurs. With the right preventative measures and education in place, the United State should continue to recruit and retain China’s best talent, alongside that from other nations.

Public-Private Sector Collaboration: We should facilitate and encourage the domestic private sector to cooperate with the federal government in reasonable ways. After all, government contracts were critical to the growth of Silicon Valley companies like Fairchild Semiconductor, Varian and others, while its lifeblood—the Internet—arose out of Defense Department R&D. Establishing the Defense Innovation Unit (DIU) was a good start, and has helped small, innovative firms cooperate with the Department of Defense. In addition to the federal R&D investments listed above, this paper proposes to enhance channels of information sharing regarding resources and opportunities for funding and/or collaboration, including: (a) building a web-based, data-driven IP map outlining strategic sectors for prioritized investment and collaboration; (b) developing sophisticated road shows to demonstrate federally-funded technology to investors; and (c) establishing competent interagency outposts in innovation centers in Silicon Valley, Boston, Austin, New York.

Collaborate: Opportunities to Work with China

Although China is a serious strategic competitor, the “new Cold War” some American commentators are calling for is not the right approach. The United States should continue to seek trade and economic cooperation between the two largest economies in the world as long the playing field is fair. Furthermore, if we identify and capitalize on opportunities to build trust, we can increase the odds of better behavior from China in the long-term.

Private Capital: Turning away all capital from the largest global economy would be short-sighted and potentially harm U.S. competitiveness. As China's economy continues to grow, private capital will continue to seek opportunities outside China. China invested \$49 billion in the United States in 2016, though that figure was down approximately 90% by 2018.^{xliv} As long as private Chinese capital meets standards and accepts restrictions set by CFIUS and other defensive measures, U.S. companies should welcome the financial support for our technology economy.

Problems of the Global Commons: A range of technologies can help mitigate international threats such as climate change, nuclear non-proliferation, and intellectual property theft. The United States should continue to engage China in addressing such shared problems, including by deploying and sharing non-critical technologies to facilitate those efforts.

Non-critical technologies: There are areas of Chinese technological investment where the United States should leverage China's success. For example, China's investment in solar panels has reduced the cost of solar deployment in the United States, accelerating our shift to a clean energy economy.^{xlv}

Conclusion

China's technological rise is a real challenge to the United States and the international system. In order to respond effectively to this challenge, the United States must clarify what lines cannot be crossed—such as industrial espionage and forced technology transfer—amid China's otherwise legitimate efforts, and promptly enforce those rules by exacting costs for transgressions.

However, defense alone will not be sufficient to address the challenge, which shines a light on a set of larger issues facing the United States. In response, we must go on the offensive, reinvesting in America's own ability to compete and lead in global technology innovation—including talent development and federal R&D—and strengthening our global alliances in order to lead the norms, rules, and institutions that govern technological innovation among nations for the coming century.

China views technology supremacy as a core driver of the economic and military dominance in the world they aspire to—so too should the United States. Such focus will help us out-compete China in this strategic contest and secure American leadership for the rest of the 21st century and beyond.

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Former diplomat, author, and advisor on emerging markets, Anja Manuel is Co-Founder and Principal along with former Secretary of State Condoleezza Rice, former National Security Advisor Stephen Hadley and former Secretary of Defense Robert Gates, in RiceHadleyGates LLC, a strategic consulting firm that helps US companies navigate international markets.

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Pavneet Singh previously served in several roles on the National Security Council (NSC) and National Economic Council at the White House where he managed the U.S.-China and U.S.-India economic relationships, and broader U.S. participation in multilateral fora.

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Pavneet earned his master's with distinction in international relations at Georgetown University where he was an Institute for the Study of Diplomacy fellow and a Yahoo! fellow. He earned his undergraduate degrees in business administration and political economy from University of California, Berkeley.

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- ^{xx} Brown and Singh, pp. 19-20.
- ^{xxi} “U.S. Companies Dominate Worldwide IC Marketshare.” IC Insights, June 18, 2019; Note that 3% market share represents that of Chinese companies. The number grows to 16% if you include chips produced in China by non-Chinese companies, available at <http://www.icinsights.com/news/bulletins/US-Companies-Dominate-Worldwide-IC-Marketshare/>.
- ^{xxii} Lewis, James A. “Learning the Superior Techniques of the Barbarians: China’s Pursuit of Semiconductor Independence,” p. 14. CSIS, January 2019, available at https://csis-prod.s3.amazonaws.com/s3fs-public/publication/190115_Lewis_Semiconductor_v6.pdf.
- ^{xxiii} Levesque, and McLaughlin, David. “China State-Owned Firm Charged with Micron Secrets Theft.” *Bloomberg*, November 1, 2018, available at <https://www.bloomberg.com/news/articles/2018-11-01/u-s-says-china-state-owned-co-stole-micron-trade-secrets>.
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- ^{xxv} See, e.g., “Chinese Telecommunications Device Manufacturer and its U.S. Affiliate Indicted for Theft of Trade Secrets, Wire Fraud, and Obstruction Of Justice.” Department of Justice, January 28, 2019, available at <https://www.justice.gov/opa/pr/chinese-telecommunications-device-manufacturer-and-its-us-affiliate-indicted-theft-trade>.
- ^{xxvi} Eurasia Group, pp. 4, 9.
- ^{xxvii} Sullivan, Laura. “As China Hacked, U.S. Businesses Turned a Blind Eye.” *National Public Radio*, April 12, 2019. Available at <https://www.npr.org/2019/04/12/711779130/as-china-hacked-u-s-businesses-turned-a-blind-eye>.
- ^{xxviii} Branstetter, pp. 7-8.
- ^{xxix} Buckley, Chris and Mozur, Paul. “How China Uses High-Tech Surveillance to Subdue Minorities.” *New York Times*, May 22, 2019. Available at <https://www.nytimes.com/2019/05/22/world/asia/china-surveillance-xinjiang.html>.
- ^{xxx} See Mozur, Kessel, and Chan at note 3.
- ^{xxxi} Uyghur Human Rights Policy Act of 2019 (S. 178). Available at <https://www.congress.gov/bill/116th-congress/senate-bill/178/text>. In October 2019, the administration did add some firms to the Entity List that are accused of facilitating surveillance of the Uighur minority.
- ^{xxxii} For example, there has been a nine-fold increase in Chinese investment in Indian start-ups between 2016 to 2018 (\$600m to \$5.5bn). <https://www.ft.com/content/8fdeaedc-a944-11e9-b6ee-3cdf3174eb89>.
- ^{xxxiii} Some relevant governments have Ministers of Technology. In the U.S. this could be the Director of the Office of Science and Technology Policy, or some other Chief Scientist from a Science-based Agency
- ^{xxxiv} Examples of technology initially funded by the federal government include: Google Search Engine (NSF); GPS (DARPA; Navy; DoD); Supercomputing (USAF; Los Alamos; Lawrence Livermore; DoD); AI and Speech Recognition- SIRI, Dragon Systems (Air Force/RAND; DARPA; MIT; CMU; Stanford); Internet (ARPANET; DARPA; NSF; UCLA); Closed Captioning (NIST); Smartphones – semiconductors, touch screens (NASA; USAF; DARPA-SEMATECH; NSF; SBIC); Shale Gas Hydraulic Fracturing (Dept. of Energy; National Labs); 3D and 4D seismic imaging (DOE; MIT); LED Technology (DOE; Air Force); MRI Machines (NIH; NSF); Prosthetics (DARPA; VA); Human Genome Project (NIH; DOE); HIV/AIDS (NIH; FDA); Reverse Auctions (NSF); Kidney Matching Algorithm (NSF; RAND; Office of Naval Research); Fast Multipole Method (DARPA; NYU); SCALE UP Education method (NSF); Civil Aviation, Aeronautical design, jet engines (Army; Navy; NASA); Hybrid Corn (NSF, DOE, USDA); Lactose Free Milk (USDA).
- ^{xxxv} Federal Support for Research and Development, A CBO Study, June 2007.
- ^{xxxvi} American Association for the Advancement in Science, Historical Trends in Federal R&D.
- ^{xxxvii} We understand that this is an enormous increase. The U.S. government could offset some of the cost by investing less in outdated and enormously expensive legacy weapons systems and finding other efficiencies. Chris Brose, Richard Danzig and others have written compelling arguments in favor of an R&D forward approach.
- ^{xxxviii} “PISA Worldwide Ranking – average score of math, science and reading.” Available at <http://factsmaps.com/pisa-worldwide-ranking-average-score-of-math-science-reading/>. See also, “China’s AI dream is well on its way to becoming a reality.” *South China Morning Post*, April 22, 2018, available at <https://www.scmp.com/comment/insight-opinion/article/2142641/chinas-ai-dream-well-its-way-becoming-reality>.

China's Ministry of Education has a new five-year AI talent training program to train 500 more AI instructors and 5,000 students at top Chinese universities; Chun, Andy.

^{xxxix} Singer, Natasha. New York Times, "Top Universities Join to Push 'Public Interest Technology'." March 11, 2019, available at <https://www.nytimes.com/2019/03/11/technology/universities-public-interest-technology.html>.

^{xl} See, e.g., Webb, p. 249; Rosenbach, Eric. [Prepared Statement for Senate Hearing: "China: Challenges to US Commerce."](https://www.belfercenter.org/publication/eric-rosenbach-china-challenges-us-commerce) March 7, 2019, available at <https://www.belfercenter.org/publication/eric-rosenbach-china-challenges-us-commerce>.

^{xli} Carter, William A. "Building Jobs for the Future Is Losing Us the AI Race." CSIS, 2017, available at <https://www.csis.org/analysis/plan-build-jobs-future-losing-us-ai-race>.

^{xlii} Ma, Joy Dantong. "The AI Race is Wide Open, if the US Remains Open." Macro Polo, April 15, 2019, available at <https://macropolo.org/us-china-ai-race-talent/>.

^{xliii} Cooper, Zack and Sacks, Samm. "Bad Idea: Banning Chinese Students from Studying in the United States." Defense360 (CSIS), December 8, 2018, available at <https://defense360.csis.org/bad-idea-banning-chinese-students-from-studying-in-the-united-states/>.

^{xliiv} Hanemann, Thilo, Gao, Cassie, and Lysenko, Adam. "Net Negative: Chinese Investment in the US in 2018." Rhodium Group, January 13, 2019, available at <https://rhg.com/research/chinese-investment-in-the-us-2018-recap/>.

^{xliv} As Chinese manufacturers has reduced panel costs, cost of and therefore total installations has increased in the US; see, e.g., "China Ramps Up Solar Exports After Reforms Hit Home Market." *Bloomberg*, December 6, 2018, available at <https://www.bloomberg.com/news/articles/2018-12-06/china-ramps-up-solar-panel-exports-after-policy-hits-home-market>; and Robbins, Denise. "What Will Accelerate US Solar Adoption?" Chesapeake Climate Action Network, January 24, 2018.