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Testimony before the House Permanent Select Committee on Intelligence China's Threat to American Government and Private Sector Research and Innovation Leadership

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Chairman Nunes, Ranking Member Schiff, distinguished members of the committee, thank you for the opportunity to discuss the challenge that China poses to American research and innovation leadership.

In my remarks, I will discuss the near-term threat of China's attempts to exploit the U.S. innovation ecosystem and also address the long-term challenge of China's advances and ambitions in strategic technologies.

In recent history, U.S. leadership in innovation has been a vital pillar of our power and predominance. Today, however, in this new era of strategic competition, the U.S. confronts a unique, perhaps unprecedented challenge to this primacy.

Given China's continued exploitation of the openness of the U.S. innovation ecosystem, from Silicon Valley to our nation's leading universities, it is imperative to pursue targeted countermeasures against practices that are illegal or, at best, problematic.

At the same time, our justified concerns about constraining the transfer of sensitive and strategic technologies to China must not distract our attention from the long-term, fundamental challenge—to enhance U.S. competitiveness, at a time when China is starting to become a true powerhouse and would-be superpower in science and technology (科技强国).

China's Quest for Indigenous Innovation

China's attempts to advance indigenous innovation (自主创新) have often leveraged and been accelerated by tech transfer that is undertaken through both licit and illicit means. This history and these techniques of industrial espionage have been extensively documented, and cases abound.¹ Some of the more notorious examples include the theft of data on the F-35² and recent Chinese targeting of the semiconductor industry, which has involved targeted poaching of engineers and the theft of intellectual property,^{3, 4} as well as attempted and successful acquisitions.⁵

Bold.

Innovative.

Bipartisan.

At the same time, there have been well-funded and significant initiatives within China to build up indigenous technology and innovation resources. Even fairly recently, it would not have been inaccurate to say that Chinese “indigenous” innovation seemed to be an oxymoron, due to this heavy reliance upon foreign technologies. However, it would be arrogant, even dangerous, to claim today that China “can’t innovate,” when there is such abundant evidence to the contrary.

Beyond the hype and fear, China’s ambitions of technological dominance should be taken skeptically, but seriously. In particular, the Chinese government has launched sixteen S&T “megaprojects,”^a increased funding for basic research,^b and prioritized the education and recruitment of talent.^{6,7} China aspires and has the potential to emerge as a leader in new frontiers of innovation, including artificial intelligence and quantum technologies.

Artificial Intelligence:

Although its ambitions to “lead the world” in AI may seem grandiose, China could indeed emerge as an ‘AI superpower.’⁸ By all available indicators, from patents to publications and investments, China is already emerging as a global center of AI innovation.^c As early as 2013, China’s AI publications overtook those of the U.S. to become the world’s most cited papers.^{9, 10} As of 2017, China produced 27.7% of the academic research on AI published in the world. Chinese companies also appear to be overtaking their U.S. competitors and counterparts in AI-related patent applications, including in deep learning.¹¹ Beyond billions in state funding,^d China is also attracting a sizable and increasing proportion of global investment in AI, which amounted to \$27 billion in 2017, constituting 60% of the world total across the past five years.^{12,13} In 2017, Chinese AI start-ups received nearly 50% of global funding to start-ups, surpassing the U.S.¹⁴

The Chinese government has prioritized AI at the highest levels and is dedicating strong state support to its advancement. The New Generation AI Development Plan (新一代人工智能发展规划) characterized this strategic technology as a “new focal point of international competition,” declaring China’s intention to emerge as the world’s “premier AI innovation center” by 2030.¹⁵ The Three-Year Action Plan to Promote the Development of New-Generation AI Industry (促进新一代人工智能产业发展三年行动计划) (2018–2020) called for China to “establish international competitive advantage” in AI products by 2020.¹⁶ China’s central and many local governments are

^a These include: aero-engines and gas turbines, deep-space and deep-sea exploration, quantum communications and computing, brain-science and brain-inspired research, national cyberspace security, integrated space-to-earth information networks, big data, smart manufacturing and robotics, and new key materials development. In addition, artificial intelligence was added as another megaproject as of July 2017.

^b China’s funding for R&D in basic sciences doubled in the past five years, from 41.2 billion RMB (about \$6.5 billion

^b China’s funding for R&D in basic sciences doubled in the past five years, from 41.2 billion RMB (about \$6.5 billion U.S. dollars) in 2011 to 82.3 billion RMB (about \$12.25 billion) in 2016, according to China’s Ministry of Science and Technology.

^c At the same time, it is important to recognize that China is not “winning” in AI *per se*, and the frequent characterization of advances in these technologies as a race is not particularly accurate or constructive at this point.

^d Despite frequent claims to the contrary, the Chinese government has not committed to spending \$150 billion on AI. It is difficult to come up with a precise estimate of current levels of funding, across both central and local governments, which would include a number of guidance funds, science and technology plans, and institutions like the National Natural Science Foundation of China.

providing high and ever-rising levels of funding for the research, development, and commercialization of AI applications and next-generation technologies. For instance, the city of Tianjin alone has created a new \$16 billion fund for AI.¹⁷ At the same time, China's policies seek to create a robust foundation for innovation through developing standards and regulatory frameworks and supporting the availability of data, testing, and cloud platforms.^{18, 19}

If there is a U.S.-China “AI arms race” today, then the primary battlefield is talent.^{e, 20} Confronting major shortfalls in AI talent relative to the intense demands for it, the Chinese government is aggressively advancing a range of training and educational initiatives.²¹ As of late 2017, China had an estimated 18,232 AI talents, or a mere 8.9% of the world's total, by one estimate, ranking behind the U.S.,^f which is estimated to account for 13.9% of the world's AI talent.²² According to data from LinkedIn,²³ of the approximately 1.9 million AI engineers worldwide, nearly one million reside in the US, while just about 50,000 are in China.²⁴ In response to this gap, China's Ministry of Education released a plan to build up AI as a discipline in Chinese higher educational institutions,²⁵ including through establishing new AI academic and research institutes at universities throughout China.²⁶ Of note, Kai-Fu Lee's Sinovation Ventures has partnered with the Ministry of Education and Peking University to launch a new program that plans to train at least 500 AI teachers and 5000 AI students in top universities in five years.²⁷ At the same time, Chinese state talent plans continue to concentrate on recruitment.²⁸ China may lag behind the U.S. in talent for now, but it is committed to developing the requisite human resources.

China's ‘national champions’ – Baidu, Alibaba, Tencent, and iFlytek – are global leaders in AI that also benefit from strong state support, while contributing to national priorities for AI development. For instance, Baidu is leading China's National Engineering Laboratory for Deep Learning Technologies and Applications (深度学习技术及应用国家工程实验室),²⁹ and iFlytek, which makes ‘China's Siri,’ is leading the State Key Laboratory of Cognitive Intelligence (认知智能国家重点实验室).³⁰ At the same time, these players are heavily investing in research and development, while undertaking investments and acquisitions within China and worldwide. For instance, Baidu's R&D budget in 2017 was about \$2 billion,³¹ and Alibaba plans to invest \$15 billion into disruptive technologies, including artificial intelligence and quantum technologies, through its new DAMO (Discovery, Adventure, Momentum, and Outlook) Academy.³² These champions will also undertake the development of new open innovation platforms in AI: Baidu will be responsible for autonomous vehicles, Alibaba Cloud (Aliyun) for smart cities, Tencent for medical imaging and iFlytek for smart voice technologies.³³ The platforms will be piloted in the Xiong'an New Area, a development southwest of Beijing that is intended to be a futuristic demonstration of Chinese innovation and to showcase AI technologies and applications in action.³⁴ In addition, to advance China's national strategy of military-civil fusion (军民融合),^{g, 35} Baidu is partnering with the China Electronics Technology Group (CETC), a state-owned defense conglomerate, through the Joint Laboratory for Intelligent Command and Control Technologies (智能指挥控制技术联合实验室), to pursue

^e Please note that I do not think that “arms race” is an apt framing for U.S.-China military and strategic competition in AI for a variety of reasons, including that “AI” is not a weapon but rather a diverse range of technologies for which development is driven predominantly by commercial enterprises.

^f It is worth noting that estimates of AI talent vary greatly across different measurements, depending on the methodology used to count, the requirements for who is counted, etc.

^g This term can also be translated as civil-military integration, but I choose to use the more literal rendering of it here.

applications of big data, cloud computing, and artificial intelligence, in military command and information systems.³⁶ Beyond these champions, a diverse and extensive ecosystem of AI start-ups is emerging. As of May 2018, there are an estimated 4,040 AI enterprises in China, of which 1,070 of those companies are in Beijing alone.^{37, 38}

Quantum Technologies:

China aspires to lead in quantum science and to pioneer the development of a range of quantum technologies that could prove transformative. Chinese scientists have launched the world's first quantum satellite, broken world records in quantum computing,³⁹ and even claimed to achieve rapid progress in the development of quantum radar.⁴⁰ The Chinese government has launched a national megaproject in quantum communications and computing, prioritizing these technologies for advances by 2030.⁴¹ Building upon a history of steady support for basic research and development, China's quantum innovation ecosystem is dynamic and characterized by integration between academia, industry, and the military. China is in the process of constructing a National Laboratory for Quantum Information Science (量子信息科学国家实验室),^{42, 43} which has received 7 billion RMB (\$1.06 billion) in funding to start.^{h, 44} This new national laboratory will pursue advances in quantum technologies, including computing, while reportedly engaging in research “of immediate use” to the Chinese military.⁴⁵ Meanwhile, Alibaba has partnered with the Chinese Academy of Sciences to establish its new Quantum Computing Laboratory,⁴⁶ and Baidu has also recently established an Institute of Quantum Computing.⁴⁷ Although China has not emerged as a clear leader in quantum computing, Chinese researchers may catch up and surpass their competitors in the decades-long marathon to develop a fully functional quantum computer. At the same time, the Chinese defense industry is actively engaged in the development of quantum radar, imaging, and navigation technologies that could have more direct and immediate military applications.

China's Tactics for Tech Transfer

Despite such estimable progress in innovation, it is critical to recognize that also China continues to confront considerable challenges, including a lack of talent and core technologies.ⁱ These obstacles motivate the “going out” (走出去) of Chinese enterprises and their attempts to facilitate the “bringing in” (引进来) of tech and talent back to China.⁴⁸ Although China is seeking to progress beyond reliance on tech transfer to engage in truly original innovation, state-driven attempts to leverage foreign innovation ecosystems will likely remain quite prevalent, in the U.S. and worldwide, for the foreseeable future. These efforts constitute a complex and often opaque landscape of varied activities, and this testimony does not attempt to be comprehensive in its coverage of them. For instance, it is clear that, despite the 2015 Xi-Obama agreement, Chinese cyber espionage, including that undertaken for purposes of IP theft, has continued,⁴⁹ as in the recent troubling compromise of a Navy contractor by hackers from the Ministry of State Security.⁵⁰ Beyond such illicit tactics, I seek to highlight a series of relevant examples of tech transfer that will merit further consideration going

^h In addition, the new Anhui Quantum Science Industry Development Fund, created in December 2017, also plans to devote 10 billion RMB (nearly \$1.6 billion) in funding to quantum computing, communications, and metrology.

ⁱ China's level of advancement in science and technology is highly varied across and even within domains. For instance, China may lead in certain AI techniques and applications, such as facial recognition in particular, but is not yet considered a clear leader in all aspects of the discipline.

forward. My remarks will concentrate on Chinese investments, incubators, and acquisitions focused on strategic technologies; the targeting and exploitation of U.S. academia and universities; and questionable research and commercial collaborations.

Investments, Incubators, and Acquisitions:

Chinese investments, as well as tech incubators and targeted acquisitions, can enable access to U.S. technologies that conveys a level of risk, but may provide valuable opportunities for U.S. companies as well.⁵¹ In many respects, the extensive engagement and collaboration in innovation between the U.S. and China, often characterized by open exchanges of ideas, talent, and technologies, can be mutually beneficial in enriching and accelerating innovation in both countries.⁵² However, to the extent that the Chinese government seeks to direct and exploit these efforts with levels of involvement that are often opaque or obscured, it is worth reevaluating the risks and benefits of these ‘entanglements.’

For instance, the dramatic increase in levels of Chinese investment in strategic technologies within the past several years reflects the confluence of state priorities and commercial enthusiasm that can be very difficult to differentiate in practice. Between 2012 and mid-2017, China-based investors engaged in tech investments of \$19 billion in the U.S., across 641 deals, focusing on AI, robotics, and augmented or virtual reality, according to data from CB Insights.⁵³ Not all Chinese investments are risky or problematic – particularly if there are safeguards in place to limit access to IP – and this influx of capital can also be beneficial to U.S. start-ups that may otherwise struggle to receive adequate funding.⁵⁴ However, the access and insights that investment can enable, including when an investor takes on a board position in the company, can enhance situation awareness in ways that might inform future targeting and acquisitions of sensitive technologies.

These trends and dynamics in Chinese investments will merit much more extensive analysis and consideration, given the scope, scale, and variety of these activities. Although the majority of Chinese venture capital investment in the U.S. is assessed to be private and primarily financially-motivated, certain investments can be linked to or directed by Party-state priorities in ways that are not necessarily transparent.⁵⁵ As scrutiny of Chinese investments in Silicon Valley increases, pursuant to proposed updates to CFIUS, certain investors and venture capital funds will look to obscure further the origins of their funding and their connections to China or the Chinese government in ways that may render balanced evaluation of risk even more challenging. Certain funds are directly guided and supported by the central or local governments or elements of China’s defense science and technology ecosystem, such that their engagements with U.S. start-ups may serve to draw their tech and talent back into it. While a full review of relevant investors would be beyond the scope of this testimony, several examples serve to illustrate the focus and nature of these activities.

- The China Investment Corporation, China’s national sovereign wealth fund, has sought to pursue greater access and investments in the United States,⁵⁶ including in Silicon Valley, where it invested in Unity Technologies, a platform for virtual/augmented reality.⁵⁷

- Danhua Capital (丹华基金, DHVC)^j was established in 2013 in Silicon Valley by the Zhongguancun (ZGC) Development Group (中关村发展集团),⁵⁸ which is a state-owned enterprise of the Beijing municipal government.⁵⁹
 - ✧ DHVC, which manages total investments of \$600 million as of fall 2017,⁶⁰ has made 137 investments in total as of July 2018, with a focus on emerging and disruptive technologies, including Meta, a leading company in augmented reality.⁶¹
 - ✧ DHVC affiliates have taken on board-related and/or advisory positions on a number of start-ups after investment.⁶²
 - ✧ According to its co-founder, the fund is committed to “narrowing the gap” in technological development between China and the U.S.⁶³
- HEDA Ventures, established and supported by the Hangzhou government’s Economic and Technology Development Zone,⁶⁴ has invested in disruptive innovations, including in the biotech sector, such as Paragon Genomics.⁶⁵
 - ✧ This fund received \$150 million in total to start, and its objectives include to encourage ‘overseas talents’ to settle in Hangzhou and to support the upgrading and transformation of China’s domestic industries.⁶⁶
- Qihoo 360, China’s leading cyber security company, which is closely linked to the Chinese military and government,⁶⁷ has established a venture capital fund in Silicon Valley in order to support start-ups that it considers strategically significant.⁶⁸
 - ✧ In addition, Zhou Hongyi, Qihoo’s CEO and co-founder, serves as an advisor to 11.2 Capital, an early stage venture capital fund that has invested in “breakthrough” technologies, such as AI, AR/VR, robotics, and biotechnology, across a range of companies, including Ginkgo Bioworks.^{69, 70}

To access talent, a number of leading Chinese tech companies, including Baidu, Alibaba, Tencent, Huawei, and iFlytek, have created or plan to establish one or more centers for research and development in the U.S.,⁷¹ just as a number of U.S. companies, including recently Google, have created similar centers in China.^k For U.S. and Chinese companies alike, this access to talent is advantageous to their innovation and competitiveness. However, when enterprises that have clear or direct links to the Chinese military or defense industry seek to establish R&D operations in the U.S. or worldwide, then that presence may raise greater concerns. For instance, CETC Software Information Services Co., Ltd. (中电科软件信息服务有限公司), a subsidiary of the China Electronics Technology Group Corporation (CETC), a state-owned defense conglomerate, reportedly established an innovation center in Silicon Valley in 2014,^{l, 72} which seeks to take advantage of that ecosystem with a focus on big data and other advanced information technologies.⁷³

^j Danhua Capital’s full name is the “Zhongguancun-Stanford Emerging Technologies Venture Capital Fund” (中关村斯坦福新兴技术创业投资基金).

^k For this reason, I would discourage considering policy options that restrict these commercial activities, lest U.S. companies become constrained in their own overseas R&D activities.

^l Please note that I have not been able to find detailed accounts of its activities in Silicon Valley based on an initial search, which could imply that its presence and activities are fairly limited at present.

Beyond investments, China's presence in U.S. innovation ecosystems extends to include incubators and accelerators, of which there are at least eleven in total in Silicon Valley, that may enable more direct access to talent and technology than investment alone would typically provide.⁷⁴ For this reason, the risk and impact of these institutions, which may also often benefit U.S. start-ups through providing them support and access to China's sizable market, merit further scrutiny.^m Since their establishment is typically motivated by and characterized in terms of the benefits of access to U.S. talent, research, and technologies, these activities should be viewed in the broader context of Chinese efforts to leverage tech transfer through legal means that may, in some cases, prove problematic nonetheless to advance indigenous innovation.

- The ZGC Innovation Center in Silicon Valley (中关村硅谷创新中心) was established in May 2016 as an incubator by Zhongguancun (ZGC) Capital.^{75, 76}
 - ✧ It has invested in major funds in Silicon Valley, such as Danhua (see above), Plug & Play, and KiloAngel,ⁿ while also leveraging an incubator that supports early-stage U.S. start-ups, including through providing office space, financing, and business development.
 - ✧ According to its website, to incubate and 'accelerate' start-ups, it also helps facilitate these start-ups' pursuit of opportunities cooperation, mergers and acquisitions, etc. with major Chinese companies and arranges for them to go to China on field trips and roadshows.⁷⁷
- The Hangzhou Silicon Valley Incubator (杭州硅谷孵化器), established in 2014 with support from the government of Hangzhou,⁷⁸ had, as of fall 2017, reportedly attracted 47 'overseas high-tech enterprises' to settle in Hangzhou.⁷⁹
 - ✧ The projects that it has incubated have included companies in big data, cloud computing, and biotechnology, and the objective is to build a "bridge" for tech and talents to return to Hangzhou.⁸⁰
- Lab360, an incubator founded in October 2014 and supported by Qihoo 360, has focused on the development of intelligent hardware, providing seed investment and partnerships to start-ups.⁸¹

Such activities extend well beyond Silicon Valley to other dynamic American innovation ecosystems, including to Boston's biotech sector,^o which has attracted a number of Chinese biotech and pharmaceutical companies to establish R&D operations and incubators to access local talent and leading universities.⁸² In the Boston area, several incubators that involve partnership between the Chinese and the Massachusetts government may positively contribute to competitiveness but should also be recognized as linked to China's strategic approach to the 'bringing in' of innovation resources

^m To clarify, I mention these centers and incubators only as examples of activities that may merit further consideration in the context of current debates over risks of tech transfers, not to imply that there is any direct evidence that I have seen so far of wrongdoing. I caveat my concerns based on the fact that my research is limited to open sources available online, and I have not had the opportunity to visit or engage directly with these institutions. Moreover, since their establishment is relatively recent, it is likely that their impact has been fairly limited to date, though that may change as this focus on incubators, overseas innovation centers, etc. expands.

ⁿ In addition, its 'cooperative institutions' include Peakview Capital, C.M. Capital Foundation, Danhua Capital, and AngelList.

^o The question of Chinese investments in Boston's biotech sector was not a topic that I had a chance to explore at length within the framework of this testimony but should receive further attention.

back to China's domestic innovation ecosystems, many of which aspire to become "China's Silicon Valley" or biotech leaders on par with Boston.

- The China-US Boston Innovation Center (CUBIC), founded in February 2015 with the backing of China's Ministry of Science and Technology, is located on the campus of MIT in the Boston Cambridge Innovation Center.⁸³ CUBIC is intended to become a platform for collaboration, including for mergers and acquisitions, between the U.S. and China.⁸⁴
 - ✧ It focuses on helping U.S. enterprises enter the China market, including facilitating access to government resources, with the aim of seeking out top talent and promising technologies.⁸⁵
 - ✧ CUBIC and its Miti Venture (米天创投) announced, with Chinese government officials in attendance, a strategic partnership that involved two new funds to incubate "outstanding overseas entrepreneurial teams."⁸⁶
- The Shanghai Zhangjiang Boston Enterprise Park (上海张江波士顿企业园) was established in Marlborough, Massachusetts in February 2016, with support from the state government, under the guidance of the Shanghai government, with plans to construct innovation centers focused on biomedical technology, artificial intelligence, and semiconductor integrated circuitry, among others.^{87, 88}
 - ✧ At the time, the president of China's National Eastern Tech Transfer Center (国家技术转移东部中心) highlighted this as an important "icebreaker," as the first case of U.S.-China cooperation in building a high-tech park, in ways that can help Shanghai to emerge as a global tech transfer hub.⁸⁹
- Zhongguancun launched the ZGC Boston Innovation Center as of April 2018, with Beijing government officials in attendance, and its establishment was characterized as important to "build the ecosystem of Zhongguancun's overseas collaborative innovation resources."⁹⁰

The potential benefits and negative externalities of these engagements via venture capital and incubation should receive further consideration going forward, given the clear linkages to government priorities and initiatives to advance Chinese indigenous innovation. Even when there is not evidence that a particular mechanism has been exploited thus far for tech transfer in ways that are illegal or obviously concerning, the access to and knowledge of prioritized technologies can still be beneficial to future targeting and acquisitions. Potentially, as Chinese investments are subjected to greater scrutiny, the focus of tactics for tech transfer could shift further towards these alternative techniques for access to tech and talent resources via accelerators and innovation centers. Again, the main factor that should raise questions and differentiate these from purely commercial activities is the consistent government involvement in their guidance and direction.

Looking to the most direct type of tech transfer, selected examples of targeted acquisitions illustrate how buyers that have may links to the Chinese government or appear to act in furtherance of its priorities have targeted U.S. and global companies and their technologies. When attempts at acquisitions in the U.S. are blocked, this targeting can shift to look for comparable companies and technologies outside of the U.S., often in countries where scrutiny and review mechanisms are less rigorous. This dynamic highlights the importance of a global approach to these challenges, in close coordination with U.S. allies and partners worldwide.

- After several failed Chinese attempts at acquisitions in the semiconductor industry, Atop Tech, known for a cutting-edge automated designer capable of producing high-end microchips, was acquired in bankruptcy proceedings in the summer of 2017 by Avatar Integrated Systems, a company for limited information is available except that the board chairman is a prominent Chinese steel magnate, without any scrutiny from CFIUS.⁹¹
- Complete Genomics was acquired in March 2013 by the Beijing Genomics Institute (BGI, 华大基因), which has links to and has received support from the Chinese government,⁹² to bolster its attempts to create a next-generation sequencer.⁹³
- As China aims to emerge as a leader in industrial robotics, a priority in “Made in China 2025,” there have been a number of acquisitions of robotics companies in the U.S. and worldwide, which include, but are not limited to:⁹⁴
 - ✧ Paslin, an industrial robot integrator based in the U.S., acquired by Zhejiang Wanfeng Technology in April 2016;⁹⁵
 - ✧ Midea Group’s acquisitions of Kuka, based in Germany, in January 2017, and Servotronics, an Israeli motion control and automation company, in February 2017;⁹⁶ and
 - ✧ HTI Cybernetics, an industrial robotics integrator based in Michigan, acquired by Chongqing Nanshang Investment group, in October 2017.

Targeting and Leveraging Universities:

U.S. and international universities have been a major target of Chinese cyber and, in some cases, human espionage. In the past few years, there have been a number of intrusions targeting universities that engage in sensitive or military research, including Penn State and the University of Virginia.^{97, 98} Chinese hackers have continued to target universities, which tend to be tempting as easy targets, including because of limited attention to cyber security, as well as the potential availability of ample IP and data.⁹⁹ In some cases, students and researchers have leveraged academic research environments in ways that may contravene U.S. law or academic norms. The potential for negative externalities has been clearly illustrated by the case of Liu Ruopeng (刘若鹏),⁹ a Duke PhD student, who allegedly appropriated sensitive research funded by the U.S. military on metamaterials,¹⁰⁰ and then returned to China to fund a highly successful research institute, the Kuang-Chi (光启) Group, which supports the Chinese military in advanced technological developments.¹⁰¹ In a more typical occurrence, Chinese students and researchers with experience in top U.S. universities are often targeted for recruitment through Chinese state talent plans and by Chinese companies.¹⁰² Although the openness of university environments is integral to the greatness of the U.S. education systems, the potential for such risks highlights the importance of further engagement with academia in order to raise awareness and enhance appropriate safeguards and precautions.¹⁰³

⁹ For instance, just this month, reports emerged that Chinese hackers have infiltrated Australian National University, potentially compromising the university’s research and intellectual property.

⁹ Please note that I consider this case to be an extreme example. It is difficult to estimate how many such incidents have occurred in the past few years.

While there are compelling reasons to welcome Chinese students to the U.S. – and to encourage them to stay and contribute to American innovation – it is clear that there are instances when the U.S. education system has been exploited in ways that are problematic at best or, at worst, even contribute to Chinese military modernization. These incidents are not reasons to direct suspicion towards or shut the door on Chinese students and scientists,¹⁰⁴ and a case-by-case response to these incidents, focusing on prevention and enforcement in instances where there is clear wrongdoing, is the best way forward. However, when students from PLA universities or Chinese universities that are closely linked to Chinese defense technological development study and pursue research in the U.S., there is a more definite rationale for stronger screening mechanisms to limit access to those with such direct linkages to Chinese military research. Notably, the PLA’s National University of Defense Technology (NUDT, 国防科技大学) has been quite active in sending doctoral students, and also undergraduates, overseas, including to the United States, United Kingdom, and Australia, among others.¹⁰⁵

- As of the fall of 2017, there were at least two NUDT PhD students studying at U.S. universities, one of whose research focused on big data.¹⁰⁶
- At NUDT’s Center for Interdisciplinary Quantum Information Science (量子信息学科交叉中心), one prominent researcher returned to “devote all his energy to the military,”¹⁰⁷ after pursuing post-doctoral research at Stanford University.¹⁰⁸
- A researcher with the PLA’s NUDT was recently a visiting scientist at a U.S. national laboratory, where his research focused on optics and metrology.¹⁰⁹

Pursuant to China’s Thousand Talents Plan (千人计划), launched in 2008,¹¹⁰ over 7,000 scientists and researchers are estimated to have been attracted back to China, receiving substantial financial incentives,[†] on a permanent or temporary basis, as of January 2018.¹¹¹ Similarly, the Thousand Youth Talents Plan concentrates on the recruitment of younger scientists. While examples of such targeted recruitment of talent through these plans and otherwise abound, certain instances, by way of illustration, raise questions about the possibilities for tech transfer in sensitive and strategic technologies. In particular, certain U.S. scientists have been recruited to take appointments at Chinese universities and to contribute as co-investigators of Chinese laboratories that are linked to dual-use technological development.

- A leading expert on quantum physics and materials, such as topological insulators, from a prominent U.S. university was recruited through the Thousand Talents Plan to become a professor and the co-investigator of a laboratory at Tsinghua University, and later awarded the People’s Republic of China International Science and Technology Cooperation Award.¹¹²
- A professor at a public research university who had received U.S. military funding for research on bionic robotics later became a co-investigator of a key laboratory supported by the Shenzhen municipal government and also apparently co-founded a company based on that

[†] Typically, successful applicants receive a bonus of 1 million RMB (\$151,000) to start, and then can apply research funding of 3–5 million RMB (about \$450,000 to \$740,000). Those foreign scientists who are recruited receive further incentives, such as subsidies for accommodations.

research.¹¹³

Chinese funding for research at U.S. universities also raises questions about potential externalities and should receive further scrutiny going forward. For instance, Huawei has actively funded research worldwide and pursued academic partnerships through its Huawei Innovation Research Program.¹¹⁴ In the U.S., Huawei has invested about \$10 million each year in research, including on 5G development, collaborating with at least fifty universities that include Harvard University, Stanford University, and the Massachusetts Institute of Technology (MIT).¹¹⁵ In 2017, Huawei devoted \$1 million to funding research on AI at the University of California, Berkeley.¹¹⁶ Although many universities may welcome this source of funding, at a time when U.S. government expenditures on basic research have been declining, there is a need for greater transparency about ways in which that funding may enable access to sensitive data and research, as well as the end uses of IP generated through these research collaborations.

Some U.S. universities have created joint laboratories or partnerships with Chinese enterprises that have clear links to military research or support state priorities.

- The Tsinghua-Michigan Joint Center for Quantum Information (JCQI) seeks to leverage the respective advantages of Tsinghua and the University of Michigan in quantum information in order to establish a “first-class platform and center for talent cultivation” in quantum information, while also “promot[ing] China’s research in quantum information to the world-leading level.”¹¹⁷
 - ✧ In this context, it’s worth noting that Tsinghua is also involved in the development of quantum technologies for national defense applications, in partnership with the PLA’s National University of Defense Technology.¹¹⁸
- In June 2017, MIT’s Computer Science and Artificial Intelligence Laboratory (CSAIL) announced a new five-year collaboration with iFlytek, a Chinese national champion known for its leadership in smart voice technologies, including making ‘China’s Siri.’¹¹⁹ Their researchers will collaborate on projects, including computer vision, speech-to-text systems, and human-computer interaction.¹²⁰
 - ✧ iFlytek’s technologies have been leveraged by China’s Ministry of Public Security to enable voice biometric collection, providing capabilities threaten privacy and that have the potential for abuse.¹²¹ The company has not yet responded to concerns and questions raised by Human Rights Watch on that point.¹²²
- In September 2017, Carnegie Mellon University (CMU) and LAB Venture signed an agreement to establish the Chengdu Institute of Carnegie Mellon University (CICMU) in the Chengdu Hi-tech Zone, one of many such zones that focuses on military-civil fusion in some of its activities, where it will serve as “a global platform of technology transfer.”
 - ✧ CMU will provide funding, management, expertise, and human resources for the institute, which will focus on AI and smart infrastructure.¹²³

While U.S. universities may often attain clear benefits from global presence and partnerships, such engagement should always be undertaken with appropriate awareness of potential externalities.

Research Collaborations and Commercial Partnerships:

U.S. companies that engage in joint ventures and partnerships in China can face risks to their technologies in some cases or have become involved in potentially problematic engagements with counterparts that have linkages to the military in other instances.^{s, 124}

- In June 2015, NVIDIA established a strategic partnership with Sugon (曙光), an enterprise established under China's 863 Plan, and the CAS Institute of Computing Technologies, focusing on deep learning, which involved creation of joint laboratories and release of deep learning projects.^{t, 125, 126}
 - ✧ Although this ongoing partnership has primarily focused on commercial applications of deep learning, such as to biomedical data,¹²⁷ it is worth noting that Sugon has also been involved in the development of military applications of AI, including in command and control, supporting military-civil fusion.^{128, 129, 130, 131}
- Google's China AI Center, announced in December 2017,¹³² has started to pursue engagement with several Chinese universities. In particular, Tsinghua's new Institute for Artificial Intelligence plans to pursue cooperation with Google,¹³³ at a time when the university is also deeply and institutionally committed to China's national strategy of military-civil fusion in AI,¹³⁴ including with a high-end laboratory for military intelligence and research funded by the PLA's Central Military Commission.¹³⁵

Such partnerships and research engagements require careful structuring and implementation to mitigate risks of tech transfer or unintended externalities.

Policy Considerations and Recommendations

The United States has benefited tremendously from the openness and inclusivity of our innovation ecosystem, but it is vital to balance that openness with recognition of the risks and benefits inherent in today's levels of engagement and 'entanglement' with China. Our policy responses to these issues should thus be highly nuanced and targeted in order to mitigate the risks of collateral damage to our own competitiveness. Given the global nature of these issues, it is also vital that the U.S. engage and coordinate with allies and partners in undertaking appropriate countermeasures, which include stricter reviews of acquisitions, investments, and certain collaborations.

Looking forward, the U.S. must not only defend its research and technologies but also go on the offensive, not fearing competition with China, but rather embracing it. That is, the U.S. must recognize and reinforce its own enduring advantages in innovation through the pursuit of policies that have enabled and can revitalize its own innovation ecosystem. These include a focus on STEM

^s Since this issue has received greater concern and attention in the past, I limit this discussion to highlighting a few recent cases of partnerships in emerging technologies in particular.

^t Of note, in April 2015, the U.S. government had banned NVIDIA and Intel from selling GPUs to China's four supercomputer centers. However, this ban does not appear to have curtailed NVIDIA's partnership with Sugon, which has continued.

education at all levels, robust and sustained investments in basic research, and openness to welcome talented scientists and entrepreneurs, including from China. In today's strategic competition for technological dominance, the U.S. can win only by sprinting ahead.

U.S. policymakers should consider a range of policy responses that can mitigate risk – while also concentrating on the preemption and punishment of unlawful activities. These measures might include, but should not be limited to, the following recommendations:

Targeted Countermeasures:

- Explore updates and revisions to national export controls, defense trade controls and investment review mechanisms that take into account the unique challenges of dual-use commercial technologies.^{u, 136}
 - ✧ Share lessons learned and pursue coordination with allies and partners to account for the global scope and scale of these dynamics.
- Engage in outreach to companies and universities in order to highlight the potential for risk or unintended externalities in joint ventures and partnerships.
 - ✧ Develop and present a series of case studies based on past incidents.
 - ✧ Consider reestablishing the now-disbanded FBI National Security Higher Education Advisory Board to facilitate and institutionalize such engagements.^{v, 137, 138}
- Enhance and enforce cyber security standards and requirements for contractors and laboratories engaged in sensitive academic research.
- Review recent and existing research and commercial partnerships on strategic technologies that involve support and funding from foreign militaries, governments or state-owned/supported enterprises, evaluating the dual-use risks and potential externalities in each case.
- Consider introducing, or where appropriate adjusting, policies or guidelines restricting those who have received from the U.S. military or government at a certain level from also accepting funding from or collaborating with a foreign military, state-owned enterprise, or 'national champion' that is not an ally.
- Enhance counterintelligence capabilities, particularly by augmenting language and technical expertise, to focus on prevention and enforcement.^{w, 139}
- Improve visa screening of foreign nationals who plan to study or research sensitive or strategic technologies, targeting scrutiny on the basis of whether or not students or researchers have direct and clear connections to foreign militaries, governments or intelligence services.

^u Of note, a case that illustrates these dynamics is Aqueti, a company founded by Duke University scientists who developed a sophisticated gigapixel camera that was originally intended to provide long-range surveillance for the U.S. Navy, with support and funding from the Pentagon. After the founder later struggled to raise money in the U.S., he relocated the company to China, where it has since found a sizable market for use with Chinese police.

^v Rush Doshi is to be credited for initially bringing this board to my attention. Please see the citation for his perspective on these issues.

^w For a recent example of successful apprehension and enforcement, see the arrest at the airport of a former Apple employee who had downloaded a plan for a self-driving car circuit board and then booked a flight to China, where he planned to work for and transfer the design to a Chinese self-driving car start-up.

- ✧ Incorporate an independent review mechanism into the process to assess evidentiary standards and mitigate risks of bias in such visa determinations.
- Identify organizations engaging in talent recruitment that are linked to the Chinese central and local governments or to the Chinese Communist Party (CCP), and require their registration as foreign agents, where appropriate.^x

Ensuring American Competitiveness:

- Increase and commit to sustaining funding for basic research and the long-term development of strategic technologies.
- Prioritize improving the accessibility and affordability of STEM education at all levels, including creating new scholarships to support those studying computer science, artificial intelligence, and quantum information science, among other priority disciplines.
- Sustain openness to immigration, welcoming graduating students and talented researchers, while potentially offering a fast-track option to citizenship.
- Explore the expansion of alliance coordination and cooperation in innovation, including deeper collaboration in research, development, and experimentation with new technologies and their applications.

^x I have argued and want to emphasize again that I do *not* believe that scrutiny or restrictions should be imposed against Chinese students and researchers on the basis of national origin alone. When state-driven recruitment, such as through China's talent plans, that is targeted against persons who are of Chinese heritage and/or Chinese citizens is deemed problematic, then the response should be directed against the organizations in question, not the individuals who are being targeted.

Recommendations for Further Reading

William C. Hannas, James Mulvenon, Anna B. Puglisi, *Chinese Industrial Espionage: Technology Acquisition and Military Modernisation*, Routledge, 2013.

Elsa Kania, “Battlefield Singularity: Artificial Intelligence, Military Revolution, and China’s Future Military Power,” Center for a New American Security, November 28, 2017, <https://www.cnas.org/publications/reports/battlefield-singularity-artificial-intelligence-military-revolution-and-chinas-future-military-power>

Elsa Kania, “Artificial Intelligence and Chinese Power,” *Foreign Affairs*, December 5, 2017, <https://www.foreignaffairs.com/articles/china/2017-12-05/artificial-intelligence-and-chinese-power>

Elsa Kania, “China’s challenge to US quantum competitiveness,” *The Hill*, June 30, 2018, <http://thehill.com/opinion/technology/394894-the-chinese-challenge-to-us-quantum-competitiveness>

Elsa Kania, “Technological Entanglement: Cooperation, Competition, and the Dual-Use Dilemma in Artificial Intelligence,” Australian Strategic Policy Institute, June 28, 2018, <https://www.aspi.org.au/report/technological-entanglement>

Elsa Kania and John Costello, “Quantum Hegemony?—China’s Ambitions and the Challenge to U.S. Innovation Dominance,” Center for a New American Security, August 2018, *forthcoming*

Greg Levesque and Mark Stokes, “Blurred Lines: Military-Civil Fusion and the “Going Out” of China’s Defense Industry,” Pointe Bello, December 2016, <http://www.pointebello.com/researchandinsights/>

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Notes

¹ For the authoritative perspective on these issues, please see: William C. Hannas, James Mulvenon, Anna B. Puglisi, *Chinese Industrial Espionage: Technology Acquisition and Military Modernisation*, Routledge, 2013.

² Justin Ling, “Man Who Sold F-35 Secrets to China Pleads Guilty,” *Vice*, March 24, 2016, <https://news.vice.com/article/man-who-sold-f-35-secrets-to-china-pleads-guilty>

³ Paul Mozur, “Inside a Heist of American Chip Designs, as China Bids for Tech Power,” *New York Times*, June 22, 2018, <https://www.nytimes.com/2018/06/22/technology/china-micron-chips-theft.html>

⁴ Kartikay Mehrotra and Ian King, “U.S. Chip Engineers Charged in Theft Scheme for Chinese Firm,” *Bloomberg*, December 6, 2017, <https://www.bloomberg.com/news/articles/2017-12-07/u-s-chip-engineers-charged-with-secrets-theft-for-chinese-firm>

⁵ See the recounting of this acquisition here: Cory Bennet and Bryan Bender, “How China acquires ‘the crown jewels’ of U.S. technology,” *Politico*, May 22, 2018, <https://www.politico.com/story/2018/05/22/china-us-tech-companies-cfius-572413>

⁶ “The State Council’s Several Opinions on Comprehensively Strengthening Basic Scientific Research” [国务院关于全面加强基础科学研究的若干意见], January 31, 2018, http://www.gov.cn/zhengce/content/2018-01/31/content_5262539.htm

⁷ “The State Council’s Notice on the Printing and Distribution of the Thirteenth Five-Year National Science and Technology Innovation Plan” [国务院关于印发“十三五”国家科技创新规划的通知], August 8, 2016, http://www.gov.cn/zhengce/content/2016-08/08/content_5098072.htm

⁸ For the initial usage of this term and valuable insights on the status of AI development in the U.S. and China, see: Kai-Fu Lee, *AI Superpowers: China, Silicon Valley, and the New World Order*, Houghton Mifflin Harcourt, 2018, forthcoming.

⁹ For reporting in English on this report, “China attracts 60% of global AI investment: report,” *Global Times*, July 13, 2018, <http://www.globaltimes.cn/content/1110703.shtml>

¹⁰ This milestone was also documented in a fall 2016 report: “The National Artificial Intelligence Research and Development Strategic Plan,” National Science and Technology Council, October 2016, https://obamawhitehouse.archives.gov/sites/default/files/whitehouse_files/microsites/ostp/NSTC/national_ai_rd_strategic_plan.pdf

¹¹ CB Insights, “Top AI Trends To Watch In 2018,” https://www.cbinsights.com/reports/CB-Insights_State-of-Artificial-Intelligence-2018.pdf

¹² “China attracts 60% of global AI investment: report.”

¹³ “China AI Development Report 2018” Officially Released Today!” [《中国人工智能发展报告 2018》今天正式发布！], *Science and Technology Daily*, July 13, 2018, http://www.stdaily.com/index/kejixinwen/2018-07/13/content_689979.shtml

For a partial PDF of the report, see: <http://www.ctoutiao.com/828106.html>

¹⁴ CB Insights, “Top AI Trends To Watch In 2018.”

¹⁵ “State Council Notice on the Issuance of the New Generation AI Development Plan” [国务院关于印发新一代人工智能发展规划的通知], July 20, 2017, http://www.gov.cn/zhengce/content/2017-07/20/content_5211996.htm

¹⁶ “MIIT Notice on the Release of the Three-Year Action Plan to Promote the Development of New-Generation Artificial Intelligence Industry (2018–2020) [工业和信息化部关于印发《促进新一代人工智能产业发展三年行动计划（2018–2020年）》的通], December 14, 2017, <http://www.miit.gov.cn/n1146295/n1652858/n1652930/n3757016/c5960820/content.html>

¹⁷ “Tianjin city in China eyes US\$16 billion fund for AI work, dwarfing EU’s plan to spend US\$1.78 billion,” *South China Morning Post*, May 16, 2018, <https://www.scmp.com/tech/innovation/article/2146428/tianjin-city-china-eyes-us16-billion-fund-ai-work-dwarfing-eus-plan>

¹⁸ For a more detailed discussion of this approach, see: Elsa Kania, “China’s AI Agenda Advances,” *The Diplomat*, February 14, 2018, <https://thediplomat.com/2018/02/chinas-ai-agenda-advances/>

¹⁹ For a more detailed discussion of China’s approach to AI standards, see: Jeffrey Ding, Paul Triolo, and Samm Sacks, “Chinese Interests Take a Big Seat at the AI Governance Table,” *DigiChina*, June 20, 2018, <https://www.newamerica.org/cybersecurity-initiative/digichina/blog/chinese-interests-take-big-seat-ai-governance-table/>

²⁰ For a more extensive discussion Elsa Kania, “The Pursuit of AI Is More Than an Arms Race,” *Defense One*, April 19, 2018, <https://www.defenseone.com/ideas/2018/04/pursuit-ai-more-arms-race/147579/>

²¹ For a more detailed discussion of this competition for talent, see: “China’s AI Talent “Arms Race,”” April 16, 2018, <https://www.battlefieldsingularity.com/musings-1/china-s-ai-talent-arms-race>

²² “China AI Development Report 2018” Officially Released Today!” [《中国人工智能发展报告 2018》今天正式发布!], Science and Technology Daily, July 13, 2018, http://www.stdaily.com/index/kejixinwen/2018-07/13/content_689979.shtml

For a partial PDF of the report, see: <http://www.ctoutiao.com/828106.html>

²³ This report from LinkedIn has different estimates of talent, based on using LinkedIn as a platform as the primary source for management: “Global AI Domain Talent Report” [全球 AI 领域人才报告], LinkedIn, 2017, <https://business.linkedin.com/content/dam/me/business/zh-cn/talent-solutions/Event/july/lts-ai-report/%E9%A2%86%E8%8B%B1%E3%80%8A%E5%85%A8%E7%90%83AI%E9%A2%86%E5%9F%9F%E4%BA%BA%E6%89%8D%E6%8A%A5%E5%91%8A%E3%80%8B.pdf>

²⁴ For more context on this issues, see: “China Prepares for AI Talent Shortage,” Medium, April 12, 2018, <https://medium.com/syncedreview/china-prepares-for-ai-talent-shortage-e66d0a3a0de2>

²⁵ For further discussion of these issues, see: “Academicians Exhort As Rapidly As Possible Constructing the Layout for an AI 2.0 Era Discipline” [院士呼吁尽快布局人工智能 2.0 时代学科建设], September 28, 2017, http://www.stdaily.com/dxskjw/redian/2017-09/28/content_580861.shtml?utm_content=buffer9ccfa&utm_medium=social&utm_source=twitter.com&utm_campaign=buffer

²⁶ Ministry of Education, “Artificial Intelligence Innovation Action Plan for Institutions of Higher Learning” [高等学校人工智能创新行动计划], April 3, 2018, http://www.moe.edu.cn/srcsite/A16/s7062/201804/t20180410_332722.html

²⁷ Tom Simonite, “Ex-Google Executive Opens a School for AI with China’s Help,” WIRED, April 5, 2018, <https://www.wired.com/story/ex-google-executive-opens-a-school-for-ai-with-chinas-help/>

²⁸ For more context on talent plans, please see the existing literature that includes the following publications:

Fan Yang, “Surveying China’s Science and Technology Human Talents Programs,” Study of Innovation and Technology in China, 2015, <https://escholarship.org/uc/item/5qg340x3>

Liming Salvino, “China’s Talent Recruitment Programs: The Road to a Nobel Prize and World Hegemony in Science?,” Study of Innovation and Technology in China, 2015, <https://escholarship.org/uc/item/30h2t8tr>

²⁹ “National Development and Reform Commission: Baidu to lead, BAT to build indigenous AI laboratories” [发改委：百度牵头，BAT 筹建“国字号”人工智能实验室], *EET*, 22 February 2017, <http://www.eet-china.com/news/article/201702220927>

‘National Engineering Laboratory of Deep Learning Technologies and Applications unveiled at Baidu’ [深度学习技术及应用国家工程实验室在百度揭牌], *Xinhua*, 2 March 2017, http://news.xinhuanet.com/tech/2017-03/02/c_1120557779.htm

³⁰ “Cognitive Intelligence Has a State Key Laboratory” [认知智能有了国家重点实验室], *Xinhua*, December 21, 2017, http://www.xinhuanet.com/tech/2017-12/21/c_1122143364.htm

³¹ CB Insights, “Rise Of China’s Big Tech In AI: What Baidu, Alibaba, And Tencent Are Working On,” April 26, 2018, <https://www.cbinsights.com/research/china-baidu-alibaba-tencent-artificial-intelligence-dominance/>

For a more detailed breakdown of Baidu’s R&D spending quarterly, see:

https://ycharts.com/companies/BIDU/r_and_d_expense

³² “Alibaba to spend more than US\$15bn on technology research with launch of collaborative academy,” *South China Morning Post*, October 11, 2017, <http://www.scmp.com/business/article/2114853/alibaba-spend-more-u15bn-technology-research-launch-collaborative-academy>

³³ “AI “national team” Xiong’nn Debut! Will Change Your Life” [人工智能“国家队”雄安登场！将改变你的生活], *Xiong’an*, November 30, 2017, http://www.xiongan.gov.cn/2017-11/30/c_129766243.htm

³⁴ Ibid.

³⁵ For a more detailed discussion of military-civil fusion and its intersection with these going out activities, see: Greg Levesque and Mark Stokes, “Blurred Lines: Military-Civil Fusion and the “Going Out” of China’s Defense Industry,” *Pointe Bello*, December 2016, <http://www.pointebello.com/researchandinsights/>

³⁶ “CETC 28th Research Institute and Baidu Company Establish the “Joint Laboratory for Intelligent Command and Control Technologies” Step Forward Military-Civil Fusion in the Field of New Technologies in Depth” [中国电科 28

所与百度公司成立“智能指挥控制技术联合实验室”推动军民融合向新技术领域纵深迈进], January 23, 2018, www.sohu.com/a:218485100%E2%80%AD_%E2%80%AC779538

³⁷ “China has over 4,000 AI enterprises: report,” Xinhua, July 2, 2018, http://www.xinhuanet.com/english/2018-07/02/c_137295831.htm

³⁸ For a more detailed discussion of the status of AI development in Beijing, see: Beijing Municipal Commission of Economy and Information Technology (BMCEIT), “White Paper on Beijing AI Industry Development (2018)” [北京人工智能产业发展白皮书 (2018年)], June 30, 2018, <http://jxw.beijing.gov.cn/docs/2018-07/20180702170625874148.pdf>

³⁹ Xi-Lin Wang et al., “18-Qubit Entanglement with Six Photons’ Three Degrees of Freedom,” *Physical Review Letters*, June 28, 2018, <https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.120.260502>

⁴⁰ For a detailed discussion of Chinese advances in quantum science and technologies, please see a report that is forthcoming this summer: Elsa Kania and John Costello, “Quantum Hegemony?—China’s Ambitions and the Challenge to U.S. Innovation Dominance,” Center for a New American Security, August 2018, *forthcoming*.

⁴¹ “The State Council’s Several Opinions on Comprehensively Strengthening Basic Scientific Research” (国务院关于全面加强基础科学研究的若干意见), January 31, 2018, http://www.gov.cn/zhengce/content/2018-01/31/content_5262539.htm

⁴² Stephen Chen, “China building world’s biggest quantum research facility,” *South China Morning Post*, September 11, 2017, <http://www.scmp.com/news/china/society/article/2110563/china-building-worlds-biggest-quantum-research-facility>

⁴³ “Hefei’s Construction of a National Science Center from “Design” to “Construction Map”” [合肥建设国家科学中心从“设计图”转为“施工图], China News Network, September 13, 2017, <http://www.chinanews.com/gn/2017/09-13/8330201.shtml>

⁴⁴ “Anhui Reports on the Construction of the National Laboratory of Quantum Information Science, Total Investment 7 Billion Yuan” [安徽拟申报建设量子信息科学国家实验室，总投资约 70 亿元], July 11, 2017, <http://news.163.com/17/0711/15/CP2TJ9V7000187VE.html>

⁴⁵ Ibid.

⁴⁶ “Chinese Academy of Sciences – Alibaba Quantum Computing Laboratory Established” [中国科学院—阿里巴巴量子计算实验室挂牌], September 2, 2015, http://webcache.googleusercontent.com/search?q=cache:iiEL8f5-o30J:www.bsc.cas.cn/gzdt/201509/t20150902_4419884.html+&cd=2&hl=en&ct=clnk&gl=us

⁴⁷ “Baidu has entered the race to build quantum computers,” MIT Technology Review, March 8, 2018, <https://www.technologyreview.com/the-download/610449/baidu-has-entered-the-race-to-build-quantum-computers/>

⁴⁸ For a discussion of this concept as applied by one Chinese city, see: “Qingdao’s Science and Technology “bringing in” and “going out”” [青岛科技的“引进来”和“走出去”], Sina, May 19, 2018, <http://news.sina.com.cn/c/2018-05-19/doc-ihaturfs5184650.shtml>

⁴⁹ For a more detailed discussion of these trends, see: “Careful what you wish for—change and continuity in China’s cyber threats (parts 1 and 2), The Strategist, April 5/9, 2018, [https://www.aspistrategist.org.au/careful-wish-change-continuity-chinas-cyber-threat-activities-part-2/](https://www.aspistrategist.org.au/careful-wish-change-continuity-chinas-cyber-threats-part-1/), <https://www.aspistrategist.org.au/careful-wish-change-continuity-chinas-cyber-threat-activities-part-2/>

⁵⁰ Ellen Nakashima and Paul Sonne, “China hacked a Navy contractor and secured a trove of highly sensitive data on submarine warfare,” *Washington Post*, June 8, 2018, https://www.washingtonpost.com/world/national-security/china-hacked-a-navy-contractor-and-secured-a-trove-of-highly-sensitive-data-on-submarine-warfare/2018/06/08/6cc396fa-68e6-11e8-bea7-c8eb28bc52b1_story.html?utm_term=.70f27371221b

⁵¹ Michael Brown and Pavneet Singh, “China’s Technology Transfer Strategy: How Chinese Investments in Emerging Technology Enable A Strategic Competitor to Access the Crown Jewels of U.S. Innovation,” Defense Innovation Unit Experimental (DIUx), [https://admin.govexec.com/media/diux_chinatechnologytransferstudy_jan_2018_\(1\).pdf](https://admin.govexec.com/media/diux_chinatechnologytransferstudy_jan_2018_(1).pdf)

⁵² For a more extensive discussion of benefits (and politics) of collaborative innovation among the U.S., China, and India, see: Andrew Kennedy, *Conflicted Superpower: America’s Collaboration with China and India in Global Innovation*, Columbia University Press, 2018,

<https://books.google.com/books?id=z0pBDwAAQBAJ&pg=PP8&clpg=PP8&dq=andrew+kennedy+conflicted+superpower&source=bl&ots=D0H28IvfuE&sig=OyuFmE3NrdzYRBK9eIWXzSl08k&hl=en&sa=X&ved=0ahUKEwiUs0PWh6ncAhVFU8tKHdjPDwkQ6AEIQjAF#v=onepage&q&f=false>

-
- ⁵³ “From China With Love: AI, Robotics, AR/VR Are Hot Areas For Chinese Investment In US,” CB Insights, August 1, 2017, <https://www.cbinsights.com/research/chinese-investment-us-tech-expert-research/>.
- ⁵⁴ For a U.S. government assessment of the benefits of foreign direct investment, see: <https://www.selectusa.gov/FDI-Benefits>
- ⁵⁵ Thilo Hanemann and Adam Lysenko, “Chinese Venture Capital in the U.S: Recent Trends and FIRRMA Impacts,” Rhodium Group, July 11, 2018.
- ⁵⁶ For context on controversies in its investments in the U.S., see: Sui-Lee Wee, “China’s \$800 Billion Sovereign Wealth Fund Seeks More U.S. Access,” *New York Times*, July 11, 2017, <https://www.nytimes.com/2017/07/11/business/china-investment-infrastructure.html>
- ⁵⁷ See: “China Investment Corporation,” Crunchbase, <https://www.crunchbase.com/organization/china-investment-corporation>
- ⁵⁸ See, “About,” DHVC, <http://danhuacap.com/about?lang=zh>
- Zhongguancun (ZGC) Development Group [中关村发展集团], “Overseas Innovation Platform” [海外创新平台], http://www.zgcgroup.com.cn/business/overseas_funds.html
- ⁵⁹ Zhongguancun (ZGC) Development Group [中关村发展集团], “Group Profile” [集团概况], <http://www.zgcgroup.com.cn/about/intro.html>
- ⁶⁰ “Cross-Border S&T and Investment; DHVC’s Gu Anjia Won the “World Outstanding Chinese Award”” [跨界科技与投资，丹华资本谷安佳获“世界杰出华人奖”], *PEDaily*, September 27, 2017, <http://pe.pedaily.cn/201709/420572.shtml>
- ⁶¹ See: “DHVC (Danhua Capital)>Investments,” Crunchbase, https://www.crunchbase.com/organization/danhua-capital/investments/investments_list
- ⁶² Examples are available upon request.
- ⁶³ “Cross-Border S&T and Investment; DHVC’s Gu Anjia Won the “World Outstanding Chinese Award”” [跨界科技与投资，丹华资本谷安佳获“世界杰出华人奖”], *PEDaily*, September 27, 2017, <http://pe.pedaily.cn/201709/420572.shtml>
- ⁶⁴ Hangzhou Economic and Technology Development Zone [杭州经济技术开发区], <http://heda.hangzhou.gov.cn//>
- ⁶⁵ “HEDA Ventures,” Crunchbase, <https://www.crunchbase.com/organization/heda-ventures#section-overview>
- ⁶⁶ “Hangzhou Economic Development Zone established the first overseas technology investment fund in Silicon Valley” [杭州经济开发区在硅谷成立首支海外科技投资基金], People’s Daily Network, <http://world.people.com.cn/n1/2016/1025/c1002-28806114.html>
- ⁶⁷ In particular, Qihoo360 supports China’s strategy of military-civil fusion in cyber security, including through leading the Cyberspace Security Military-Civil Fusion Innovation Center. See: “Cyberspace Security Military-Civil Fusion Innovation Center Established in Beijing” [网络空间安全军民融合创新中心在北京成立], China News Network, December 26, 2017, <http://www.chinanews.com/it/2017/12-26/8409861.shtml>
- ⁶⁸ Lizette Chapman, “Qihoo 360 Joins Asian Companies Launching VC Groups in Silicon Valley,” *Wall Street Journal*, July 10, 2014, <https://blogs.wsj.com/venturecapital/2014/07/10/qihoo-360-joins-asian-companies-launching-vc-groups-in-silicon-valley/>
- ⁶⁹ For further information on the fund, see its website: “11.2 Capita,” <http://www.112capital.com>
- ⁷⁰ See: “11.2 Capital: Board Members and Advisers,” Crunchbase, <https://www.crunchbase.com/organization/eleventwocapital#section-board-members-and-advisors>
- ⁷¹ For one example, see: “China’s Baidu increases US presence with new Silicon Valley office,” *South China Morning Post*, March 25, 2017, <http://www.scmp.com/tech/china-tech/article/2082069/chinas-baidu-increases-us-presence-new-silicon-valley-office>
- ⁷² See “About Us,” <http://www.etdbchina.com/about-us>
- ⁷³ “CETC Chairman Xiong Qunli Inspected the CETC Software Information Services Co. Silicon Valley Innovation Center” [中国电科董事长熊群力视察电科软信硅谷创新中心], November 6, 2015, <http://www.chinacloud.com.cn/news/group/50.html>
- ⁷⁴ For recent media reporting that provides further context on these incubators and accelerators, see: Koh Gui Qing, Salvador Rodriguez, “In Silicon Valley, Chinese ‘accelerators’ aim to bring startups home,” Reuters, May 17, 2018, <https://www.reuters.com/article/us-usa-trade-china-startups/in-silicon-valley-chinese-accelerators-aim-to-bring-startups-home-idUSKCN1H0UG>

- ⁷⁵ ZGC Innovation Center in Silicon Valley [中关村硅谷创新中心], “Overseas Fund Layout” [海外基金布局], <http://zgccapital.com/cn/overseasfund/>
- ⁷⁶ For English-language reporting on its opening, see: “ZGC Innovation Center @ Silicon Valley opens in San Francisco, U.S.,” Xinhua, May 12, 2016, http://www.xinhuanet.com/english/photo/2016-05/12/c_135354672.htm
- ⁷⁷ ZGC Innovation Center in Silicon Valley [中关村硅谷创新中心], “Incubation and Acceleration” [孵化加速], <http://zgccapital.com/cn/incubateaccelerate/>
- ⁷⁸ “Hangzhou Silicon Valley Incubator Going Out, Promoting 41 Overseas High-Tech Projects” [杭州硅谷孵化器走出去推动 41 个海外高科技项目], December 6, 2016, http://hznews.hangzhou.com.cn/jingji/content/2016-12/06/content_6410731.htm
- ⁷⁹ “Hangzhou Silicon Valley Incubator’s Journey of Talent Attraction,” September 26, 2017, http://en.hangzhou.com.cn/News/content/2017-09/26/content_6671785.htm
- ⁸⁰ “Hangzhou Silicon Valley Incubator Going Out, Promoting 41 Overseas High-Tech Projects” [杭州硅谷孵化器走出去推动 41 个海外高科技项目], December 6, 2016, http://hznews.hangzhou.com.cn/jingji/content/2016-12/06/content_6410731.htm
- ⁸¹ See: “Lab360 Hardware Incubator,” <http://about.lab360.com/>
<https://www.crunchbase.com/organization/lab360-hardware-incubator>
- ⁸² For context on Chinese involvement in Boston’s biotech sector, see, for instance: Stephen Hansen, “BRIDGE TO INNOVATION: WHY CHINESE BIOPHARMAS ARE BUILDING BEACHHEADS IN BOSTON,” Biocentury, September 29, 2017, <https://www.biocentury.com/biocentury/strategy/2017-09-29/why-chinese-biopharmas-are-building-beachheads-boston>
- ⁸³ See CUBIC’s English language website: <http://www.cubic-boston.com/cubic/?lang=en> or activities as described here: <https://www.linkedin.com/company/china-us-boston-innovation-center>
- ⁸⁴ “China-US Enterprise Innovation Center Cuts Ribbons in the US” [中美企业创新中心在美国落成剪彩], March 5, 2015, <http://world.people.com.cn/n/2015/0305/c1002-26642474.html>
- ⁸⁵ “Boston Students Studying Abroad Entrepreneurship Night” [波士顿留学生创业之夜], July 30, 2017, <http://ny.uschinapress.com/m/spotlight/2015/07-30/76112.html>
- ⁸⁶ “CUBIC establish strategic partnership with Haiquan Fund,” April 12, 2016, <http://www.cubic-boston.com/2016/04/12/cubic-together-with-miti-venture-establish-strategic-partnership-with-haiquan-fund/?lang=en>
- ⁸⁷ “Sino-US S&T Cooperation “Breaking Ice” [中美科技合作“破冰”], Shanghai Technology Business Incubation Association, <http://www.shbia.org.cn/fhq/gjhz/hzdt/u1ai658.html>
- See also: <http://webcache.googleusercontent.com/search?q=cache:FP7BVJQvtS4J:www.stcsm.gov.cn/xwpt/kjdt/345584.htm+&cd=1&hl=en&ct=clnk&gl=us>
- ⁸⁸ For an English-language overview, see: “Shanghai Zhangjiang Boston Enterprise Park, Zhangjiang National Innovation Demonstration Zone, <http://www.chinadaily.com.cn/regional/zjbostonpark.html>
- ⁸⁹ “The Zhangjiang Boston Park Will Welcome the First Batch of Science Innovation Teams” [张江波士顿园区将迎首批科创团队], August 15, 2016, <http://webcache.googleusercontent.com/search?q=cache:FP7BVJQvtS4J:www.stcsm.gov.cn/xwpt/kjdt/345584.htm+&cd=1&hl=en&ct=clnk&gl=us>
- ⁹⁰ “Zhongguancun Lauches an Innovation Center in Boston” [中关村在波士顿启动创新中心], April 3, 2018, <http://scholarsupdate.hi2net.com/news.asp?NewsID=24512>
- ⁹¹ Cory Bennet and Bryan Bender, “How China acquires ‘the crown jewels’ of U.S. technology,” *Politico*, May 22, 2018, <https://www.politico.com/story/2018/05/22/china-us-tech-companies-cfius-572413>
- ⁹² Shenzhen Beijing Genomics Inc. and America’s Complete Genomics Announce their Agreement for a Definite Mergers and Acquisitions Agreement [深圳华大基因和美国 Complete Genomics 宣布达成确定性的并购协议], September 17, 2012, http://www.genomics.cn/news/show_news?nid=99218
- ⁹³ Megan Molteni, “A Chinese Genome Giant Sets Its Sights on the Ultimate Sequencer,” *WIRED*, May 18, 2017, <https://www.wired.com/2017/05/chinese-genome-giant-sets-sights-ultimate-sequencer/>
- ⁹⁴ For a detailed discussion of these activities from an industry source, see: Frank Tobe, “Another two Chinese acquisitions of international robotics companies,” November 14, 2017, <https://www.therobotreport.com/another-chinese-acquisition-european-robotics-manufacturer/>

-
- ⁹⁵ “Zhejiang Wanfeng acquires US robotics maker Paslin,” *China Daily*, April 21, 2016, http://www.chinadaily.com.cn/business/2016-04/21/content_24719433.htm
- ⁹⁶ For more information on Kuka and Midea’s acquisitions, see: “Chinese-Owned Robot Maker Is Gunning for No. 1 in Booming Market,” *Bloomberg*, March 8, 2017, <https://www.bloomberg.com/news/articles/2017-03-08/midea-eyes-top-spot-for-kuka-in-china-s-booming-robot-market>
- ⁹⁷ Shane Harris and Alexa Corse, “Chinese Hackers Target U.S. University With Government Ties,” *The Daily Beast*, August 21, 2015, <https://www.thedailybeast.com/chinese-hackers-target-us-university-with-government-ties>
- ⁹⁸ Elizabeth Weise, “Chinese hackers hit Penn State computer system,” *USA Today*, May 15, 2015, <https://www.usatoday.com/story/tech/2015/05/15/university-of-pennsylvania-penn-china-cyber-attack/27373601/>
- ⁹⁹ Anne Lu, “ANU computer networked infiltrated by Chinese hackers,” *International Business Times*, July 7, 2018, <http://www.ibtimes.com.au/anu-computer-networked-infiltrated-chinese-hackers-1569794>
- ¹⁰⁰ Ana Swanson and Keith Bradsher, “White House Considers Restricting Chinese Researchers Over Espionage Fears,” *New York Times*, April 30, 2018, <https://www.nytimes.com/2018/04/30/us/politics/trump-china-researchers-espionage.html>
- ¹⁰¹ For one (of many) indicators of Kuang-Chi’s engagement to support the PLA, see: “How To Create a Joint Force Through Civilians Participating in Military [Developments]?” [装备领域 “民参军” 如何形成合力?], *China Military Online*, http://www.81.cn/jmywyl/2017-04/15/content_7563563.htm
- ¹⁰² For instance, a number of Chinese companies recruit directly from U.S. universities, and Chinese talent plans often focus on encouraging overseas students to return.
- ¹⁰³ For a more detailed consideration of these issues, see: Daniel Golden, *Spy Schools: How the CIA, FBI, and Foreign Intelligence Secretly Exploit America's Universities*, Henry Holt and Co., 2017.
- ¹⁰⁴ For a powerful perspective on these issues, see: Yangyang Cheng, “Don’t Close the Door on Chinese Scientists Like Me,” *Foreign Policy*, June 4, 2018, <https://foreignpolicy.com/2018/06/04/dont-close-the-door-on-chinese-scientists-like-me/>
- ¹⁰⁵ I am very grateful to Alex Joske for his research on NUDT’s internationalization in sending students overseas, and please see his past and future writings on the topic for further insights. Clive Hamilton, Alex Joske, ‘Australian universities are helping China’s military surpass the United States’, *Sydney Morning Herald*, 27 October 2017, <https://www.smh.com.au/world/australian-universities-are-helping-chinas-military-surpass-the-united-states-20171024-gz780x.html>
- ¹⁰⁶ “NUDT Overseas Students Study in Step the 19th Party Congress Report” [国防科大海外留学生同步学习党的十九大报告], October 20, 2017, <http://hunan.voc.com.cn/mobile/article/201710/201710200716194889001.html>
- ¹⁰⁷ “Zhang Chaofan: Making Ordinary Basic Research Extraordinary” [张超凡：把平凡的基础研究做超凡], *China Military Online*, July 7, 2017, http://webcache.googleusercontent.com/search?q=cache:ekiOw-K0RF8J:www.81.cn/jfjmap/content/2017-07/07/content_181798.htm+&cd=11&hl=en&ct=clnk&gl=au
- ¹⁰⁸ For further details on his research at Stanford, see: https://www.researchgate.net/profile/Chaofan_Zhang
- ¹⁰⁹ Further information is available upon request. Thank you to Alex Joske for mentioning this example.
- ¹¹⁰ There is additional information available via its official website: <http://www.1000plan.org/>
- ¹¹¹ Hepeng Jia, “China’s plan to recruit talented researchers,” *Nature*, January 17, 2018, <https://www.nature.com/articles/d41586-018-00538-z>
- ¹¹² “2017 People’s Republic of China International Science and Technology Cooperation Award” [2017 年度中华人民共和国国际科学技术合作奖获奖人], Ministry of Science and Technology, January 8, 2018, http://webcache.googleusercontent.com/search?q=cache:wQjn0Cg20e8J:www.most.gov.cn/ztlz/gjxjsjldh/jldh2017/jldh17jlgg/201801/t20180103_137373.htm+&cd=4&hl=en&ct=clnk&gl=us
- ¹¹³ The sources in question are available upon request.
- ¹¹⁴ “Huawei in America: university partners,” *Huawei*, <http://usahuawei.com/huawei-in-america/university-partners/>
- ¹¹⁵ As discussed in this source, Huawei’s engagement also extends to educational programs, which may be of genuine benefit to American students but could also be used as a mechanism for recruitment in some cases. See also: “Huawei’s ‘Seeds for the Future’ Program Launches in US,” *American Councils Editorial Staff* July 21, 2016, <https://www.americancouncils.org/news/announcements/huaweis-seeds-future-program-launches-us>
- ¹¹⁶ Ingrid Lunden, “Huawei puts \$1M into a new AI research partnership with UC Berkeley,” *Tech Crunch*, October 11, 2016, <https://techcrunch.com/2016/10/11/huawei-puts-1m-into-a-new-ai-research-partnership-with-uc-berkeley/>
- ¹¹⁷ “Tsinghua-Michigan Joint Center for Quantum Information (JCQI),” <http://iis.tsinghua.edu.cn/en/list-373-1.html>

- ¹¹⁸ “Quantum Information and Frontier Coordinated Innovation Center Established and Introduced” [量子信息与前沿协同创新中心建设发展介绍], August 16, 2013, http://www.moe.gov.cn/s78/A16/A16_ztzt/ztl_ztzt_kjs2011/kjs2011_jyjl/201512/t20151204_222894.html.
- ¹¹⁹ For further context and a description of iFlytek, see: Yiting Sun, “Why 500 Million People in China Are Talking to This AI,” MIT Technology Review, September 14, 2017, <https://www.technologyreview.com/s/608841/why-500-million-people-in-china-are-talking-to-this-ai/>
- ¹²⁰ “CSAIL launches new five-year collaboration with iFlyTek,” MIT, June 15, 2018, <http://news.mit.edu/2018/csail-launches-five-year-collaboration-with-iflytek-0615>
- ¹²¹ Human Rights Watch, “China: Voice Biometric Collection Threatens Privacy: Police, AI Giant Collaboration in Legal Gray Area,” October 22, 2017, <https://www.hrw.org/news/2017/10/22/china-voice-biometric-collection-threatens-privacy>
- ¹²² See Human Rights Watch’s letter to iFlytek’s chairman, Liu Qingfeng, which details these concerns and unanswered questions: https://www.hrw.org/sites/default/files/supporting_resources/201710asia_china_iflytek.pdf
- ¹²³ “CMU to Set up Research Institute in Chengdu,” September 10, 2017, <http://www.gochengdu.cn/news/Highlights/cmu-to-set-up-research-institute-in-chengdu-a5996.html>
See also: <http://news.sina.com.cn/c/2017-09-04/doc-ifykpuui0894933.shtml>
- ¹²⁴ For one such consideration of this dynamic, see: “US tech companies and their Chinese partners with military ties,” *New York Times*, October 30, 2015, <https://www.nytimes.com/interactive/2015/10/30/technology/US-Tech-Firms-and-Their-Chinese-Partnerships.html>
- ¹²⁵ “With Powerful Partnership, Sugon’s Position in the Domain of AI” [强强联合，曙光布局人工智能领域], June 29, 2015, <http://www.sugon.com/about/detail/id/391.html>
- ¹²⁶ CMU to Set up Research Institute in Chengdu, September 10, 2017, <http://www.gochengdu.cn/news/Highlights/cmu-to-set-up-research-institute-in-chengdu-a5996.html>
- ¹²⁷ “CAS Dawn Releases the LAMBDA Platform in the U.S.” [中科曙光在美发布 LAMBDA 平台], *China Science Times*, May 11, 2017, <http://news.sciencenet.cn/htmlnews/2017/5/376000.shtml>
- ¹²⁸ “Sugon: Military-Civil Fusion and Autonomous Cyber Security” [曙光：军民融合与网络自主安全], Sohu, July 20, 2015, http://www.sohu.com/a/23543243_117770
- ¹²⁹ Ibid.
- ¹³⁰ “China Command and Control Society Joins Hands with CAS Sugon” [中国指挥与控制学会联手中科曙光], *China New Network*, January 15, 2016, <http://www.chinanews.com/mil/2016/01-15/7718692.shtml>
- ¹³¹ “Accelerate the “Cloud-ization” and Intelligentization of Military Command Information Systems” [推进军事指挥信息系统“云”化和智能化], *Global Times*, January 17, 2017, http://www.js7tv.cn/news/201601_33024.html
- ¹³² Fei-Fei Li, “Opening the Google AI China Center,” December 13, 2017, <https://www.blog.google/topics/google-asia/google-ai-china-center/>
- ¹³³ “Tsinghua University Launches Institute For AI; Hires Google’s Jeff Dean As Advisor,” Medium, June 28, 2018, <https://medium.com/syncedreview/tsinghua-university-launches-institute-for-ai-hires-googles-jeff-dean-as-advisor-e2875fc0847f>
- ¹³⁴ Elsa B. Kania (translator), “Tsinghua’s Approach to Military-Civil Fusion in Artificial Intelligence,” July 5, 2018, <https://www.battlefieldsingularity.com/musings-1/tsinghua-s-approach-to-military-civil-fusion-in-artificial-intelligence>
- ¹³⁵ You Zheng (尤政), Vice President of Tsinghua University, “The Road of Military-Civil Fusion for Artificial Intelligence Development” [军民融合的人工智能发展之路] June 8, 2018, http://www.moe.gov.cn/jyb_xwfb/xw_fbh/moe_2069/xwfbh_2018n/xwfb_20180608/sfcl/201806/t20180607_338728.html
- ¹³⁶ Wenxin Fan, “How a Powerful Spy Camera Invented at Duke Ended Up in China’s Hands,” *Wall Street Journal*, June 11, 2018, <https://www.wsj.com/articles/how-a-powerful-spy-camera-invented-at-duke-ended-up-in-chinas-hands-1528714895>
- ¹³⁷ See Rush Doshi’s contribution in this multi-part debate: “Should the U.S. Start a Trade War with China over Tech?,” A ChinaFile Conversation, June 26, 2018, <http://www.chinafile.com/conversation/should-us-start-trade-war-china-over-tech>
- ¹³⁸ For discussion of its importance, see: “Letter to FBI on the National Security Higher Education Advisory Board,” American Council on Education, April 24, 2018, <http://www.acenet.edu/news-room/Pages/Letter-to-FBI-on-the-National-Security-Higher-Education-Advisory-Board.aspx>

¹³⁹ Matthew Panzarino, “Ex-Apple employee charged with stealing self-driving car secrets,” Tech Crunch, July 10, 2018, <https://techcrunch.com/2018/07/10/ex-apple-employee-charged-with-stealing-self-driving-car-secrets/>