Testimony before the United States Senate Committee on Foreign Relations
"Advancing Effective U.S. Policy for Strategic Competition with China in the Twenty-First Century"

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Chairman Menendez, Ranking Member Risch, members of the Committee: Good morning, and thank you for the opportunity to speak today. I'm a research fellow specializing in semiconductor policy at the Center for Security and Emerging Technology (CSET), a nonpartisan think tank at Georgetown University that studies the security implications of new technologies.

Today, I'll cover three topics. First, the United States' and China's respective advantages in technological competition. Second, our best strategy to sustain long-term leadership will be to double down on our current strengths, including our international partnerships and ability to attract the world's top talent. Third, the importance of maintaining U.S. competitiveness in two linchpin technologies: semiconductors and artificial intelligence.

China's science and technology has progressed faster than U.S. efforts to track it. China has a vast technology transfer infrastructure, R&D investments equal to the United States, and more than twice as many yearly S&T graduates as America does.[2] China's efforts have resulted in competitive capabilities across facial recognition, genomics, IT applications, military aviation, and materials science. But the United States and its allies retain advantages in many core technologies, especially areas with hard-to-acquire implicit know-how and high capital costs that pose barriers to entry.[3] These areas include semiconductor chips, jet engines, certain space-related technologies, and equipment for quantum computing.[4] The United States also leads China in fundamental research.[5]

But the areas in which the United States is currently ahead may not provide a durable strategic advantage. First, the technology landscape evolves quickly and unpredictably. Where China is behind in a critical domain, it seeks to "leapfrog" ahead by acquiring cutting-edge technologies from abroad and investing in new paradigms that render U.S. and allied advantages obsolete.[6] Second, supply chains have become increasingly complex and globalized, meaning no single country controls all inputs necessary to secure technological capabilities through unilateral trade controls. Third, unlike decades ago, the private sector dominates today's most strategic technologies, requiring governments to adapt them before any strategic advantage can be gained.[7]

To compete with the increasing scale and quality of China's science and technology efforts, we must double down on our asymmetric advantages.

First, our network of allies is the world's strongest. The United States funds only 28% of global R&D compared to China's 26%. But the United States plus six allies fund over half.[8] And although the United States is just one node in globalized supply chains, together with allies it controls key technologies, such as chip manufacturing equipment. To mount an effective response to China, we must cooperate with allies on research, investment, technology standards, and export controls.

Second, America's open society has continually attracted the world's best and brightest. About half of the PhD-level scientists and engineers employed in the United States were born abroad.[9] Immigrants to the United States invented the modern computer chip and launched companies critical to America's security and prosperity today, from SpaceX to Google. But outdated U.S. immigration restrictions have made other nations increasingly attractive.[10] At the same time, China's science and engineering workforce is growing much faster than its U.S. counterpart—and will become the world's largest, if it hasn't already. In response, we must both invest in our domestic workforce and ensure the United States remains the world's top destination for global talent by broadening and accelerating pathways to permanent residency for scientists and engineers.[11] They want to stay: foreign nationals graduating from U.S. science and engineering PhD programs overwhelmingly remain in the United States.[12] Strong evidence suggests that increases in high-skilled immigration improve innovation, jobs, and wages for U.S.-born workers.[13]

Finally, I want to call special attention to two linchpin technologies: semiconductor chips and artificial intelligence.

Semiconductor chips underpin all modern technology. While the United States and allies still enjoy the lead in semiconductors, China is investing at an unprecedented rate. If current trends continue, China will become the world's largest semiconductor manufacturer, fundamentally altering the global economic and security landscape. Meanwhile, U.S. manufacturers have lost market share, and will continue to fall behind under the policy status quo. To reduce supply chain risks and create high-quality American jobs, we should generously fund the manufacturing incentives program in the CHIPS for America Act. And to ensure that democracies lead in advanced chips and that they are used for good, we must partner with allied democracies on joint R&D and tighten multilateral export controls on chip manufacturing equipment.[14]

The second technology I want to discuss is artificial intelligence. AI promises to revolutionize national security, healthcare, agriculture, energy, transportation, and scientific discovery. But AI systems are fragile and error-prone. Deploying them in critical systems without verifying their trustworthiness poses grave risks. We must better collaborate with allies on R&D for AI safety and security; test & evaluation, validation & verification (TEVV) of AI systems; and testbeds and standards for AI development. We must also identify opportunities to collaborate with competitors, including China, to build confidence and avoid races to the bottom.[15] We should invest in new types of AI technologies that protect privacy and other civil liberties,[16] and tightly control exports of American technology to human rights abusers, such as Chinese companies using advanced AI systems for surveillance.[17]

In summary:

- The United States and China each have technological advantages; and U.S. advantages may not provide a durable strategic edge.
- We must double down on our international partnerships and openness to the world's top talent.
- We must place a special focus on leadership in certain linchpin technologies such as semiconductors and artificial intelligence.

The U.S. can ensure long-term technological leadership, but only with concerted action. I thank the Committee for the opportunity to speak today. I look forward to your questions.

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[1] For helpful feedback, I thank Zachary Arnold, Daniel Hague, Helen Toner, Igor Mikolic-Torreira, Lynne Weil, and Remco Zwetsloot.

[2] National Science Foundation, "The State of U.S. Science and Engineering 2020," January 2020, https://ncses.nsf.gov/pubs/nsb20201/u-s-and-global-education.

[3] Andrea Gilli and Mauro Gilli, "Why China Has Not Caught Up Yet: Military-Technological Superiority and the Limits of Imitation, Reverse Engineering, and Cyber Espionage," *International Security*, vol. 43, no. 3, p. 141, https://www.mitpressjournals.org/doi/full/10.1162/isec_a_00337.

[4] Saif M. Khan, Alexander Mann, and Dahlia Peterson, "The Semiconductor Supply Chain: Assessing National Competitiveness" (Center for Security and Emerging Technology, January 2021), https://cset.georgetown.edu/research/the-semiconductor-supply-chain/; Matt Daniels, "The History and Future of US-China Competition and Cooperation in Space" (John Hopkins University Applied Physics Laboratory, 2020), https://www.jhuapl.edu/Content/documents/Daniels-Space.pdf.

[5] See William Hannas and Huey-Meei Chang, "China's Access to Foreign AI Technology: An Assessment" (Center for Security and Emerging Technology, September 2019), 7-8, https://cset.georgetown.edu/research/chinas-access-to-foreign-ai-technology/.

[6] Lauren Dudley, "China's Quest for Self-Reliance in the Fourteenth Five-Year Plan," *CFR Net Politics*, March 8, 2021, https://www.cfr.org/blog/chinas-quest-self-reliance-fourteenth-five-year-plan.

[7] This analysis derives from a more detailed assessment of U.S.-China technology competition in Zachary Arnold, "U.S. Investment in China's Capital Markets and Military-Industrial Complex," Testimony before the U.S.-China Economic and Security Review Commission, March 19, 2021, https://www.uscc.gov/hearings/us-investment-chinas-capital-markets-and-military-industrial-complex.

[8] Melissa Flagg, "Global R&D and a New Era of Alliances" (Center for Security and Emerging Technology, June 2020), https://cset.georgetown.edu/research/global-rd-and-a-new-era-of-alliances/.

[9] National Science Foundation, "Science and Engineering Labor Force," September 2019, https://ncses.nsf.gov/pubs/nsb20198/immigration-and-the-s-e-workforce.

[10] Tina Huang and Zachary Arnold, "Immigration Policy and the Global Competition for AI Talent" (Center for Security and Emerging Technology, June 2020), https://cset.georgetown.edu/research/immigration-policy-and-the-global-competition-for-ai-talent/.

[11] Zachary Arnold, Roxanne Heston, Remco Zwetsloot and Tina Huang, "Immigration Policy and the U.S. AI Sector" (Center for Security and Emerging Technology, September 2019), https://cset.georgetown.edu/research/immigration-policy-and-the-u-s-ai-sector/.

[12] Remco Zwetsloot, Jacob Feldgoise, and James Dunham, "Trends in U.S. Intention-to-Stay Rates of International Ph.D. Graduates Across Nationality and STEM Fields" (Center for Security and Emerging Technology, September 2020), https://cset.georgetown.edu/research/trends-in-u-s-intention-to-stay-rates-of-international-ph-d-graduates-across-nationality-and-stem-fields/; Remco Zwetsloot, James Dunham, Zachary Arnold, and Tina Huang, "Keeping Top AI Talent in the United States" (Center for Security and Emerging Technology, December 2019), https://cset.georgetown.edu/research/keeping-top-ai-talent-in-the-united-states/.

[13] See, e.g., National Academies of Sciences, Engineering, and Medicine, "The Economic and Fiscal Consequences of Immigration," Washington, DC: The National Academies Press, 2017, https://doi.org/10.17226/23550; Jennifer Hunt and Marjolaine Gauthier-Loiselle, "How Much Does

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[14] Saif M. Khan, "Securing Semiconductor Supply Chains" (Center for Security and Emerging Technology, January 2021), https://cset.georgetown.edu/research/securing-semiconductor-supply-chains/.

[15] Andrew Imbrie and Elsa Kania, "AI Safety, Security, and Stability Among Great Powers: Options, Challenges, and Lessons Learned for Pragmatic Engagement" (Center for Security and Emerging Technology, December 2019), https://cset.georgetown.edu/research/ai-safety-security-and-stability-among-great-powers-options-challenges-and-lessons-learned-for-pragmatic-engagement/; Michael Horowitz and Paul Scharre, "AI and International Stability: Risks and Confidence-Building Measures" (Center for a New American Security, January 12, 2021), https://www.cnas.org/publications/reports/ai-and-international-stability-risks-and-confidence-building-measures.

[16] Tim Hwang, "Shaping the Terrain of AI Competition" (Center for Security and Emerging Technology, June 2020), https://cset.georgetown.edu/research/shaping-the-terrain-of-ai-competition/.

[17] Dahlia Peterson, "China's System of Oppression in Xinjiang: How It Developed and How to Curb It" (Brookings Institution, September 2020), https://cset.georgetown.edu/research/chinas-system-of-oppression-in-xinjiang-how-it-developed-and-how-to-curb-it/.