The Sino-U.S. Technology Cold War: How the U.S. Leverages Technology Advantages through Economic Statecraft

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Abstract

This article explores the dynamics of the Sino-U.S. technology Cold War, focusing on how the U.S. leverages its technological advantages through economic statecraft. It delves into China's technology acquisition strategies, including instances of economic espionage and the theft of trade secrets, within the context of China's national priorities like the Made in China 2025 initiative. The U.S. response involves a mix of export controls, sanctions, and foreign direct investment controls aimed at preserving its technological lead, particularly in "chokepoint" technologies like jet engines and semiconductors. The efficacy of these technology controls over time is also examined, highlighting the complex interplay of economic engagement, strategic competition, and national security concerns shaping the bilateral relationship.

Keywords

Strategic competition, economic security, export controls, foreign direct investment (FDI) screening, China, United States, emerging technologies, sanctions

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Introduction

Made in China 2025 – the Chinese government's signature technology development plan – identifies developing domestic dynamic random-access memory (DRAM) and aerospace technology as a national priority. In September 2018, a Chinese state-owned enterprise was implicated in a conspiracy to commit economic espionage through the theft of stolen trade secrets from a U.S. semiconductor company. The target U.S. company is a global leader in the semiconductor industry and specializes in dynamic random-access memory (DRAM).[1] Later that same year, a Chinese Ministry of State Security (MSS) officer was arrested and charged with economic espionage involving the theft of trade secrets for civilian and military aircraft technology related to engineering services and signature material, jet engines, and aircraft propulsion, and engine containment structures from leading U.S. aviation firms.[2]

These two cases illustrate a larger, ongoing trend about the nature of technology acquisition by China. They also represent the paradoxical dynamics within the larger Sino-American relationship, one defined by economic interdependence and increasingly antagonistic political currents. Since the normalization of relations in 1979, Washington has sought simultaneously to maximize economic engagement while selectively controlling the export of strategic and military-related technology. The U.S. believed that through economic engagement, China's anti-capitalist and anti-Western posture (more specifically that of the Chinese Communist Party (CCP)) would moderate. Recently, U.S. National Security Advisor Jake Sullivan declared such China engagement a failure, asserting that:

> "*[m]uch of the international economic policy of the last few decades has relied upon the premise that economic integration would make nations more responsible and open and that the global order would be more peaceful and cooperative, that bringing countries into the rules-based order would incentivize them to adhere to its rules. It didn't turn out that way. In some cases it did, and in lot of cases it did not.*"[3]

The new era maintains and intensifies many of the former strategic approaches to Chinese military development. For decades, Washington has deployed export controls as the primary

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1 See "PRC State-Owned Company, Taiwan Company, and Three Individuals Charged with Economic Espionage," U.S. Department of Justice, November 1, 2018 and "U.S. DOD: Military And Security Developments Involving The People's Republic Of China 2011-2020 Annual Report To Congress," Office of the Secretary of Defense, May 2019.

2 See "Chinese Intelligence Officers and their Recruited Hackers and Insiders Conspired to Steal Sensitive Commercial Aviation and Technological Data for Years," U.S. Department of Justice, October 30, 2018.

3 Remarks by National Security Advisor Jake Sullivan on Renewing American Economic Leadership at the Brookings Institution, April 27, 2023. The White House's 2022 National Security Strategy asserts that, "The most pressing strategic challenge facing our vision is from powers that layer authoritarian governance with a revisionist foreign policy. It is their behavior that poses a challenge to international peace and stability—especially waging or preparing for wars of aggression, actively undermining the democratic political processes of other countries, leveraging technology and supply chains for coercion and repression, and exporting an illiberal model of international order. Many non-democracies join the world's democracies in forswearing these behaviors. Unfortunately, Russia and the People's Republic of China (PRC) do not."

means to limit Chinese acquisition of military and dual-use technologies. In recent years, the U.S. has added sanctions to the mix and expanded controls over foreign direct investment (FDI) to restrict technology access. Moving forward, an intensification and full deployment of tools of "economic statecraft," particularly in the domain of emerging or "innovation" technology, can be expected.[4] Indeed, the current trajectory of Sino-American relations is increasingly described as a "tech war," where the national security narrative is defined both by traditional military assets and high technology prowess.[5] The policy tools in this conflict are economic in nature and have rapidly expanded in scope and application during the Trump and Biden administrations.[6]

In this article, the author will review the current tools of economic statecraft arrayed against China in its efforts to acquire U.S.-origin high technology. Subsequent sections will examine export controls, sanctions, and foreign direct investment controls. The penultimate section will survey "chokepoint" technologies over which the U.S. exercises a commanding lead: jet engine and semiconductor manufacturing. The concluding section will examine the efficacy of technology controls over time.

Controlling Technology

Since the dawn of the Cold War, U.S. national security strategy has arguably hinged upon military technical superiority: the ability to field and maintain advanced military assets one or two generations ahead of any adversary. Export controls – policy instruments designed to facilitate and control trade in military and dual-use items – are fundamental to this end through technology acquisition denial. Globalization, the economic rise of China, and changing military and defense doctrines required the evolution in and deployment of the policy tools of economic

4 The focus on "innovation" and emerging technologies animates the Pentagon's current, third, Offset Strategy, as a means to "assure U.S. military superiority." See "Deputy Secretary: Third Offset Strategy Bolsters America's Military Deterrence, Office of the Secretary of Defense," October 31, 2016. See also, Paul McLeary, "The Pentagon's Third Offset May Be Dead, But No One Knows What Comes Next: Experts Say the U.S. Advantage over China and Russia is Eroding," *Foreign Affairs*, December 18, 2017, <https://foreignpolicy.com/2017/12/18/the-pentagons-third-offset-may-be-dead-but-no-one-knows-what-comes-next/>.

5 There is a growing body of literature describing the current Sino-U.S. geopolitical contest in explicitly technology-centric terms. See for example, Caitlin Lee, "Winning the Tech Cold War," RAND, August 17, 2023; Riley Callanan, "US-China Tech "Cold War" is On," *GZero*, The Eurasia Group, June 2, 2023; and Adam Segal, "The Coming Tech Cold War with China," *Foreign Affairs*, September 9, 2020, <https://www.foreignaffairs.com/articles/north-america/2020-09-09/coming-tech-cold-war-china>.

6 Some analysts maintain that we are in a new era of global politics, one best described as "geoeconomics." See for example, Robert D. Blackwill and Jennifer M. Harris, *War by Other Means: Geoeconomics and Statecraft* (Cambridge, MA: Harvard University Press, 2016). Also see Mikael Wigell, "Conceptualizing Regional Powers' Geoeconomic Strategies: Neo-Imperialism, Neo- Mercantilism, Hegemony, and Liberal Institutionalism," *Asia Europe Journal*, Vol. 14, Issue 2 (2016), p. 135.

statecraft.[7] This broader suite of controls includes and combines export controls, FDI national security reviews, and sanctions, much of which is currently focused on China's Military-Civil Fusion (MCF) policy and broader state-led high technology development efforts.[8]

Export Controls: Lists and Regulatory Innovation

The modern U.S. export control system began with the enactment of the *Export Control Act of 1949* (ECA) and the establishment of the Coordinating Committee on Multilateral Export Controls (COCOM) that same year.[9] The singular focus of both systems was to curtail Soviet and Chinese Communist acquisition of military, nuclear, and dual-use items and technologies that could be used to advance their respective military capabilities.[10] The initial list structure for both U.S. and multilateral systems was identical save for the inclusion of additional items

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7 The broader deployment of economic policy to achieve strategic ends was explicitly referenced in the 2017 National Security Strategy: "Economic tools—including sanctions, anti-money-laundering and anti-corruption measures, and enforcement actions—can be important parts of broader strategies to deter, coerce, and constrain adversaries." National Security Strategy of the United States of America, December 2017, <https://trumpwhitehouse.archives.gov/wp-content/uploads/2017/12/NSS-Final-12-18-2017-0905.pdf>, p. 42.

8 As noted in a C4ADS report on China's defense industrial policy, "[At] its core, MCF is a domestic strategy to catalyze resource sharing between the civilian and military spheres to build a modern defense industrial complex. Among the goals stated in the MCF five-year plan is "mutual open sharing of basic science and technology (S&T) resources" and "effective two-way technology transfer." Essentially, it aims to open China's defense markets to a broad pool of civilian participants in order to benefit from existing policies designed to stimulate innovation in the civilian industrial base." See Marcel Angliviel de la Beaumelle, Ben Spevack, and Devin Thorne, "Open Arms: Evaluating Global Exposure to China's Defense-Industrial Base," C4ADS, October 2019. For additional context on how MCF is attempting to integrate the civilian industrial base and defense economy and other goals, see for example the full text of Tai Ming Cheung, "13th Five-Year Plan for the Integration of Civilian and Military," in *Forging China's Military Might: A New Framework for Assessing Innovation* (Baltimore: Johns Hopkins University Press, 2014); and "Hearing on What Keeps Xi Up at Night: Beijing's Internal and External Challenges," Testimony of Greg Levesque before the U.S.-China Economic and Security Review Commission, 2019.

9 The ECA was preceded by the *Export Control Act of 1940*, which authorized the President to license or prohibit the export of "essential defense materials." The ECA of 1949, however, was the first peacetime export control regime and amended in 1951, 1953, 1956, 1958, 1960, 1962, and 1965. While the short supply ethos of the earlier Act animated the 1949 Act, national security became the dominant rationale. With regards to the ECA of 1949, "[p]robably no single piece of legislation gives more power to the President to control American commerce." See Harold J. Berman and John R. Garson, "United States Export Controls—Past, Present, and Future," *Columbia Law Review*, Vol. 67, Issue 5 (May 1967), pp. 791–890 as quoted in Richard T. Cupitt, *Reluctant Champions: U.S. Presidential Policy and Strategic Export Controls* (Routledge: New York, 2000).

10 As an adjunct to COCOM and in response to Chinese involvement in the Korean War, the United State petitioned for the creation of a separate committee, CHINCOM, to multilaterally control exports to communist China in 1952. Export controls by CHINCOM were considerably more restrictive and corresponding lists more expansive than controls by COCOM, which became known as the "China Differential." In 1957, however, U.S. allies formally incorporated CHINCOM into COCOM. For more information on CHINCOM, see, among others, Frank Cain, "The U.S.-Led Trade Embargo on China: The Origins of CHINCOM, 1947–1952," *Journal of Strategic Studies*, Vol. 18 (1995), pp. 33–54 and Hugo Meijer, *Trading with the Enemy: The Making of US Export Control Policy toward the People's Republic of China* (Oxford: Oxford University Press, 2016). See also Scott Jones, "Think Twice Before Bringing Back the COCOM Export Control Regime," *Defense News*, April 9, 2021.

on the lists (e.g., unilateral controls). The size and content of the control lists were subject to constant debate within the U.S. and between NATO allies, a characteristic that persists into current export control deliberations.[11] Arguably, the less complicated and relatively static parts of the lists – nuclear and directly military-related items – were uncontroversial. The bourgeoning dual-use list, by its very nature, roiled consensus-building efforts on establishing control parameters.[12]

As understood during the Cold War, "military superiority" was a concept relative to the Communist Bloc countries and to the Soviet Union in particular. Military superiority was also predicated on conventional weapons as opposed to Weapons of Mass Destruction (WMD), a distinction codified in law and in conceptual practice.[13] Indeed, with the exception of the Atomic List, COCOM controls were almost entirely focused on conventional weapons items and technologies.[14] With the end of the Cold War, the primacy of military superiority as the *raison d'etre* of export control policy became diffuse and subordinate to nonproliferation. As Richard Cupitt observes:

> *"In the summer of 1990, the United States finally appeared ready to abandon anti-Soviet containment as the basis for export controls. Critics pestered the Bush administration to formulate a new rationale for export controls, but none emerged. As some pundits pondered 'the end of history,' concerns about another military threat, the proliferation of weapons of mass destruction and their means of delivery, became ever more prominent."*[15]

In tandem with the collapse of the Soviet threat, the U.S. national security establishment became acutely aware of the rapid rate of "technology-leveling" occurring throughout the global

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11 The dynamic nature of export controls figured prominently in policy tensions between the U.S. Executive and Legislative branches. The complex policy interplay between control list parameters and associated policy guidelines also extended to debates within and between Executive agencies. The canonical review of this export control "policy entrepreneurism" can be found in Richard T. Cupitt, *Reluctant Champions: U.S. Presidential Policy and Strategic Export Controls* (Routledge: New York, 2000).

12 Michael Mastanduno, *Economic Containment: CoCom and the Politics of East-West Trade* (Ithanca: Cornell University Press, 1992). See also Major Rand Lewis, "COCOM: An International Attempt to Control Technology," *Defense Institute of Security Assistance Management (DISAM) Journal*, Vol. 13, Issue 1, Fall 1990, pp. 66-73.

13 See for example, Michael T. Klare, "Endless Military Superiority," *The Nation*, June 27, 2002, <https://www.thenation.com/article/archive/endless-military-superiority/>.

14 As noted by Evans, "Throughout CoCom's existence, the lists of controlled items were modified at least every few years, both to reflect new technological advances and the political/economic balance participating states—mainly the U.S.—were trying to reach. Most of these changes were made to the Industrial List." Samuel Weiss Evans, "Revising Control Lists," Flemish Peace Research Institute, March 2014, pp. 17-18.

15 Richard T. Cupitt, *Reluctant Champions: U.S. Presidential Policy and Strategic Export Controls* (Routledge: New York, 2000), p. 121.

economy as a technology-trade-investment virtuous cycle restructured international markets.[16] As noted in a 1999 Defense Science Board study on globalization and U.S. technological superiority:

> *"The strategic significance of global military-technological leveling cannot be overstated. It presents a direct challenge to perhaps the (emphasis in original) fundamental, if subliminal, assumption underlying the modern—and certainly post-Cold War—concept of U.S. military superiority: that the United States enjoys disproportionately greater access to advanced technology than its potential adversaries."*[17]

Hence, the U.S. export control system is increasingly focused on denying technology more so than the by-products of technology. In 2022, National Security Advisor Jake Sullivan articulated the new calculus for technology control:

> *"On export controls, we have to revisit the longstanding premise of maintaining "relative" advantages over competitors in certain key technologies. We previously maintained a "sliding scale" approach that said we need to stay only a couple of generations ahead. That is not the strategic environment we are in today. Given the foundational nature of certain technologies, such as advanced logic and memory chips, we must maintain as large of a lead as possible."*[18]

The rapid economic and, by extension, military rise of China throughout the early 2000s resuscitated the earlier Soviet-era concept of conventional military superiority.[19] As during the Cold War, the logic of deterrence constrained bilateral nuclear threat dynamics. Under the guide

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16 For example, as economist Richard Baldwin notes: "Managerial and technical know-how became more internationally mobile. After all, the offshored stages of production had to mesh seamlessly and evolve in tandem with the rest of the production network. This 'technology lending' – which is very different from the 1970s 'technology transfer' – could create advanced manufacturing activity in a developing nation in a matter of months. Developing nations no longer had to follow Korea's decade-long slog up the value chain (a feat that dozens of developing nations tried and failed before the 2nd unbundling)." Richard Baldwin, "Trade and Industrialization After Globalization's 2nd Unbundling: How Building and Joining A Supply Chain Are Different and Why It Matters," NBER Working Paper No. 17716, Issued in December 2011, Revised in January 2013, <https://www.nber.org/papers/w17716>, p. 6.

17 "Final Report of the Defense Science Board Task Force on Globalization and Security," Office of the Under Secretary of Defense for Acquisition and Technology, December 1999, p. 29.

18 Remarks by National Security Advisor Jake Sullivan at the Special Competitive Studies Project Global Emerging Technologies Summit, September 16, 2022, <https://www.whitehouse.gov/briefing-room/speeches-remarks/2022/09/16/remarks-by-national-security-advisor-jake-sullivan-at-the-special-competitive-studies-project-global-emerging-technologies-summit/>.

19 The re-emergence of "great power competition" with Russia and, more pointedly, China has impacted the national security narrative regarding export controls, which had earlier focused on WMD and anti-terrorism. For example, a recent Congressional Research Service report contends that: "The shift to renewed great power competition has profoundly changed the conversation about U.S. defense issues from what it was prior to 2014, leading to a reduced relative emphasis in the conversation on counterterrorist operations (although such operations continue), and to a new or renewed emphasis in the conversation on … maintaining U.S. technological superiority in conventional weapons…" See, Renewed Great Power Competition: Implications for Defense—Issues for Congress," Congressional Research Service, R43838, November 7, 2019, p. 6.

of "military-civil fusion," the People's Liberation Army (PLA) modernization is therefore the central threat, complicated by a bourgeoning awareness of the potentially revolutionary impact of so-called "disruptive technologies" such as artificial intelligence, additive manufacturing (e.g., 3D printing), and quantum computing.[20,21] Originally a business school concept, disruptive or exponential technologies were soon adopted by national security strategists. For example, in a Center for a New American Security report, Ben FitzGerald and Shawn Brimley defined disruptive technology in the defense sector as "a technology or a set of technologies applied to a relevant problem in a manner that radically alters the symmetry of military power between competitors" which then "immediately outdates the policies, doctrines and organization of all actors."[22] The focus on "innovation" and emerging technologies animates the Pentagon's current, third Offset Strategy, as a means to "assure U.S. military superiority."[23]

The National Defense Authorization Act for Fiscal Year 2019 repealed the portion of the Export Administration Act (EAA) of 1979 that mandated the creation and maintenance of the Military Critical Technologies List (MCTL). In December 2018, the U.S. Department of Defense cancelled the related DOD Instruction 3020.46, thereby officially terminating the MCTP.[24] As part of the 2019 NDAA, Congress enacted the Export Control Reform Act of 2018 (ECRA). Section 1758 of ECRA instructs that:

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20 See Elsa B. Kania and Lorand Laskai, "Myths and Realities of China's Military-Civil Fusion Strategy," Center for a New American Security (CNAS), January 28, 202, < https://www.cnas.org/publications/reports/myths-and-realities-of-chinas-military-civil-fusion-strategy>.

21 The theory of disruptive innovation was first developed by Clayton Christensen of Harvard Business School in his book, *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail* (1997). Dr. Christensen used the term to describe innovations that create new markets by discovering new categories of customers. They do this partly by harnessing new technologies, but also by developing new business models and exploiting old technologies in new ways. See Clayton Christensen, *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail* (Harvard Business Review Press, New Haven: 1997). See also Klaus Schwab, "The Fourth Industrial Revolution: What it Means, How to Respond," World Economic Forum, January 14, 2016 and James Manyika et al, *Disruptive Technologies: Advances that Will Transform Life, Business, and the Global Economy*, McKinsey Global Institute, May 2013, p. 6.

22 Ben FitzGerald and Shawn Brimley, "Game Changers: Disruptive Technology and U.S. Defense Strategy," Center for a New American Security (CNAS), September 2013, p. 11. See also Jennifer J. Snow, "Entering the Matrix: The Challenge of Regulating Radical Leveling Technologies," Monterey: Naval Post Graduate School, 2015, p. 5.

23 See "Deputy Secretary: Third Offset Strategy Bolsters America's Military Deterrence," U.S. Department of Defense, October 31, 2016. See also Paul McLeary, "The Pentagon's Third Offset May Be Dead, But No One Knows What Comes Next," *Foreign Affairs*, December 18, 2017.

24 "This Instruction, under the authority of DoD Directive 5134.01 (Reference (a)), establishes policy, assigns responsibilities, and prescribes procedures for developing and maintaining the MCTL as initially mandated by section 2401 et seq. of title 50, United States Code (also known as the Export Administration Act of 1979) (Reference (b)), and extended via section 1701 et seq. of Reference (b) (the International Economic Emergency Powers Act). This Instruction applies to OSD, the Military Departments, the Office of the Chairman of the Joint Chiefs of Staff and the Joint Staff, the Combatant Commands, the Defense Agencies, the DoD Field Activities, and all other organizational entities of the Department of Defense." See The Military Critical Technologies List, Department of Defense Instruction, October 15, 2018, <https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/302046p.pdf?ver=2018-10-24-091538-257>.

> *"The President shall establish and, in coordination with the Secretary, the Secretary of Defense, the Secretary of Energy, the Secretary of State, and the heads of other Federal agencies as appropriate, lead, a regular, ongoing interagency process to identify emerging and foundational (emphasis added) technologies that— (A) are essential to the national security of the United States; and (B) are not critical technologies described in clauses (i) through (v) of section 721(a)(6)(A) of the Defense Production Act of 1950, as amended by section 1703."*

The "critical technologies" not otherwise captured in the new designations include current military, nuclear, and dual-use controls and are emblematic of the new trajectory for export controls: technology.[25]

In the context of the passage of ECRA, it is noteworthy that Congress had been unable to reauthorize the lapsed EAA (2001) to enact new dual-use export control legislation for nearly twenty-years.[26] The rapid techno-industrial rise of China – particularly its Made in China 2025 industrial policy – at last galvanized and concentrated collective Congressional attention to dramatically reorient U.S. export and foreign direct investment controls.[27] The addition of emerging and foundational technologies strongly suggested that the extant military and dual-

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25 As defined in the NDAA, critical technologies consist of the following: "(a) Defense articles or defense services included on the United States Munitions List set forth in the International Traffic in Arms Regulations (ITAR) (22 CFR parts 120-130). (b) Items included on the Commerce Control List set forth in Supplement No. 1 to part 774 of the Export Administration Regulations (EAR) (15 CFR parts 730-774) and controlled: (1) Pursuant to multilateral regimes, including for reasons relating to national security, chemical and biological weapons proliferation, nuclear nonproliferation, or missile technology; or (2) For reasons relating to regional stability or surreptitious listening. (c) Specially designed and prepared nuclear equipment, parts and components, materials, software, and technology covered by 10 CFR part 810 (relating to assistance to foreign atomic energy activities). (d) Nuclear facilities, equipment, and material covered by 10 CFR part 110 (relating to export and import of nuclear equipment and material). (e) Select agents and toxins covered by 7 CFR part 331, 9 CFR part 121, or 42 CFR part 73. (f) Emerging and foundational technologies controlled pursuant to section 1758 of the Export Control Reform Act of 2018."

26 See Ian Fergusson and Paul Kerr, "The U.S. Export Control System and the Export Control Reform Initiative," Congressional Research Service, March 2019, R41916. See also "Prepared Remarks of The Honorable Kevin J. Wolf: Modernizing Export Controls: Protecting Cutting-Edge Technology and U.S. National Security," U.S. House Committee on Foreign Affairs," March 14, 2018. Wolf notes: "applaud the members for addressing this issue [ECRA]. Many of the threats and technologies are very different now than they were in 1979 and the issue warrants evaluation more frequently than every 40 years."

27 In terms of investment controls, the NDAA included the Foreign Investment Risk Review Modernization Act (FIRRMA). FIRRMA reforms the Committee on Foreign Investment in the United States (CFIUS) process currently used to evaluate and address national security-related concerns related to foreign investment into the United States. FIRRMA's most substantial change was to the scope of "covered transactions," which defines much of CFIUS's jurisdiction, to include "critical technologies." As defined in ECRA, critical technologies include "emerging and foundational technologies."

use lists were insufficient to safeguard U.S. national security and assure military superiority.[28] Although ECRA does not define "national security," a request for comment BIS published in November 2018 described the national security concerns to be addressed by the effort, e.g., to identify now uncontrolled items that "have potential conventional weapons, intelligence collection, weapons of mass destruction, or terrorist applications, or [that] could provide the United States with a qualitative military or intelligence advantage."[29]

On 19 November 2018, BIS published an Advanced Notice of Proposed Rulemaking (ANPRM) seeking public comment on criteria for identifying emerging technologies, with an ANPRM for foundational technologies published in 2020. The 2018 ANPRM included fourteen broad representative categories of technology, including illustrative subcategories, from which BIS seeks to determine whether if and which emerging technologies are important to U.S. national security for which effective export controls should be implemented:

1. Biotechnology
2. Artificial intelligence (AI) and machine learning
3. Position, Navigation, and Timing technology
4. Microprocessor technology
5. Advanced computing technology
6. Data analytics technology
7. Quantum information and sensing technology
8. Logistics technology
9. Additive manufacturing (e.g., 3D printing)
10. Robotics
11. Brain-computer interfaces
12. Hypersonics
13. Advanced materials
14. Advanced surveillance technologies

The ANPRM also included a list of explanatory examples of emerging technologies for each category (e.g., computer vision and national language processing within the AI and machine learning category). The ANPRM noted that the definitional process would need to be ongoing through continued interagency and private sector outreach, such as the Emerging Technology

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28 The catalyzing effect of Chinese "Civil-Military Fusion" efforts cannot be underestimated. In particular, a seminal study, the "DIUx Report," analyzed the rapid rate at which the Chinese government sought to acquire and invest in emerging technologies, while at the same noting "DoD does not currently have agreed-upon emerging technologies the U.S. must protect although there has been extensive work on export controls to protect technology products from being shipped to U.S. adversaries." See 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), updated 2016 and 2017, and January 2018, p. 15.

29 The expansion of the scope of U.S. export controls coincides with efforts to apply them to other policy domains. For example, one analyst recently noted: "There are growing calls in Washington to further expand the use of export controls as an economic tool—helping maintain America's technological edge generally, and not simply in the military domain." See Peter Harrell, "Export Controls Are Bigger and Broader. But Are We Safer?" Center for a New American Security, August 13, 2020, <https://www.cnas.org/publications/commentary/export-controls-are-bigger-and-broader-but-are-we-safer>.

Technical Advisory Committee and the Committee on Foreign Investment in the United States (CFIUS).[30] Through a focus on emerging technology, the U.S. radically revised and conflated two otherwise disconnected control systems: export controls and FDI national security reviews.

Notwithstanding the new consensus on export control reform, the effort to identify otherwise nebulous categories of emerging and foundational technologies proved very limited in practice. Arguably, the limited technology identification results should not have been surprising given the earlier experience with the MCTL.[31] Nevertheless, BIS endeavored to categorize and list several emerging technologies. During 2019 and 2020, BIS authored four final rules related to emerging technologies, resulting in controls being placed on thirty-seven technologies. These included technologies such as post-quantum cryptographic algorithms and law enforcement surveillance software. From 2021-22, BIS extended its controls to include new emerging technologies, including software for nucleic acid assembly and geospatial imagery.[32]

The apparently slow pace of technology identification and therefore control was not sufficient for Congress. In 2021, the U.S.-China Economic and Security Review Commission published a report, "Unfinished Business: Export Control and Foreign Investment Reform," criticizing the slow pace and asserting that BIS was not fulfilling its responsibilities under ECRA.[33] Thereafter, Senator Tom Cotton (R-AR) along with nine other Republican senators wrote a letter to Secretary of Commerce Gina Raimondo urging her to direct BIS to expedite identifying emerging and foundational technologies as outlined in Section 1758.[34] The letter highlighted five technology areas crucial for America's strategic competition with China, including AI, quantum computing, semiconductors, biotechnology, and autonomous systems. The letter also emphasized the need for BIS to follow the Intelligence Community's example in identifying

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30 Interestingly, the MCTL was also intended to inform CFIUS decisions. However, according to DOD officials, the MCTL was not used to inform these decisions. Instead, the DOD relied on input from technical experts in the Directorate for Defense Research and Engineering on an ad hoc basis. See "Defense Trade: Enhancements to the Implementation of Exon-Florio Could Strengthen the Law's Effectiveness," Government Accountability Office, GAO-05-686, September 28, 2005, p. 22.

31 See Scott A. Jones, "Disrupting Export Controls: Emerging and Foundational Technologies and Next Generation Controls," *Strategic Trade Review*, Vol. 6, Issue 9 (Winter/Spring 2020). Jones notes: "Established in 1980, the MCTP was of limited practical utility. As revealed by GAO and other analyses, the MCTL and DSTL constructs were too broad and/or imprecise to be of direct use in controlling exports and investments and in conditioning control lists. These limitations notwithstanding, the extant military and dual-use control lists continued to operate seamlessly precisely because they are based on established weapons systems or platforms."

32 The 37 technologies were identified before ECRA but were cast as emerging technologies presumably to appease Congress. The Congressional pressure to identify emerging technologies was largely insensitive to the long-standing statutory tools available to BIS and the interagency. Namely, the routine list-making process and other regulatory routes such as the 0Y521 process. See Scott Jones and Kevin Wolf, "0Y521 and Section 1758: Emerging Technologies by any Other Name?" *World Export Control Review*, Issue 89, May 2016.

33 See "Unfinished Business: Export Control and Foreign Investment Reforms," U.S.-China Economic and Security Review Commission, June 1, 2021, <https://www.uscc.gov/research/unfinished-business-export-control-and-foreign-investment-reforms>.

34 "Letter from Senator Tom Cotton to Secretary of Commerce Gina Raimondo, United States Senate, November 15, 2021, <https://www.cotton.senate.gov/imo/media/doc/commerce_bis_letter.pdf>.

key American technologies that should be protected from the Chinese Communist Party, with a particular focus on technology acquisition by Chinese AI firms.

In response to pressure from Congress and the perceived lack of clarity and practicality in ECRA's inclusion of commodity categories without clear definitions, BIS published a proposed rule. This rule signified an important change in BIS's approach to identifying new technologies of high strategic importance for control. In a May 23, 2022 rule, BIS informed the public that the agency would no longer characterize new controls as corresponding to emerging or foundational technologies pursuant to Section 1758 of ECRA, instead referring to the technologies at issue as "Section 1758 technologies."[35]

In terms of policy modernizations, BIS has notably revised its export controls (e.g., the Military End-User List) and the scope of the Foreign Direct Product Rule (FDPR) in October 2022 and 2023, reflecting a strategic stance towards advanced computing and semiconductor manufacturing.[36] The 2022 rules initially targeted exports of advanced chips and semiconductor manufacturing equipment, focusing on preventing their use in China's military modernization, specifically in large-scale AI systems. A year later, the 2023 updates expanded these controls by revising the criteria for restricted chips and extending the geographic scope to include additional countries and entities headquartered in U.S. arms-embargoed nations. The October Rules are some of the most complicated export control policies to date.[37] Simultaneously, in 2022, BIS clarified and reorganized the FDPR, which has been in statutory form since 1959, consolidating the rules for greater coherence and addressing specific confusions around definitions and license requirements. Lastly, BIS is increasing its compliance messaging through policy updates (e.g., voluntary self-disclosure revisions and "multi-seal" notices) and enforcement (e.g., the 2023 USD $300 million enforcement action against Seagate for FDPR violations).[38]

FDI Controls: In and Out

Until recently, the Committee on Foreign Investment in the U.S. (CFIUS) operated in relative obscurity, with only an *ad hoc* headline presence. However, in light of China's expansive FDI efforts, deepening skepticism of Beijing's global intentions, and tighter growth margins in the global economy, CFIUS has been elevated in prominence as a hedge against emerging geoeconomic risks in general and against Chinese technology acquisition efforts in particular. During the 115th Congress (2017-2019), many Members expressed concerns over China's growing investment in the United States, particularly in the technology sector, the result of which was the Foreign Investment Risk Review Modernization Act (FIRRMA), which further

35 "Commerce Implements New Multilateral Controls on Advanced Semiconductor and Gas Turbine Engine Technologies," BIS Press Release, August 12,2022

36 See for example, Hanna Dohmen and Jacob Feldgoise, "A Bigger Yard, A Higher Fence: Understanding BIS's Expanded Controls on Advanced Computing Exports," Center for Security and Emerging Technology, December 4, 2023, <https://cset.georgetown.edu/article/bis-2023-update-explainer/>.

37 For example, the October 2023 rule is over 400 pages. See Reva Goujon and Jan-Peter Kleinhans, "All In: U.S. Places a Big Bet with October 17 Controls," Rhodium Group Research Note, November 6, 2023.

38 See Kyle Brasseur, "BIS Updates Voluntary Self-Disclosure Policy to Punish Not Coming Forward," *Compliance Week*, April 19, 2023 and Karen Freifeld, "Seagate to Pay USD $300 Million Penalty for Shipping Huawei 7 Million Hard Drives," *Reuters*, April 20, 2023.

empowered and broadened the CFIUS mandate.

In February 2020, CFIUS jurisdictional scope was broadened through regulatory amendments to include its authority to review non-controlling foreign investments in U.S. enterprises engaged in the development or production of critical technologies, execution of critical infrastructure functions, and the collection or storage of sensitive personal data of U.S. citizens, all under the purview of national security concerns. CFIUS has been proactively identifying and scrutinizing firms involved in such transactions that failed to seek CFIUS clearance before finalization. A notable instance in 2019 saw CFIUS compelling Beijing Kunlun Tech Co., Ltd. to divest its ownership of the dating app Grindr LLC, acquired in 2016, due to fears of potential misuse of sensitive U.S. personal data by the Chinese government. Additionally, CFIUS exerted pressure on Pamplona Capital Management, a fund with partial Russian investment, to relinquish its minority interest in a U.S. cybersecurity company.[39]

The U.S. government has been particularly focused on controlling technology mergers and acquisition in general, and by Chinese acquirers in particular.[40] Several recent high-profile cases focused on deals involving semiconductor design and manufacturing:

- In 2016, President Obama blocked the Chinese firm Fujian Grand Chip Investment Fund from acquiring Aixtron, a German-based semiconductor firm with U.S. assets.

- In 2017, President Trump blocked the acquisition of Lattice Semiconductor Corp. of Portland, Oregon for USD $1.3 billion by Canyon Bridge Capital Partners, a Chinese investment firm.

- In 2018, President Trump blocked the acquisition of semiconductor chip maker Qualcomm by Singapore-based Broadcom for USD $117 billion over China and 5G concerns.[41]

The technology acquisition loopholes closed by FIRRMA and accompanying technology denial logic has now been extended to U.S. outbound FDI into "countries of concern."[42]

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39 CFIUS's expanded authority under FIRRMA directs it to review investment transactions whether or not the investment conveys a controlling equity interest in certain cases. See "The Committee on Foreign Investment in the United States (CFIUS)," Congressional Research Service, RL33388, August 3, 2023, <https://crsreports.congress.gov/product/pdf/IF/IF10177>.

40 See for example, Blair Wang, "CFIUS Ramps up Oversight of China Deals in the US," *The Diplomat*, September 14, 2021. Greater scrutiny of Chinese acquisition and investment efforts by CFIUS has resulted in a significant drop in Chinese investments requiring a CFIUS review, from an average of 57 cases per year in the 2016-18 time period to 28 in 2019 and 22 in 2020.

41 Other rejected deals include Royal Philips's sale of a controlling interest in its Lumileds business to a Chinese buyer, Fairchild Semiconductor's rejection of a Chinese acquisition offer due to CFIUS risk, HNA Group's proposed acquisition of Global Eagle Entertainment Inc., and T.C.L. Industries Holdings' proposed purchase of Inseego Corporation. For more on CFIUS reforms, see "The Committee on Foreign Investment in the United States (CFIUS)," Congressional Research Service, RL33388, August 3, 2023, <https://crsreports.congress.gov/product/pdf/IF/IF10177>.

42 The order initially focuses on "countries of concern," currently only China (including Hong Kong and Macau), and investments in three sensitive technology sectors: semiconductors and microelectronics, quantum information technologies, and artificial intelligence.

In August 2023, President Biden enacted Executive Order (E.O.) 14105 which restricts *outbound* investment to China, Hong Kong, and Macau in areas deemed critical to U.S. national security. These include three main industries: advanced computing chips, microelectronics, and artificial intelligence (AI). In certain instances, particularly when the technology is intended for military or surveillance use, investment is completely forbidden. However, for products that are less sensitive, investment is allowed, provided that the government is notified.[43]

As outlined in a Department of Treasury ANPRM, the directive precisely focuses on investments that pose a risk of conveying "intangible benefits" like managerial know-how, access to talent networks, and pathways to market entry. It explicitly excludes passive investments in publicly traded instruments, such as stocks or bonds. The Treasury Department, tasked with enforcing these restrictions, indicated that they would be applicable solely to transactions conducted after the directive becomes operational in 2024. The proposed outbound investment scheme is set to include a series of specific bans and compulsory reporting requirements for investments in sectors like artificial intelligence, quantum computing, and semiconductor technology.[44] The ANPRM further formulates the government's increasingly unified technology denial strategy: "The PRC government explicitly seeks to advance these technologies and to ensure that new innovations simultaneously benefit its military and commercial aims. The PRC government is aggressively pursuing these objectives to confer a decisive advantage to its military, intelligence, surveillance, and cyber-enabled services."[45] In serial fashion, the U.S. government, including Congress, is progressively identifying gaps across its heretofore disjointed technology control regimes, from exports controls to FDI.

Ahead of the House-Senate conference on the 2024 National Defense Authorization Act, the Senate's resounding approval of the Outbound Investment Transparency Act signals a decisive move towards comprehensive investment controls. This bipartisan-backed act strengthens oversight over a wider range of sensitive technologies, including hypersonics, dual-use networked laser scanning systems, and satellite-based communications systems, addressing some minor gaps left by Executive Order 14105. This unified approach paves the way for a robust framework governing both inbound and outbound investments.[46]

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43 See Gregory Allen, "A New National Security Instrument: The Executive Order on Outbound Investment," Center for Strategic and International Studies, August 10, 2023, <https://www.csis.org/analysis/new-national-security-instrument-executive-order-outbound-investment>.

44 Noah Berman, "President Biden Has Banned Some U.S. Investment in China. Here's What to Know," Council on Foreign Relations, August 29, 2023. See also Ngor Luong Emily S. Weinstein, "A Guide to the Proposed Outbound Investment Regulations," Center for Security and Emerging Technology, October 6, 2023.

45 Advanced Notice of Proposed Rulemaking, <https://home.treasury.gov/system/files/206/Treasury-ANPRM.pdf>. See also Emily Benson and Gregory C. Allen, "A New National Security Instrument: The Executive Order on Outbound Investment," Center for Strategic and International Studies (CSIS), August 10, 2023.

46 As noted by Allen, op. cit, Representative Mike Gallagher (R-WI), chairman of the United States House Select Committee on the Chinese Communist Party, wrote a letter to the White House requesting a more expansive instrument. In the letter, Representative Gallagher argued that "[f]or too long, America has funded the CCP's military buildup, technological ambitions, and human rights abuses and allowed the CCP unconstrained access to our capital markets and the dynamism and efficient capital allocation that they enable."

Sanctions

Sanctions have a long and storied history as U.S. geoeconomic policy tools – the evolution of which has culminated in a broad continuum of general and very specific measures.[47] Beyond the now routine and byzantine sanctions against Iran and North Korea, recent sanctions actions have increasingly focused on Chinese and Russian individuals, officials, companies, and economic sectors.

China

The recent trends in U.S. sanctions against Chinese entities reflect a complex interplay between geopolitical competition, concerns over national security, human rights issues, and the strategic intent to curb China's technological advancements and economic influence. The relatively fewer sanctions imposed on Chinese targets, compared to those on Russia and Iran, can be attributed to the intricate and deeply intertwined economic relationship between the U.S. and China, alongside strategic considerations that reflect the complex nature of their bilateral ties.[48]

In September 2018, the United States leveled sanctions on China's Equipment Development Department (EDD), the military branch responsible for weapons and equipment, and its director, Li Shangfu, for engaging in "significant transactions" with Rosoboronexport, Russia's main arms exporter. The sanctions are related to China's purchase of 10 SU-35 combat aircraft in 2017 and S-400 surface-to-air missile system-related equipment in 2018, the State Department said.[49] While largely symbolic and based on legislation principally targeting Russia, the action revealed the consistent U.S. focus on denying military-related technology to China.

Related to sanctions actions (e.g., asset freezes and travel bans), the U.S. government, through the Department of Commerce, tightened sanctions on Huawei in May 2020. Huawei Technologies, along with 114 of its global affiliates, was already under a de facto export ban from the United States since May 2019, a measure that was reinforced by intensive diplomatic efforts aimed at severing the firm's access to Western markets. The enhanced restrictions prevent foreign companies from utilizing U.S.-origin designs or components to manufacture semiconductors essential for Huawei's product line. Shortly thereafter, the U.S. expanded its measures by placing an additional thirty-three Chinese entities on an export control blacklist citing their alleged involvement in human rights abuses or connections to the Chinese military.

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47 See for example, Richard Nephew, *The Art of Sanctions: A View from the Field* (New York: Columbia University Press: 2017).

48 U.S. calculus on sanctioning Chinese entities may be changing. Democratic Senator Gerald Connolly, member of the U.S. House Committee on Foreign Relations, said that lawmakers were already considering more sanctions after similar measures were proposed in the European Union. Senator Connolly noted: "China has to understand that the same kinds of sanctions which are beginning to really take hold in Russia and are affecting Russian productivity, economic performance and quality of life, can also be applied to China; and China has a lot more to lose." See Karen Gilchrist, "China Has a lot More to Lose: U.S. Considering Sanctioning Chinese Firms Aiding Russia's War," *CNBC*, February 19, 2024.

49 The sanctions action was based upon the Countering America's Adversaries Through Sanctions Act of 2017 (CAATSA), 115th Congress, August 2, 2017, <https://congress.gov/115/plaws/publ44/PLAW-115publ44.pdf>.

In parallel, U.S. lawmakers introduced legislation aimed at preventing a federal pension fund from investing in Chinese equities, curtailing Chinese firms' capacity to secure capital in the U.S. market, and imposing sanctions on Chinese officials implicated in suppression efforts.[50]

Russia

In the case of Russia, sanctions have intensified, especially following the invasion of Ukraine in 2022. U.S. sanctions have targeted Russia's defense, aerospace, and maritime sectors as well as individuals and government entities. These sanctions are designed to degrade Russia's ability to modernize its military capabilities and maintain its industrial base. The export controls implemented have been particularly effective in limiting Russia's access to high-tech items, including electronics and software, which are crucial for the development of advanced military systems.[51]

Both sets of sanctions against China and Russia have been coordinated with allies, ensuring a broader impact. The U.S. has worked closely with the European Union and other countries to align their sanction efforts, creating a more unified and effective approach to limiting technology access. This coordination is crucial because it reduces the ability of targeted countries to circumvent U.S. sanctions by turning to alternative sources for their technological needs.[52]

Assessment of Technology Controls

With China's economic and military rise, the U.S. has reassembled and combined the various aspects of economic policy, up to and including general trade policy (e.g., tariffs), to curtail China's Military-Civil Fusion (MCF) process. Export controls, FDI reviews, and sanctions are effective to the degree that they actually limit the ability of the target to acquire technology they are otherwise unable to procure or produce. While China's rapid economic development has

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50 During this period, the Department of Commerce also added SenseTime, Hikvison, and other Chinese companies to its Entity List, thereby prohibiting these entities from obtaining any hardware, software, or technology that is subject to the U.S. Export Administration Regulations. The Department of Defense (and other agencies) also prohibited federal agencies from buying "covered telecommunications equipment or services" from designated Chinese entities, including Huawei and ZTE, as a substantial or essential component of any system, or as critical technology as part of any system. In addition, the Administration has issued executive orders authorizing the Department of Commerce and the Department of Energy to issue regulations to review and mitigate certain types of transactions in the telecom and bulk energy sectors, respectively. See Andrew Rennemo, "With China Sanctions, America Pushes the Limits of Its Financial Power: U.S. Diplomacy has Developed an Unhealthy Dependence on Sanctions," *The Diplomat*, June 19, 2020; Kathy Gilsinan, "A Boom Time for U.S. Sanctions: The Explosive Growth in their Use has Prompted Questions About How Much is Too Much," *The Atlantic*, May 3, 2019; and "Economic Sanctions: Agencies Assess Impacts on Targets, and Studies Suggest Several Factors Contribute to Sanctions' Effectiveness," Government Accountability Office, GAO-20-145, October 2019, <https://www.gao.gov/assets/gao-20-145.pdf>.

51 Alena Epifanova, "Tech Sanctions Against Russia: Turning the West's Assumptions into Lessons," German Council on Foreign Relations, June 2023, <https://dgap.org/en/research/publications/tech-sanctions-against-russia>.

52 See for example, Scott Anderson, "What Sanctions Has the World Put on Russia?" Lawfare, 2March 24, 2022.

enabled significant growth in production sophistication and efficiency, China is still deficient in key strategic sectors, including jet engines and semiconductors, a point often noted in official publications.[53] For example, President Xi has variously cautioned that China is critically dependent on advanced economies regarding several chokepoint technologies and that "key core technologies are controlled by others," particularly military jet engines and advanced semiconductors.[54] These two technology sectors represent fundamental obstacles to both military modernization and further economic innovation objectives.

Jet Engines

China's military modernization has been noteworthy both for its speed and indigenized production of major weapons system platforms.[55] This being noted, the latter capacity has been limited to major land and marine systems. China's military aerospace capabilities are still highly dependent upon foreign technology, particularly jet engines. For example, in 2016, China's 13th Five-Year Plan for the National Development of Strategic Emerging Industries emphasized the importance of improving the performance of indigenous jet engine designs and the further development of the aerospace industry to move firmly to an indigenous production system.

The current fleet of People's Liberation Army Air Force (PLAAF) frontline and multi-role fighters bear the distinct marks of foreign lineages.[56] For example, as noted by Robert Farley, the J-10 is reportedly based on the Israeli IAI Lavi and, by extension, General Dynamics F-16; the J-11 is a copy of the Russian Su-27; the JF-17 is an updated development of the Soviet MiG-21; the J-20 bears a arresting resemblance to the F-22, and finally, "the J-31 is widely believed to rely heavily on technology appropriated from the F-35 Joint Strike Fighter."[57] Chinese efforts to reverse engineer certain Russian jet engines such as AL-31s and AL-117s

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53 See for example, Douglas Zhihua Zeng, "Measuring the Effectiveness of the Chinese Innovation System: A Global Value Chain Approach," *International Journal of Innovation Studies*, Volume 1, Issue 1 (2017), pp. 57-71 and Ben Murphy, "Chokepoints: China's Self-Identified Strategic Technology Import Dependencies," Center for Security and Emerging Technology, May 2022, <https://cset.georgetown.edu/publication/chokepoints/>.

54 See Xi, J. (2021), "Strive Hard to Become the World's Major Science Centre and Innovation Hub," Qiushi, March 15, 2021, <http://www.qstheory.cn/dukan/qs/2021- 03/15/c_1127209130.htm>, quoted in Yu Ji, "China's New Scientists: The Emerging Leaders Behind Beijing's Drive for Technological Self-Reliance," Chatham House, July 24, 2023, <https://www.chathamhouse.org/2023/07/chinas-new-scientists>.

55 See for example, "China Military Power: Modernizing a Force to Fight to Win," U.S. Defense Intelligence Agency, 2019 and Vance Hawkins, *China's Military Modernization and Search for Power* (London: Alpha Edition, 2018).

56 See Sebastien Roblin, "Most of China's Aircraft are Russian or American Copies," *The National Interest*, November 23, 2021. Regarding Chinese domestic jet engine production capabilities, Roblin notes: "Jet-engine tech remains the chief limitation of Chinese combat aircraft today. Indeed, in 2016 China purchased twenty-four Su-35s, the most sophisticated and maneuverable variant of the Flanker so far—likely to obtain their AL-41F turbofans engines."

57 See, Robert Farley, "Why China Struggles to Produce an Indigenous Jet Engine," *The National Interest*, September 21, 2022 and Dimitri Simes, "Russia Up in Arms over Chinese Theft of Military Technology: Beijing's Rise as a Major Armaments Exporter is a Double-Edged Sword for Moscow," Nikkei Asia Times, December 20, 2019.

during the 1990s and 2000s invariably produced engines with extremely short lifespans and without the power of their Russian counterparts.[58]

A recent study of China's military aerospace modernization concludes the following regarding jet engine production capacity:

> *"China's struggle to indigenously develop aircraft engines thus throws into question the growing belief among observers that China has closed the military-technological gap with the United States with respect to fifth generation fighters.[59] Possibly more important, it also illustrates that the advantages of imitation that China has enjoyed have inevitably been limited. As mentioned earlier, several factors significantly facilitated China's efforts to develop turbofan engines; and from 2010 to 2015, it spent some USD $22 billion to develop an indigenous engine for its combat aircraft. Yet, as of 2019, it continues to struggle."*[60,61]

Reliance on Russian jet technology and the limited ability to reverse engineer hot section components has sharply limited Beijing's ability to indigenously produce its own military-grade turbofan engines.[62] Despite warming relations with China, Moscow is unlikely to share the associated intellectual property (IP) precisely because of IP theft concerns.[63] Furthermore, the U.S. can deploy sanctions against Russia for deepening military-technical cooperation, as was the recent case involving S-400 and Su-35 sales which resulted in Russian and Chinese sanctions. Lastly, the U.S. will continue to use unilateral and plurilateral (e.g., coordination with other jet engine technology providers such as France) export controls against the Chinese

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58 Dimitri Simes, "Russia Up in Arms over Chinese Theft of Military Technology: Beijing's Rise as a Major Armaments Exporter is a Double-Edged Sword for Moscow," *Nikkei Asia Times*, December 20, 2019.

59 The J-20 does not possess supercruise (e.g., increased engine thrust that enables sustained supersonic flight without the need for inefficient afterburners) capabilities, so it is not a 5th generation fighter. See also John A. Tirpak, "Pentagon: China Working on Upgrades to Top Stealth Fighter, Manned-Unmanned Teaming," *Air and Space Forces Magazine*, October 24, 2023, <https://www.airandspaceforces.com/pentagon-china-upgrades-top-stealth-fighter/>.

60 Author's note: Minnie Chan, "China Powers Up Military Jet Engine Tech to Wean Itself Off Russian Imports," *South China Morning Post*, December 12, 2016. The amount is 168 billion yuan, approximately equivalent to USD $21–$24 billion.

61 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 (Winter 2018/19), pp. 141–189.

62 It should also be noted that China has relied on Ukrainian engine imports and designs as detailed by the U.S. Department of Defense: "China has a longstanding reliance on Russian- and Ukrainian-built engines for fixed and rotary wing aircraft produced domestically…. Russia's war on Ukraine probably will impede China's ability to acquire military equipment and maintenance services from either country." See "Annual Report to Congress: Military and Security Developments Involving the People's Republic of China," Office of the Secretary of Defense, 2023.

63 Regarding Chinese reverse engineering, a recent review of Russian military jet transfers to China notes: "To be sure, China still imports turbofan engines from Russia as it struggles to perfect domestic alternatives such as the WS-10B and eventually the powerful WS-15. However, the latest Chinese fighters increasingly incorporate weapons and avionics that are more capable than those of their Russian counterparts." Sebastien Roblin, "Why China's Latest Jets Are Surpassing Russia's Top Fighters," *Forbes*, November 10, 2020.

military's jet engine indigenization efforts. In 2020, for example, U.S. Department of Commerce published a Military End-User (MEU) List requiring export licenses for exports, re-exports, and in-country transfers of aerospace equipment and technology.[64]

Despite apparent and episodic advances in engine design and production capabilities, the related literature strongly suggests that China is incapable of producing peer-equivalent high-performance/-reliability military jet engines. Therefore, domestic production limitations are an abiding handicap in Beijing's military modernization plans.[65] As such, Washington will continue to target associated technologies through export controls, sanctions, and FDI controls.[66]

Semiconductors

China famously imports more semiconductors than oil to power its economy. For example, in 2022, China imported USD $415.58 billion worth of semiconductors compared with USD $365.51 billion in crude oil, with most semiconductors being of direct or indirect U.S. origin.[67] More so than jet engines, mastery of semiconductor manufacturing is critically central to the projected high technology base of both future economic and military power for China.

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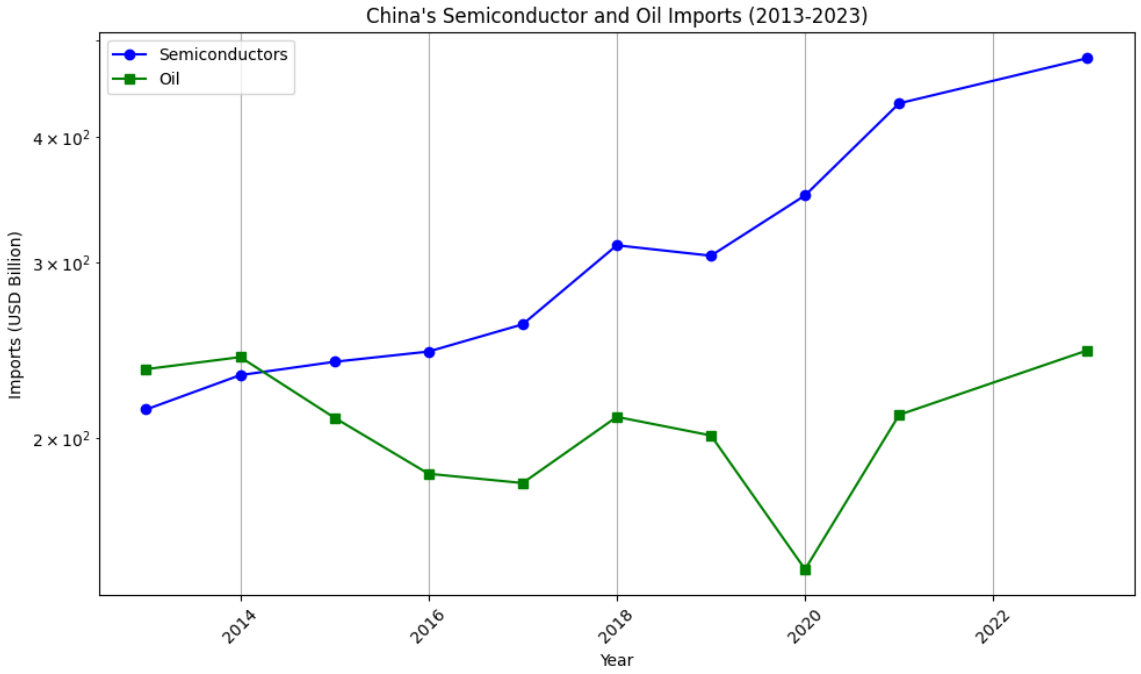
64 U.S. export controls may also impact civilian aerospace development efforts. Authorities are attempting to replace the Leap engines – manufactured a under a U.S.-French consortium – currently powering the C919, China's first domestically developed narrow-body passenger jet. According to Liu Daxiang, deputy director of the science and technology committee at the Aviation Industry Corporation of China (Avic), China lacked experience in the research and development of an engine for commercial aviation. Mechanical failures are among the most common problems seen in Chinese made jet engines, according to research released in 2022 by the Hunan civil-military integration of public service platform, an information provider under the Military-Civilian Integration Development Committee of the Hunan provincial government. Poor design, a low level of manufacturing, and a lack of experience in testing and assembly are also common problems, the research said. See Amanda Lee, "How Monumental is China's Challenge to Build its Own Jet Engine for the C919 as it Seeks Aviation Self-Reliance?" *South China Morning Post*, February 11, 2024.

65 See Alexander Holderness, et al., "Powering Proliferation: The Global Engine Market and China's Indigenization," Center for Strategic and International Studies (CSIS), March 21, 2023 and Robert Farley, "Why China Struggles to Produce an Indigenous Jet Engine," *The National Interest*, September 21, 2022. See also, Richard Aboulifa, "If China Arms Russia, the U.S. Should Kill China's Aircraft Industry," *Foreign Policy*, March 20, 2023.

66 Liu Daxiang, the Deputy Director of the Science and Technology Committee at the state-owned Aviation Industry Corporation of China, called the development of domestic jet engines "a serious and urgent political task" and said China was facing an "[u]nprecedented challenge…The established countries in aviation have become more strict with us when it comes to technology access," Liu said, adding that recent U.S. efforts to restrict opportunities for the Chinese telecommunications firm Huawei "tells us that crucial technology cannot be bought, even if you spend big." See Amanda Lee, "China Faces Urgent 'Unprecedented Challenge' to Develop Jet Engine as Foreign Hostility Grows," *South China Morning Post*, December 17, 2020.

67 U.S. semiconductor companies—including both integrated device manufacturers (IDMs), which design and manufacture their products in their own facilities, and fabless design companies, which rely on independent foundries to fabricate their chips—supplied approximately 48% of the global market for semiconductors in 2018. See Yoku Kobuta, "China Sets Up New $29 Billion Semiconductor Fund Government-Backed Fund is Part of Continuing Effort by China to Become Less Dependent on U.S. Technology," *The Wall Street Journal*, October 15, 2019. See also Owen Daniels and Will Hunt, "Sustaining and Growing the U.S. Semiconductor Advantage: A Primer," Center for Security and Emerging Technology, June 2022.

Table 1. China's semiconductor and oil imports (2013-2023).



Although the U.S. Department of Defense (DoD) currently accounts for approximately 1% of the semiconductors industry's revenue, electronics components are ubiquitous in defense and weapons systems and therefore remain critical to U.S. military capabilities.[68] The defense modernization priorities laid out in the 2018 U.S. National Defense Strategy include microelectronics, 5G, and quantum science as strategic areas requiring U.S. investment. Other priority areas – such as cybersecurity, AI, autonomous systems, and advanced imaging equipment – rely heavily on advanced semiconductor capabilities as well. In what analysts are increasingly referring to as a "tech war" between China and the U.S., the centrality of semiconductors is apparent in the narrowing focus of U.S. economic statecraft against China.[69]

The Made in China 2025 plan calls for Chinese semiconductor companies to produce 80% of chips domestically, but this goal is far from being realized.[70] Chinese semiconductor companies accounted for only USD $4.7 billion out of USD $23.8 billion worth of local

68 See Antonio Varas and Raj Varadarajan, "How Restricting Trade with China Could End U.S. Semiconductor Leadership," The Boston Consulting Group, March 9, 2020

69 See for example, Brad Slingerlend, "A Semiconductor 'Cold War' is Heating Up Between the U.S. and China," *Market Watch*, June 2, 2020; Steve Blank, "The Chip Wars of the 21st Century," *War on the Rocks*, June 11, 2020, <https://warontherocks.com/2020/06/the-chip-wars-of-the-21st-century/>.; and "Chip Wars: China, America and Silicon Supremacy," *The Economist*, December 1, 2018.

70 For example, China's Semiconductor Manufacturing International Corporation's (SMIC) 14 nm fabs represent only 2.6% of global chip fab capacity for near-state-of-the-art chips; adjusted for quality, this number further shrinks to 1.1%. And much of SMIC's 14 nm capacity is aspirational, true capacity is likely even lower. See Saif M. Khan and Carrick Flynn, "Maintaining China's Dependence on Democracies for Advanced Computer Chips," The Brookings Institution, April 2020 and Alex Capri, "Semiconductors at the Heart of the US-China Tech War How a New Era of Techno-Nationalism is Shaking up Semiconductor Value Chains," Hinrich Foundation, January 2020.

production in 2018 and Chinese producers are nowhere near manufacturing state-of-the-art level chips (<7 nanometers).[71] In June 2014, the Chinese government published "Guidelines to Promote National Integrated Circuit Industry" (the China National IC Plan, also known as the "China Big Fund"). The China National IC Plan called for USD $150 billion in funding both from the central government as well as provincial and municipal governments to increase domestic capacity and sophistication. Nevertheless, China remains years behind the leading semiconductor producers.[72]

The late 2023 announcement by Huawei about the production of a 7-nanometer (nm) chip has sparked discussions about China's capabilities in the semiconductor industry and, therefore, the effectiveness of U.S. controls. The 7nm chip was found in Huawei's new smartphone, the Mate 60 Pro, and was produced by China's leading domestic chipmaker, Semiconductor Manufacturing International Corporation (SMIC), both of which are on the BIS Entity List. According to TechInsights, a Canadian technology research firm, the chip showed various identifying features that point to fabrication by SMIC. SMIC has been able to produce the 7 nm chip for well over a year using a technique called "multi-patterning," but only in limited quantities.[73]

Despite this recent development, there are doubts about the sustainability of 7nm production with China's current capabilities.[74] Due to export controls led by the United States, the lack of access to advanced extreme ultraviolet lithography (EUV) machines is a critical limitation. These controls, which include restrictions on the export of logic chips and related

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71 For example, China's Semiconductor Manufacturing International Corporation's (SMIC) 14 nm fabs represent only 2.6% of global chip fab capacity for near-state-of-the-art chips; adjusted for quality, this number further shrinks to 1.1%. And much of SMIC's 14 nm capacity is aspirational, true capacity is likely even lower. See Saif M. Khan and Carrick Flynn, "Maintaining China's Dependence on Democracies for Advanced Computer Chips," The Brookings Institution, April 2020.

72 See Daniel Sims, "U.S. Sanctions Will Keep China 10 years Behind on Chipmaking, Intel CEO Says: U.S. Restrictions on Chipmaking Tools a Critical Factor," Tech Spot, January 28, 2024 and James Lewis, "China's Pursuit of Semiconductor Independence," Center for Strategic and International Studies (CSIS), February 27, 2019 and Edward White, "China's Ability to Make Computer Chips Still 'Years Behind' Industry Leaders: Rising Costs of R&D and Manufacturing Create New Hurdles," *Financial Times*, January 21, 2019. See also Rhett Hatch," Why China's Semiconductor Industry Remains Behind," *The National Interest*, January 31, 2022.

73 Apparently, the chip is the first commercial use of the most advanced logic process node without extreme ultraviolet (EUV), manufactured by a Chinese foundry that supports full system-on-chip (SoC) functional elements like bit cells (embedded SRAM). See William Reinsch and Matthew Schleich, "Contextualizing the National Security Concerns over China's Domestically Produced High-End Chip," Center for Strategic and International Studies (CSIS), September 26, 2023 and "Analysis of the Huawei Mate 60 Pro Reveals SMIC 7nm (N+2)," TechInsights, October 8, 2023.

74 William Reinsch and *op.cit*, "Contextualizing the National Security Concerns over China's Domestically Produced High-End Chip," Center for Strategic and International Studies (CSIS), September 26, 2023. The authors note, in particular, that "[w]hile it is, on the surface, concerning for U.S. lawmakers to see SMIC produce a 7 nm chip for Huawei, a deeper analysis suggests that U.S.-led export controls are limiting China's domestic semiconductor production capabilities. SMIC's reliance on imported DUV lithography machines—in the absence of well-controlled EUV machines—is likely to make 7 nm chip production unprofitable and unsustainable in the long term. Additionally, preventing the import of ASML's EUV machines by Chinese firms puts a hard stop on attempts to go smaller than 7 nm."

manufacturing equipment, have been instrumental in limiting China's ability to produce advanced semiconductors domestically.[75] Commerce Secretary Gina Raimondo confirmed these suspicions, saying that there was "no evidence" that China could produce these 7 nm chips at scale.[76]

As noted earlier, the current focus for U.S. export controls, sanctions, and FDI reviews is on "emerging technologies," almost all of which depend on advanced semiconductors. Washington's global pursuit of Chinese tech giant Huawei, for example, has involved all aspects of current U.S. technology-focused economic statecraft.[77] In recent months, the U.S. government has revised export control regulations to limit Huawei's access to semiconductors through direct product acquisition and through production of semiconductors using U.S.-origin technology or equipment, the latter by a revised provision of the Foreign Direct Product Rule.[78] Washington has also recently pressured the Dutch government to discourage permitting the export of extreme ultraviolet lithography (EUV) equipment to China. The Dutch company, ASML, is the sole manufacturer of EUV equipment required to make the most advanced semiconductors.[79] Washington has likewise rejected a number of Chinese attempted acquisitions of semiconductor-related companies such as Lattice Semiconductor Corporation, Fairchild Semiconductor, and Xcerra Corporation.[80]

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75 With respect to lithographic machines, Zhang Weiwei notes: "However, unlike Nvidia, which holds absolute authority in chip design and can circumvent regulatory measures with "special AI chips," ASML's photolithography machines consist of up to 100,000 parts from over 5,000 global suppliers. The most critical component, especially the EUV light source, is almost entirely monopolized by the American company Cymer. Even for the DUV light source, while some Japanese and Chinese companies relentlessly pursue it, there is still a gap compared to ASML's standards. This is the root of America's confidence in its "long-arm jurisdiction."" Zhang Weiwei, "2024: How Does China Overcome the U.S.' Chip Sanctions?" *The China Academy*, January 31, 2024.

76 Nicolle Prickett, "So What if China has 7nm Chips Now, There's No Way Huawei it Can Make Them "At Scale": Or So says U.S. Commerce Secretary," *The Register*, September 19, 2023.

77 Notably, Huawei has not been added to the Treasury Department's Specially Designated Nationals (SDN) list, which would directly deny Huawei access to the U.S. financial market and related services and indirectly chill cooperation with foreign financial institutions and technology providers. However, Congress has recently explored this option. For example, in 2023 Representatives Mike Gallagher (R-WI) and alongside Ruben Gallego (D-AZ) introduced the Neutralizing Emerging Threats from Wireless OEMs Receiving direction from Kleptocracies and Surveillance states (NETWORKS) Act, legislation that would add foreign companies producing 5G technology, like Huawei, to the SDN should they engage in economic or industrial espionage or sanctions violations.

78 Kevin Wolf, et al., "U.S. Government Clarifies, Reorganizes and Renames Descriptions of How Foreign-Produced Items Outside the United States Are Subject to U.S. Export Controls as the U.S. Contemplates New Restrictions on Russia," Akin, February 9, 2022.

79 Alexander Alper, "Trump Administration Pressed Dutch Hard to Cancel China Chip-Equipment Sale," *Reuters*, January 6, 2020. See also Martijn Rasser, "Countering China's Technonationalism: A New Approach is Needed if Today's Leaders are to Maintain their Primacy in Cutting-Edge Technology," *The Diplomat*, April 24, 2020.

80 See "Greg Roumeliotis, "U.S. Blocks Chip Equipment Maker Xcerra's Sale to Chinese State Fund," *Reuters*, February 22, 2018.

Conclusion: This is Not Your Grandparent's Cold War

On April 28, 2020, the Department of Commerce's Bureau of Industry and Security (BIS) published an amendment the Export Administration Regulations (EAR) that tightens restrictions on exports of technology to China, Russia, and Venezuela.[81] According to then Commerce Secretary Wilbur Ross, these actions were intended to combat efforts by entities in China, Russia, and Venezuela to use certain U.S. technologies obtained through civilian supply chains or under civilian-use pretenses to develop weapons, military aircraft, and surveillance technology contrary to U.S. national security interests. Including Chinese military end-users was a key component of the amendment as a military end-user is now defined as "any person or entity whose actions or functions are intended to support military end-uses," and this definition is aimed directly at China's Military-Civil Fusion program.

During the canonical Cold War, export controls had long been a part of the U.S. effort to limit Soviet military modernization. The same tools are likewise now arrayed against Russian and Chinese military development. As strategic tools they are necessary but not sufficient given the complexities attendant to globalization and the integration of supply chains and production networks.[82] As the global strategic environment has evolved to include the cyber and virtual domains, technological superiority is the new metric in establishing military dominance. Sensing that shift, the U.S. is now integrating heretofore disconnected economic policy tools to protect its technological advantages. Through export controls, sanctions, and FDI national security reviews, Washington is pursuing a whole-of-government technology access denial program. A key focus of this approach is on chokepoint technologies, such as jet engines and, more significantly, semiconductors.

On balance, these tools are effective in the short to medium term as China, and others, will eventually catch up in the relevant technology sectors.[83] Washington will continue to use and expand these tools during this period of efficacy. However, it is unclear if the U.S. has, in parallel, developed a strategy for confronting an adversary that no longer relies on U.S. technology or how to simultaneously leverage domestic economic policies (e.g., subsidies) to

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81 "Expansion of Export, Reexport, and Transfer (in-Country) Controls for Military End Use or Military End Users in the People's Republic of China, Russia, or Venezuela," *Federal Register*, April 28, 2020, <https://www.govinfo.gov/content/pkg/FR-2020-04-28/pdf/2020-07241.pdf>.

82 See Ling S. Chen, Miles M. Evers, "Wars Without Gun Smoke": Global Supply Chains, Power Transitions, and Economic Statecraft," *International Security*, Vol. 48, No. 2 (Fall 2023), pp. 164–204 and Kevin Ward, et.al., "The Second Cold War: US-China Competition for Centrality in Infrastructure, Digital, Production, and Finance Networks," *Geopolitics*, September 7, 2023.

83 See for example, Frank Tang, "U.S. Technology Embargo List Gives China a Blueprint for Home-Grown Innovation Over the Next Decade, Top Science Official Says," *South China Morning Post*, September 17, 2020.

achieve similar objectives.[84]

84 In a recent Foreign Affairs piece, Henry Farrell and Abraham Newman comment on the U.S. effort to use these otherwise disconnected economic and foreign policy tools to limit the strategic ambitions of adversaries. In particular, they note: "Responding to the coming challenges, however, will involve more than reorganizing bureaucracies. The United States needs to build a comprehensive economic security strategy. U.S. officials have said little about how they plan to do so... To get economic security right, the U.S. government must reinvent itself." See, "The New Economic Security State: How De-risking Will Remake Geopolitics," *Foreign Affairs*, November/December 2023.