AI EXPORT CONTROLS: SAFEGUARD OR A STRAITJACKET?

Siwen D. Cremean†

TABLE OF CONTENTS

DOI: https://doi.org/10.15779/Z38HH6C79B
© 2025 Siwen D. Cremean.
† J.D. Candidate, 2026, University of California, Berkeley, School of Law. Prior to law school, Siwen earned her undergraduate degree in Chinese Language and Culture Studies from the United States Naval Academy and served as an active-duty Marine Corps Aircraft Maintenance Officer, deploying throughout Southeast Asia and the Middle East with F/A-18 Hornet and MV-22 Osprey squadrons.
Siwen is deeply grateful to professors Allison Schmitt and Wayne Stacy for their invaluable guidance and support. She also extends her thanks to peer reviewers and editors Nicole Boucher, John Moore, Gaurav Lalsinghani, Ashley Fan, Maria Milekhina, Ben Clifner, and William Clark; the BTLJ production team; and the 2024 Law & Technology Writing Workshop. This Note would not exist without your hours of editing, commentary, and instruction.

I. INTRODUCTION

Artificial intelligence (AI) is an emerging technology that is reshaping global power dynamics and presenting countries with opportunities to define the next global order. As AI transforms warfare, commerce, and daily life, policymakers must balance innovation, technological advantage, and security. Export controls under the Export Control Reform Act (ECRA) lie at the heart of this issue.

Export controls are federal regulations that restrict the cross-border movement of goods, services, technology, information, and money; for example, American export controls might restrict the transfer of AI-related information and products to foreign countries and people.[1] AI technology can improve American warfighting and economic capabilities; simultaneously, adversaries and competitors can use AI created in the United States to advance foreign military and economic power.[2] Overzealous export controls can reduce

1. Cornell University, *Export Controls: Regulations and Overview*, RESEARCH & INNOVATION SERVS., https://researchservices.cornell.edu/policies/export-controls-regulations-and-overview [https://perma.cc/4PDD-HE2R] (last visited Apr. 6, 2025).

2. William A. Reinsch, *Export Control: Too Much or Too Little*, CTR. FOR STRATEGIC & INT'L STUDS. (Oct. 17, 2022), https://www.csis.org/analysis/export-control-too-much-or-too-little [https://perma.cc/82DP-R7ZS].

American overseas revenue, impede global supply chains, harm allied relationships, and reduce American market dominance.[3] Simultaneously, inadequate regulations may heighten the risk of uncontrolled international weapons proliferation and competition with American businesses.[4] How the government chooses to calibrate its commercial export controls can tip the U.S. economy and military toward either dominance or decline.

Countries around the world recognize AI as a transformative technology with strategic advantages.[5] Historically, power has rested with rich countries equipped with large, well-funded, and technologically sophisticated militaries. AI, however, offers widespread, procurable, and inexpensive opportunities to augment unsophisticated military technologies, potentially levelling the playing field.[6] This unprecedented growth in military technology, stemming from AI, combined with a shift towards limited multipolarity, may affect future alliances between the East and West.[7]

Over the last decade, China's ideological views and rise as a technological powerhouse have intensified great power competition with the United States, leading to what some believe to be a new bipolar world order with eastern and western hegemons.[8] Former Secretary of State Antony Blinken has called the Sino-American relationship the "most consequential" relationship of the twenty-first century.[9] How both countries elect to use AI, the next technological frontier, will determine the future of warfare and commerce.

Technology underpins both economic and military spheres; thus, AI technologies sold by commercial companies affect both commercial and military interests.[10] Traditionally, export controls had a military focus—the United States employed export controls as levers to manage the proliferation

3. *Id.*

4. *Id.*

5. JAMES JOHNSON, ARTIFICIAL INTELLIGENCE AND THE FUTURE OF WARFARE: THE USA, CHINA, AND STRATEGIC STABILITY 60–62 (Manch. Univ. Press 2021).

6. *Id.* at 69–70.

7. *See* Emma Ashford & Evan Cooper, *Yes, the World is Multipolar*, FOREIGN POL'Y (Oct. 5, 2023), https://foreignpolicy.com/2023/10/05/usa-china-multipolar-bipolar-unipolar/ [https://perma.cc/VWR7-CPUR].

8. JOHNSON, *supra* note 5, at 69–70.

9. *See* Graham T. Allison, Jash M. Cartin, Elizabeth Economy, Susan A. Thornton, Ryan Hass, Patricia M. Kim & Emilie Kimball, *Is the US-China Relationship the Most Consequential Relationship for America in the World?*, BROOKINGS (Feb. 6, 2024), https://www.brookings.edu/Articles/is-the-us-china-relationship-the-most-consequential-relationship-for-america-in-the-world/ [https://perma.cc/HK9D-DJWD].

10. *See* 50 U.S.C. § 4811(1)–(3). U.S. commercial export law explicitly recognizes both economic and military considerations as elements of the national security umbrella, used to protect Americans and further foreign policy and international obligations.

of high-end weapons.[11] Commercial export controls are a more recent invention, yet given the weaponizing capabilities of many commercial technologies today, they are equally important.[12] Export controls of commercial products with military applications—products like AI-augmented drones, nuclear technology, or satellite internet—stem from nonproliferation philosophies that were historically applied to weapons exports; however, these nonproliferation-focused models often prove impractical when commercial sales also have societal and statecraft-related benefits.[13] Many companies want to sell beneficial AI products on a global scale to advance society and maintain market dominance. The government must balance these beneficial sales with AI's dual-use warfighting capabilities, lest these ordinary companies turn into proverbial weapons dealers.[14]

The United States enacted ECRA in 2018 as its most recent attempt to reform the commercial export system and control sales of commercial dual-use emerging technologies.[15] ECRA enables the Department of Commerce to regulate emerging technologies, both through explicit, list-based controls as well as catch-all controls. ECRA defines dual-use technologies as those that

---

11. *See* PAUL K. KERR & CHRISTOPHER A. CASEY, CONG. RSCH. SERV., R46814, THE U.S. EXPORT CONTROL SYSTEM AND THE EXPORT CONTROL REFORM ACT OF 2018 2–6 (2021). Export controls were historically limited to foreign military sales, expanding to commercial sales during World War II (WWII). After WWII, the United States created a commercial export regime to regulate foreign demand of U.S. products. Since then, the United States has adjusted commercial export controls accordingly—export controls were stricter during the Cold War to prevent international theft of U.S. technology and more lenient in the years that followed to keep up with global technological competition (to maintain global market share in the face of European, Japanese, and now Chinese competitors).

12. *See id.*

13. *See id.*

14. *See* Amritha Jayanti, *Starlink and the Russia-Ukraine War: A Case of Commercial Technology and Public Purpose?*, BELFER CTR. FOR SCI. AND INT'L AFFS., HARV. KENNEDY SCH. (Mar. 9, 2023), https://www.belfercenter.org/publication/starlink-and-russia-ukraine-war-case-commercial-technology-and-public-purpose; *see also* Tara Brown, *Can Starlink Satellites Be Lawfully Targeted?*, WEST POINT LIEBER INST. (Aug. 5, 2022), https://lieber.westpoint.edu/can-starlink-satellites-be-lawfully-targeted/ [https://perma.cc/4WVA-GK66]; ANDURIL, https://www.anduril.com/article/anduril-s-lattice-a-trusted-dual-use-commercial-and-military-platform-for-public-safety-security/ [https://perma.cc/H5Q2-FFEC] (last visited Feb. 22, 2025). At the onset of the Russo-Ukraine War in 2022, SpaceX sent 5,000 terminals to Ukraine. Starlink was reappropriated for combat. To avoid being complicit in major acts of war (Starlink was a lawful target), SpaceX stopped sending Starlink terminals to Ukraine. The U.S. Government created a hasty Government contract for "Starshield" to continue providing Ukraine with wartime communication products. Similarly, Anduril's Lattice OS combines AI with drone technology for commercial and military uses from undersea power infrastructure inspection to military intelligence and reconnaissance. Such commercial technology sold for nonmilitary purposes has wartime applications.

15. *See* KERR & CASEY, *supra* note 11, at 1.

have "civilian applications and military, terrorism, weapons of mass destruction, or law-enforcement-related applications."[16] Because AI has broad commercial and military dual-uses, many AI-related sales fall under ECRA. Policymakers deliberately drafted ECRA broadly to allow expansive agency interpretation, particularly mindful of emerging and foundational technologies in Sino-American relations.[17]

In the six years since ECRA's enactment, the United States has been slow to implement explicit, list-based AI export controls despite flagging AI as a high-risk emerging technology.[18] To date, AI controls have focused primarily on the hardware used to power and run AI software—such as components found in data centers (semiconductors, quantum computing technologies, etc.).[19] Existing AI software controls are narrowly written and exclusively target niche, closed-weight AI.[20]

This Note argues that current export controls for AI hardware provide limited benefits, even if implemented efficiently. Many controls on AI software would be ineffective, which is why agencies operating under ECRA have declined to impose substantial software controls to date. ECRA provides guidelines for regulatory agencies to determine the effectiveness of future AI controls.[21] Based on ECRA's balancing considerations, and given AI's rapid growth and uncertainty, responsible AI related regulations must limit their scope. Even though AI controls, at present, have limited benefits, regulators should continue to analyze AI under ECRA's balancing factors, as the evolving AI landscape may necessitate future list-based controls.[22] Any future AI

16. War and Nat'l. Def., Exp. Control Reform Act, 50 U.S.C. § 4801(2) (2018).

17. *See* KERR & CASEY, *supra* note 11, at 1.

18. JON BATEMAN, U.S.-CHINA TECHNOLOGICAL "DECOUPLING": A STRATEGY AND POLICY FRAMEWORK 18 (Carnegie Endowment for International Peace 2022).

19. Export Administration Regulations, 15 C.F.R. § 774 (2025); *see* Giovanna M. Cinelli, Kenneth J. Nunnenkamp & JiaZhen Guo, *US Expands Controls on Quantum, Semiconductor Tech to Secure Industry Leadership*, MORGAN LEWIS (Sep. 18, 2024), https://www.morganlewis.com/pubs/2024/09/us-expands-controls-on-quantum-semiconductor-tech-to-secure-industry-leadership [https://perma.cc/DS7K-N7XM].

20. *See* Josephine I. Aiello LeBeau & Anne E. Seymour, *Artificial Intelligence Software Controlled for Export, Including to Foreign National Employees*, WILSON SONSINI (Jan. 10, 2020), https://www.wsgr.com/en/insights/artificial-intelligence-software-controlled-for-export-including-to-foreign-national-employees.html [https://perma.cc/58EH-JDZU]; Neena Shenai, Barry J. Hurewitz, Lauren Mandell, Leslie A. Harrelson, Stephanie Hartmann, Alexandra Maurer & Anh H. Do, *BIS Issues Long-Awaited Export Controls on AI*, WILMERHALE (Feb. 5, 2025), https://www.wilmerhale.com/en/insights/publications/20250205-bis-issues-long-awaited-export-controls-on-ai [https://perma.cc/M7JC-B2EJ].

21. *See* 50 U.S.C. § 4817(a)(2)(B)(i)–(iii).

22. *See id.*

controls should be narrowly written, balancing economic and military development with nonproliferation.

Part II introduces ECRA, discusses the geopolitical tensions motivating its development, and describes the current AI export landscape. Part III explains judicial treatment of export regulations and highlights sections of ECRA that expanded upon previous export law. Part IV provides examples of applying ECRA's balancing considerations to AI. Part V concludes.

II. LAYING THE FRAMEWORK FOR THE EXPORT CONTROL REFORM ACT (ECRA) AND AI

Part II builds a framework for understanding how and why ECRA expanded upon past export law, and how these expansions relate to AI. Section II.A reviews the contours of the U.S. export system, the scope of ECRA's jurisdiction within this system, and discusses why commercial AI falls under ECRA. Section II.B then takes the reader through history to the present day, explaining ECRA's origin story, the geopolitical factors that spur modern-day considerations, and current regulations that affect AI.

A. ECRA AUTHORIZES EXPORT CONTROLS FOR DUAL-USE TECHNOLOGIES LIKE COMMERCIAL AI

The following Sections define AI and explain why AI falls under the ECRA. Section II.A.1 explains ECRA's place within the U.S. export regime and ECRA's objective—to regulate dual-use technology. Section II.A.2 explains how AI can augment weapons systems. Section II.A.3 provides examples of how commercial AI can be used in unconventional warfare. Section II.A.4 explains how the open-source nature of many foundational AI algorithms further complicates the American national security posture.

1. *ECRA Controls the Exports of Dual-Use Technologies*

The United States imposes export controls to advance U.S. national security objectives, promote regional stability, and prevent the proliferation of weapons used in warfare, terrorism, and human rights abuses.[23] Under federal statutory authority, government agencies collaborate to regulate exports through controls, directives, and penalties.[24]

In the United States, export controls have clear lines of authority. The Department of the Treasury's Office of Foreign Assets Control (OFAC)

23. U.S. Dep't of State, *Overview of U.S. Export Control System*, U.S. DEP'T. OF STATE: A RES. ON STRATEGIC TRADE MGMT. AND EXP. CONTROLS, https://2009-2017.state.gov/strategictrade/overview/index.htm [https://perma.cc/3Z38-46F9] (last visited Apr. 6, 2025).

24. *Id.*

enforces asset freezes, trade sanctions, and travel bans targeting foreign countries, narcotics traffickers, and terrorists.[25] The Arms Export Control Act of 1976 (AECA) authorizes the Department of State to regulate arms exports and weapons sales.[26] Finally, ECRA authorizes the Department of Commerce, via the Bureau of Industry and Security (BIS), to oversee export licensing and enforcement of commercial items with weaponization potential.[27] Just as AECA gives rise to the International Traffic in Arms Regulations (ITAR), ECRA provides authority for the Export Administration Regulations (EAR).[28] A core component of the EAR is the Commerce Control List (CCL), which lists export-restricted items under export control classification numbers (ECCNs).[29] When people think of export controls, they generally think of ECCNs. However, even if an item is not explicitly listed on CCL under an ECCN, if it is of U.S. origin, it remains subject to EAR's end-user and end-use controls—discussed further, *infra*, in Section III.D.[30]

25. U.S. Dep't of Treasury, *OFAC Consolidated Frequently Asked Questions*, OFF. OF FOREIGN ASSETS CONTROL (Aug. 21, 2024), https://ofac.treasury.gov/faqs/all-faqs [https://perma.cc/G93K-9YDX].

26. CHRISTINA L. ARABIA, NATHAN J. LUCAS & MICHAEL J. VASSALOTTI, CONG. RSCH. SERV., R46337, TRANSFER OF DEFENSE ARTICLES: U.S. SALE AND EXPORT OF U.S.-MADE ARMS TO FOREIGN ENTITIES 1–2 (2023).

27. KERR & CASEY, *supra* note 11, at 1.

28. *Id.* at 6–13.

29. *Id.* at 6–7.

30. *Id.* at 30.

Table 1: United States Export Control Regime

	Sanctions-Related	Export-Related	
Purpose	Economic and Trade Sanctions (restrictions on trade, foreign taxes, asset seizures, etc.)	Export of Dual-Use Commercial Articles (non-weapons with weaponization potential)	Export of Defense Articles (weapons)
Congressional Statute	International Emergency Economic Powers Act (IEEPA)	Export Control Reform Act (ECRA) *****We are here.***	Arms Export Control Act (AECA)
Executive Agency	Department of the Treasury	Department of Commerce	Department of State
Executive Sub-Agency	Office of Foreign Assets Control (OFAC)	Bureau of Industry and Security (BIS)	Bureau of Political Military Affairs, Directorate of Defense Trade Controls (DDTC)
Regulation	Regulations Relating to Money and Finance	Export Administration Regulations (EAR)	International Traffic in Arms Regulations (ITAR)
Export List	Sanctions List Service (SLS); Specially Designated Nationals List (SDN)	Commerce Control List (CCL)	United States Munitions List (USML)
Compare/ Contrast	Focuses on the parties involved in the transaction; can apply sanctions to noncompliant countries and companies to enforce export decisions.	Focuses on limiting the exports of certain dual-use commercial goods.	Focuses on limiting the exports of weapons.

Although both ECRA and AECA regulate sensitive technologies, they serve distinct functions. AECA authorizes Department of State decisions, whereas ECRA authorizes Department of Commerce decisions. Because the Department of Commerce enforces ECRA, ECRA includes more economic balancing considerations than AECA.[31] The AECA regulates items specifically designed for military use, such as fighter jets, tanks, missiles, satellite systems, etc., while ECRA controls items primarily designed for commercial use, albeit with some warfighting function.[32] ECRA-controlled dual-use technologies include everyday commercial products that can be converted for military use, such as encryption technologies or semiconductors.[33] Even microchips from mundane items like refrigerators, washing machines, and breast pumps can be reused in weapons.[34]

An item's commercial versus military impact often lies in the eye of the beholder. Technologies with civilian applications may nevertheless be subject to AECA, while technologies with serious warfighting implications may fall under ECRA. For example, computer chips designed to run software on commercial laptops and tablets (under ECRA) can also be used to power advanced weapons systems.[35] Global positioning systems (GPS), originally created for military use (under AECA), were dithered in the 1990s for civilian travel.[36] The designation of dual-use, alone, is not always enough to justify ECRA treatment, just as some weaponizing potential is not always enough to justify AECA treatment.[37] Because a product's regulatory footprint, exposure to penalties, and end market often depends on whether it is designated under the Department of State or Department of Commerce, and because dual-use designation can be ambiguous, determining whether a product is governed by AECA or ECRA is a critical step in controlling the risk, customer base, and potential profitability of a product.[38] This Note will focus on those dual-use AI products whose civilian use cases are significant enough to warrant ECRA, as opposed to AECA, treatment.

---

31. *See* KERR & CASEY, *supra* note 11, at 10–13; *see also* 50 U.S.C. §§ 4811–4822.

32. *See* KERR & CASEY, *supra* note 11, at 11–14, 18–23.

33. *Id.* at 7.

34. *See* Alberto Nardelli, Bryce Baschuk & Marc Champion, *Putin Stirs Worry That Russia Is Stripping Home-Appliance Imports for Arms*, TIME (Oct. 29, 2022), https://time.com/6226484/russia-appliance-imports-weapons/ [https://perma.cc/NST8-RJAY].

35. *Id.*

36. Andrew Young, Christina Rogawski & Stefaan Verhulst, *United States Opening GPS Data for Civilian Use: Creating a Global Public Utility*, GOVLAB (Jan. 2016), https://odimpact.org/case-united-states-opening-gps-data-for-civilian-use.html [https://perma.cc/L7YH-T8QE].

37. *See* 50 U.S.C. § 4801(2); 15 C.F.R. § 730.3.

38. *See* 50 U.S.C. § 4801(2); 15 C.F.R. § 730.3; *see also* KERR & CASEY, *supra* note 11, at 6–14.

2. *AI is a Tool That Can Augment Weapons Systems*

AI broadly refers to computer software that can perform complex, automated tasks traditionally requiring human intelligence.[39] AI can perform these tasks with little to no human oversight.[40] Most AI is currently limited to narrow subsets of tasks rather than general functions.[41] These narrow tasks include image processing and identification, ranking and prioritization, and language processing.[42]

AI models, algorithms, and code-based automated systems ("AI software") require certain, sometimes specialized computing equipment to run them ("AI hardware"). Semiconductors, quantum computers, and other physical hardware are connected within data centers and supercomputing facilities to train large AI models.[43] Energy efficient semiconductors with large computing power, memory, and parallel processing capabilities are optimal for AI.[44] Quantum computers are capable of performing multiple calculations simultaneously, accelerating AI algorithms that require heavy data processing.[45] Together, these technologies can help remove limitations in data size, complexity, and problem-solving speed that inhibit AI's ability to perform complex functions.[46]

AI is not a weapon per se but rather a tool that can augment warfare at strategic, operational, and tactical levels.[47] Conventional weapons, such as precision-strike munitions,[48] autonomous wingmen,[49] air-to-air missiles,[50]

---

39. JOHNSON, *supra* note 5, at 20.
40. *Id.*
41. *Id.* at 18.
42. *Id.* at 19 fig. 1.1.
43. Shweta Surender, *The Convergence of AI Chips and Quantum Computing: Future Possibilities*, MARKETSANDMARKETS (Sep. 16, 2024), https://www.marketsandmarkets.com/blog/SE/the-convergence-of-ai-chips-and-quantum-computing-future-possibilities [https://perma.cc/US25-LVRE].
44. *Id.*
45. *Id.*
46. *Id.*
47. JOHNSON, *supra* note 5, at 17.
48. *See* AEON, https://www.aeonindustrial.com/what-we-do [https://perma.cc/DK6H-GXEL] (last visited Feb. 22, 2025).
49. *See* Stephen Losey, *New in 2024: Air Force Plans Autonomous Flight Tests for Drone Wingmen*, DEFENSENEWS (Dec. 30, 2023), https://www.defensenews.com/air/2023/12/30/new-in-2024-air-force-plans-autonomous-flight-tests-for-drone-wingmen/ [https://perma.cc/8CJJ-4GZA].
50. *See* Vanessa Montalbano, *Skunk Works Tests AI in Air-to-Air Combat*, INSIDE DEF. (June 6, 2024), https://insidedefense.com/insider/skunk-works-tests-ai-air-air-combat [https://perma.cc/3EHP-7R72].

sentry guns,[51] battlefield command and control systems,[52] and the like, often integrate AI. AECA governs AI that is directly integrated into weapons systems, placing them beyond the scope of this Note. Other types of AI integration, such as self-driving cars, light-show drones, facial recognition, generative pre-trained transformers (GPTs),[53] cybersecurity tools, geospatial intelligence, and home surveillance systems, have both commercial and wartime applications and fall under ECRA—these are the focus of this Note.

3. *Regulators Must Balance Unconventional Commercial AI Applications with Practicality*

There are many examples of how commercial AI technologies might be converted for military use. Self-driving cars, manufacturing robots, and surgical assistance robots, for example, may be converted into unmanned ground vehicles for bomb disposal, reconnaissance, obstacle detection, and mine detection.[54] Autonomous drones, such as those used in crop monitoring, package delivery, and aerial lightshows may conduct reconnaissance, surveillance, precision strikes, and drone swarms.[55] Facial recognition, commonly used in unlocking smartphones, public safety, and personal shopping, may identify enemy combatants, acquire targets, conduct mass surveillance, monitor dissidents, and even enforce border security.[56] GPTs that help design drugs by finding new protein combinations may also help design

---

51. *See* Alexander Velez-Green, *The Foreign Policy Essay: The South Korean Sentry—A "Killer Robot" to Prevent War*, LAWFARE (Mar. 1, 2015), https://www.lawfaremedia.org/article/foreign-policy-essay-south-korean-sentry%e2%80%94-killer-robot-prevent-war [https://perma.cc/J57K-DTFK].

52. *See* Wes Haga & Courtney Crosby, *AI's Power to Transform Command and Control*, NATIONAL DEF. (Nov. 13, 2020), https://www.nationaldefensemagazine.org/articles/2020/11/13/ais-power-to-transform-command-and-control [https://perma.cc/CQ4Q-AKVX].

53. *See What is GPT?*, AMAZON WEB SERVICES, https://aws.amazon.com/what-is/gpt/ [https://perma.cc/3MQJ-ZKHN] (last visited Feb. 22, 2025).

54. *See* Mindy Support, *Autonomous Vehicles are Making Their Way into the Military*, MINDY SUPPORT (Apr. 1, 2024), https://mindy-support.com/news-post/autonomous-vehicles-are-making-their-way-into-the-military/ [https://perma.cc/3GU8-8RND].

55. *See* Zachary Kallenborn, *InfoSwarms: Drone Swarms and Information Warfare*, 52 U.S. ARMY WAR COLL. Q. 87, 88 (2022).

56. *See* Donna Ferguson, *Police Urged to Double Use of Facial Recognition Software*, GUARDIAN (Oct. 28, 2023), https://www.theguardian.com/technology/2023/oct/29/uk-police-urged-to-double-use-of-facial-recognition-software [https://perma.cc/5ZSM-3KTU]; *see also* Nicol Turner Lee & Caitlin Chin-Rothmann, *Police Surveillance and Facial Recognition: Why Data Privacy is Imperative for Communities of Color*, BROOKINGS INST. (Apr. 12, 2022), https://www.brookings.edu/articles/police-surveillance-and-facial-recognition-why-data-privacy-is-an-imperative-for-communities-of-color/ [https://perma.cc/5LB6-GEPS].

biochemical weapons.[57] Geospatial intelligence services used in environmental monitoring, urban planning, and disaster response may assist with battlefield mapping and target identification.[58] Cybersecurity tools used for threat detection may be flipped for hacking purposes.[59]

The ease with which commercial technologies can be adapted for military purposes magnifies the potential risks of further development. AI algorithms with similar use-cases and coding structures can be modified or retrained to different use-cases—this can be done with a couple of lines of new code and readily available open-source data.[60] For example, an AI that recognizes benign flying objects may be retrained with different data to recognize incoming missiles. Thus, the government has repeatedly sought to proactively identify and create controls for AI.[61]

Yet not every commercially available, potentially weaponizable technology warrants rigorous export controls. For example, fertilizers that contain ammonium nitrate can be mixed with fuel to create improvised explosive devices (IEDs).[62] Even so, ammonium nitrate is still a common component in commercial fertilizers and can be produced either in America and exported, or developed overseas and imported.[63] Put differently, just because an adversary can weaponize any number of commercially available items does not automatically justify rigorous export controls. ECRA must balance commercial value with the likelihood of misuse, and weigh those factors against whether

57. *See* Ailin Zhao & Yijun Wu, *Future Implications of ChatGPT in Pharmaceutical Industry: Drug Discovery and Development*, 14 FRONTIERS IN PHARMACOLOGY (2023), https://pmc.ncbi.nlm.nih.gov/articles/PMC10390092/ [https://doi.org/10.3389/fphar.2023.1194216].

58. *See* Brandi Vincent, *AI Will "Revolutionize" the Way NATO Looks at Geospatial Intelligence, Leader Says*, DEFENSESCOOP (May 7, 2024), https://defensescoop.com/2024/05/07/nato-geoai-revolutionize-geoint-scott-bray/ [https://perma.cc/D2VL-NBF7].

59. *See* Sangfor Techs., *Defining AI Hacking: The Rise of AI Cyber Attacks*, SANGFOR (Aug. 13, 2024), https://www.sangfor.com/blog/cybersecurity/defining-ai-hacking-rise-ai-cyber-attacks [https://perma.cc/F7WP-KM67].

60. *See* Steve Sewell, *Training Your Own AI Model Is Not as Hard as You (Probably) Think*, BUILDER.IO (Nov. 22, 2023), https://www.builder.io/blog/train-ai [https://perma.cc/3ZD9-ZAJB].

61. Scott A. Jones, *Trading Emerging Technologies: Export Controls Meet Reality*, 31 BRILL NIJHOFF SEC. & HUM. RTS. 47, 51 (2020), https://brill.com/view/journals/shrs/31/1-4/article-p47_47.xml?language=en [https://doi.org/10.1163/18750230-31010004].

62. *IED Attack: Improvised Explosive Devices*, DEP'T. OF HOMELAND SEC. & THE NAT'L. ACAD., https://www.dhs.gov/xlibrary/assets/prep_ied_fact_sheet.pdf [https://perma.cc/9LY5-ASD6] (last visited Feb. 22, 2025).

63. ENCYCLOPEDIA OF TOXICOLOGY 209–11 (Philip Wexler et al. eds., 3d ed. 2014).

such items, even if controlled, would still be available through other channels, including the black market.[64]

Nevertheless, commercially available AI, embedded in a commercial product, can serve a military purpose. For example, inexpensive and readily available AI, combined with inexpensive commercial drones, have been used in drone swarms on the battlefields of Ukraine.[65] However, these same products have significant commercial benefits, i.e., similar drones can be used in search and rescue and firefighting operations.[66] The beneficial uses warrant further research, development, and sales.

Further, even if the United States limits domestic AI development, the United States cannot curtail similar development outside its jurisdiction; case in point, the use of drone swarms in the Russo-Ukraine war developed without U.S. oversight.[67] This increasingly blurred line between commercial and military-grade AI applications, and the complex geopolitical relationships at play, makes it difficult to predict the second and third order effects of technological development in offensive and defensive warfare, terrorism, and human rights abuses.[68] In determining the scope of AI exports, policymakers must weigh AI's economic and societal benefits against its development in international markets and its likelihood of shaping battlespaces.

---

64. *See* Sujai Shivakumar, Charles Wessner & Thomas Howell, *Balancing the Ledger: Export Controls on U.S. Chip Technology to China*, CTR. FOR STRATEGIC & INT'L STUDS. (Feb. 21, 2024), https://www.csis.org/analysis/balancing-ledger-export-controls-us-chip-technology-china [https://perma.cc/X5AW-C83T].

65. *See* Kallenborn, *supra* note 55, at 87–88; Kateryna Bondar, *Ukraine's Future Vision and Current Capabilities for Waging AI-Enabled Autonomous Warfare*, CTR. FOR STRATEGIC & INT'L STUDS. (Mar. 6, 2025), https://www.csis.org/analysis/ukraines-future-vision-and-current-capabilities-waging-ai-enabled-autonomous-warfare [https://perma.cc/2W4H-WUNK]; David Kirichenko, *The Rush for AI-Enabled Drones on Ukrainian Battlefields*, LAWFARE (Dec. 5, 2024), https://www.lawfaremedia.org/article/the-rush-for-ai-enabled-drones-on-ukrainian-battlefields [https://perma.cc/NGA9-7CPM].

66. Zacc Dukowitz, *Search and Rescue Drones: A Guide to How SAR Teams Use Drones in Their Work*, UAV COACH (June 14, 2024), https://uavcoach.com/search-and-rescue-drones [https://perma.cc/BG85-JXKJ].

67. *See supra* note 65 and accompanying text; discussion *infra* Section IV.A.2.

68. Christopher Kuner & Gabriela Zanfir-Fortuna, *Geopolitical Fragmentation, the AI Race, and Global Data Flows: The New Reality*, FUTURE OF PRIV. FORUM (Feb. 26, 2025), https://fpf.org/blog/geopolitical-fragmentation-the-ai-race-and-global-data-flows-the-new-reality [https://perma.cc/XY5M-QHVV].

4. *The Open-Source Nature of AI Software Adds Complication*

AI is further categorized as either open- or closed-source, which further complicates its controllability.[69] Currently, as much as 76 percent of AI codebases contain open-source components, and some experts think the percentage might be higher.[70]

The open-source AI movement took off in the early 2000s, when companies realized that globally adopted foundational algorithms permitted widespread AI development and innovation.[71] In the beginning, the international community collaborated on open-source AI models to accelerate the growth of the AI ecosystem.[72] Democratic, open-source research and development (R&D) allowed smaller startups to assist with AI development rather than concentrating power in a handful of well-resourced technology companies.[73] This accelerated AI innovation and safety, as more helping hands identified vulnerabilities, flaws, and biases.[74] Companies built trust in AI systems by developing AI standards that ensured high-quality training and auditability, but for these standards to be effective, they required global adoption.[75] As a result, companies often released the outputs of their AI development for free as "open-source" or "open weight" models.[76] With time, however, companies also started safeguarding some of their proprietary source code, giving rise to "closed-source" models.[77]

Open-source AI models publicly share their source code, while closed-source AI models maintain proprietary source code, trading flexibility and shared innovation for increased security of intellectual property (IP).[78] Many companies build products with open-source code, then customize those

69. *Emerging AI: Open vs Closed Source*, CTR. FORWARD (Dec. 16, 2024), https://center-forward.org/basic/emerging-ai-open-vs-closed-source/ [https://perma.cc/UM3V-6DRJ].

70. Tyler Weitzman, *The Rise of Open Artificial Intelligence: Open-Source Best Practices*, FORBES (Mar. 8, 2024), https://www.forbes.com/councils/forbesbusinesscouncil/2024/03/08/the-rise-of-open-artificial-intelligence-open-source-best-practices [https://perma.cc/Z6QP-6K4S].

71. *See* David Cain, *The Rise of Open-Source AI*, LINKEDIN (Jan. 12, 2024), https://www.linkedin.com/pulse/rise-open-source-ai-david-cain-gymoc [https://perma.cc/Z7NJ-YZZE].

72. *Id.*

73. *Id.*

74. *Id.*

75. *Id.*

76. *See* Kyle Miller, *Open Foundation Models: Implications of Contemporary Artificial Intelligence*, CTR. FOR SEC. AND EMERGING TECH. (Mar. 12, 2024), https://cset.georgetown.edu/article/open-foundation-models-implications-of-contemporary-artificial-intelligence [https://perma.cc/G642-APEC].

77. CTR. FORWARD, *supra* note 69.

78. *Id.*

products with closed-source code.[79] To continue an example from the previous Section, a software engineer can customize a closed-source model that identifies incoming missiles from a foundational open-source AI that recognizes flying objects.

Open-weight models are a middle ground between open- and closed-source models.[80] Open-weight models do not share their underlying source code, training data, and architecture, but nevertheless allow users to fine-tune the model to their personal specifications and deploy these models privately.[81] This private deployment of open-weight models assuages the creator companies' data-sharing concerns.[82] AI companies then permit such open-source and open-weight models to underpin future products.[83] When other companies subscribe to these "product packages," which they originally received for free, the creator company gains market share.[84]

Even though open-weight and closed-source models safeguard their proprietary code more so than open-source models, they are still prone to theft because they can be reverse engineered from existing open-source options.[85] Open-weight models release their entire set of model parameters (weights) for download, which allows foreign software engineers to analyze these

79. *See* Dan Leszkowicz, *AI Decision Series | Part 1: Open-Source Versus Closed-Source Models*, PIENSO (Oct. 24, 2023), https://pienso.com/blog/ai-decision-series-part-1-open-source-versus-closed-source-models [https://perma.cc/MG3F-85TD].

80. Aruna Kolluru, *Exploring the World of Open Source and Open Weights AI*, MEDIUM (Mar. 29, 2024), https://medium.com/@aruna.kolluru/exploring-the-world-of-open-source-and-open-weights-ai-aa09707b69fc [https://perma.cc/4V87-RD9R].

81. *Id.*; Miller, *supra* note 76.

82. *See* Miller, *supra* note 76; John Weil, *AI for the Edge: Why Open-Weight Models Matter*, SEMICONDUCTOR ENG'G (Apr. 3, 2025), https://semiengineering.com/ai-for-the-edge-why-open-weight-models-matter [https://perma.cc/ZP5H-BGT6].

83. *See* Marketplace Tech, *Will DeepSeek Disrupt American AI's First-Mover Advantage?*, MARKETPLACE, at 11:20 (Feb. 13, 2025), https://www.marketplace.org/episode/2025/02/13/will-deepseek-disrupt-american-ais-first-mover-advantage [https://perma.cc/3CY7-4AQE]; *see also* CFI Team, *First Mover Advantage*, CFI, https://corporatefinanceinstitute.com/resources/management/first-mover-advantage/ [https://perma.cc/Q9H3-FCLM] (last visited Apr. 8, 2025). Businesses gain a first mover advantage when it is the first to introduce a new product or service to the market. The company then establishes brand recognition, customer loyalty, and potentially captures market share before other competitors. For example, Chinese AI company DeepSeek created a usable, advanced, open-weight, and inexpensive AI model, and in being first to publicly release that product, it may have a first to market advantage (*see* discussion *infra* Section IV.A.3). It can then use this advantage—customer loyalty and brand recognition—to sell future products.

84. *See supra* note 83 and accompanying text.

85. Matt Marshall, *The Enterprise Verdict on AI Models: Why Open Source Will Win*, VENTUREBEAT (Oct. 24, 2024), https://venturebeat.com/ai/the-enterprise-verdict-on-ai-models-why-open-source-will-win/ [https://perma.cc/ZFX9-MR9H].

architectures, inputs, and outputs until they successfully replicate the model.[86] In contrast, a closed-source AI model has a proprietary system owned and managed by a private company.[87] Its code, structure, and training are kept private.[88] However, hackers can easily copy and distribute a few lines of code.[89] AI training code is unusual in that only a short snippet of code can represent mathematical innovations that lead to significantly improved performance.[90] These short snippets are easier to steal, and adversary countries can acquire this code through hacking or black market smuggling operations.[91]

Due to competing priorities, there is a security question of whether export safeguards can effectively protect national security. Open-source models are readily available for anyone to use, thus, it is impossible to subject these models to export controls.[92] Any person with the requisite engineering knowledge can take generic, basic open-source models and combine them with other generic technology, like basic commercial drones, to create potentially lethal battlespace tools, and this adds another layer of complexity to modern warfare.[93] Open-weight and closed-weight models are slightly more protected, but not by much.[94] Adversaries without the requisite engineering knowledge can still steal or reverse engineer these types of AI for nefarious uses.[95] Beyond the battlefield, foreign companies can build upon existing open-source, open-weight, and even closed-source AI to create comparable products that compete with U.S. offerings and destabilize the U.S. economic posture.[96]

---

86. *See* Manikandan Palani, *How to Reverse Engineer Open AI's o1 With Less Powerful Models?*, LINKEDIN (Sep. 15, 2024), https://www.linkedin.com/pulse/how-reverse-engineer-open-ais-o1-less-powerful-models-palani-sbkie [https://perma.cc/SZ9J-2X2Y].

87. Leszkowicz, *supra* note 79.

88. *Id.*

89. Marin Ivezic & Luka Ivezic, *The Dark Art of Model Stealing: What You Need to Know*, SECURING.AI (Nov. 13, 2019), https://securing.ai/ai-security/ai-model-stealing/ [https://perma.cc/5Z59-GX3L].

90. Programmers use snippets of code to encapsulate a calculation or act of data manipulation within an AI program. It is a way of transcribing a mathematical process. The innovation lies in the math, which can be transcribed succinctly and elegantly in short snippets of code.

91. Devin McCormick, *Why Regulating AI Is a Losing Battle*, LIBERTAS INST. (Aug. 30, 2024), https://libertas.institute/op-eds/why-regulating-ai-is-a-losing-battle/ [https://perma.cc/T69F-2NPX].

92. Miller, *supra* note 76.

93. *See supra* note 65 and discussion *supra* Sections II.A.2, II.A.3.

94. McCormick, *supra* note 91.

95. *See* discussion *supra* Sections II.A.2, II.A.3.

96. *See* Jowi Morales, *Chinese AI Built Off Open-Source Code Matches American Tech in Chatbot Benchmark Tests*, TOM'S HARDWARE (July 27, 2024), https://www.tomshardware.com/tech-industry/artificial-intelligence/chinese-ai-built-off-open-source-code-matches-american-tech-in-chatbot-benchmark-tests [https://perma.cc/65ZU-AYYU].

Simultaneously, many customers prefer using open-weight models that they can fine-tune independently, and it would be foolish for the United States not to participate and try to gain the "first mover advantage" in these markets.[97] As a result, a bright-line export control that satisfies one stakeholder often negatively affects another.

B. ECRA RESPONDS TO EMERGING GEOPOLITICAL THREATS.

The following Sections explain the history of the U.S. commercial export regime, the contemporary great power competition that spurred ECRA's development, and current regulatory developments.

1. *The U.S. Commercial Export Regime Evolved in Response to National Security Concerns*

The United States' commercial export regime originated during World War II. Initially focused on military equipment and munitions, export controls expanded in the 1940s to include exports of civilian goods.[98] After World War II, countries devastated by war relied heavily on U.S. imports.[99] Congress continued its commercial export control policy to reduce inflation caused by foreign demand.[100] For the first time, export controls were used to regulate peacetime markets.[101] In 1949, Congress officially established a three-pronged commercial export policy that (1) protected the domestic economy, (2) protected national security, and (3) furthered foreign policy.[102] These goals still underlie modern commercial export policy.

In the early 1950s, the onset of the Cold War strained United States-Soviet relations. The U.S. defense strategy became increasingly centered on technological supremacy, leading Congress to adopt embargo-like export controls as part of its containment strategy.[103] By the late 1960s, however, the United States and its allies recognized the importance of global trade in bolstering their own economies.[104] Policymakers and industry leaders feared that strict export controls would economically disadvantage U.S. companies relative to European and Japanese competitors.[105] Thus, Congress passed the

97. *See Open vs. Closed: The Fine-Tuning Divide in AI Models*, SHOUT, https://www.shoutdigital.com/insights/open-vs-closed-the-fine-tuning-divide-in-ai-models [https://perma.cc/4DJQ-QJWM] (last visited Apr. 6, 2025); *see also supra* note 83.

98. KERR & CASEY, *supra* note 11, at 2.

99. *Id.*

100. *Id.*

101. *Id.*

102. *Id.* at 3.

103. *Id.*

104. *Id.*

105. *Id.* at 4.

Export Administration Act of 1969, which relaxed certain export restrictions.[106]

From the 1970s through 1990s, Congress continued to relax export controls, even allowing subsequent EAAs to lapse.[107] However, by the 2010s, emerging geopolitical concerns centered on technological supremacy and great power competition—this time with China—renewed the focus on regulating commercial exports.[108] In 2018, amid concerns of commercial technology misappropriation for military use, Congress enacted ECRA.[109] ECRA provides statutory authorization for executive regulations on commercial technologies with military applications, recognizing economic policy as a sub-prong of national security and providing greater coverage over dual-use technologies.[110] Unlike previous export acts, ECRA has no expiration date.[111] Because AI has both commercial and military applications, many commercial AI exports fall under ECRA.[112]

2. *Great Power Competition with China Shaped U.S. Policies*

Many countries openly recognize AI as an indispensable tool that will allow militaries to achieve battlespace dominance through increased speed, surprise, focus, and boldness.[113] These factors propel great power competition, particularly the ongoing rivalry between the United States and China. China is currently the United States' primary competitor, and technology is the new arena for interstate struggle.[114]

Although ECRA outlines heightened controls for many countries, the United States has intensified export restrictions against China in response to the superpower's state-led industrial efforts, to which China has responded in kind.[115] Currently, the U.S. government levies export controls against China

106. *Id.*
107. *Id.*
108. *See id.* at 6.
109. *Id.* at 1.
110. 50 U.S.C. §§ 4811, 4822.
111. KERR & CASEY, *supra* note 11, at 20.
112. *See* discussion *supra* notes 19 and 20.
113. JOHNSON, *supra* note 5, at 60–62.
114. BATEMAN, *supra* note 18, at 2–5.
115. *Id.* at 1–2; *see* CHRISTOPHER A. CASEY & KAREN M. SUTTER, CONG. RSCH. SERV., IF11627, U.S. EXPORT CONTROLS AND CHINA 1–2 (2022); James K. Wholey, *Defense Technology Companies Targeted by Latest Chinese Trade Ruling*, PHILLIPS LYTLE LLP (Jan. 7, 2025), https://phillipslytle.com/update-to-u-s-china-trade-relations-china-adds-u-s-companies-to-new-restricted-list/ [https://perma.cc/9M7F-CDFS].

through the Entity List and other methods.[116] Many of the export controls discussed in this Note focus on China.

3. *Regulations for AI Continue to Develop*

When Congress enacted ECRA, BIS published an Advanced Notice of Proposed Rulemaking (ANPRM) signaling possible future controls on fourteen emerging technology categories, including AI.[117] The public responded negatively to the ANPRM, arguing in favor of specific technologies over blanket categories of technologies not yet evaluated for their national security impacts.[118] Therefore, to date, BIS has issued few direct export controls on AI software, instead focusing on AI-adjacent hardware to curtail foreign progress.[119]

On October 7, 2022, BIS released controls prohibiting exports of cutting-edge chips, chip design software, chip manufacturing equipment, and U.S.-built components of manufacturing equipment ("October 2022 Semiconductor Controls").[120] These measures were focused on restricting Chinese access to advanced semiconductor technology and to chill, if not freeze, China's AI developmental capability.[121] On September 6, 2024, BIS imposed export controls on quantum computers, quantum computing components, quantum software, advanced semiconductors, and gate all around field effect transistors (GAAFETs)—a type of multi-gate integrated circuit that can be used to develop supercomputers.[122] Though these controlled technologies are not themselves AI, they underpin AI software and related areas of research where the United States believes it has a technological lead.[123] On January 13, 2025, BIS released a new interim final rule that imposes export controls on certain closed-weight AI as well as semiconductor

116. *See* BATEMAN, *supra* note 18, at 19–20; *see* discussion *infra* Section III.D.2.

117. Jones, *supra* note 61, at 51.

118. *Id.* at 56; BATEMAN, *supra* note 18, at 18.

119. 15 C.F.R. § 774; *see* Cinelli et al., *supra* note 19; LeBeau & Seymour, *supra* note 20.

120. Emily Benson, *Updated October 7 Semiconductor Export Controls*, CTR. FOR STRATEGIC AND INT'L STUDS. (Oct. 18, 2023), https://www.csis.org/analysis/updated-october-7-semiconductor-export-controls [https://perma.cc/F4R5-C496].

121. *See* Shivakumar et al., *supra* note 64.

122. Cinelli et al., *supra* note 19.

123. *See* Congressional Testimony by Gregory C. Allen, *China's Pursuit of Defense Technologies: Implications for U.S. and Multilateral Export Control and Investment Screening Regimes*, CTR. FOR STRATEGIC & INT'L. STUDS. (Apr. 13, 2023), https://www.csis.org/analysis/chinas-pursuit-defense-technologies-implications-us-and-multilateral-export-control-and [https://perma.cc/6BDX-7E8F].

manufacturing clusters used to train AI.[124] This Note will center its discussion on concerns related to semiconductor controls and AI software controls.

III. ANALYSIS OF ECRA AND WHY COURTS DEFER TO IT

Section III.A uses past judicial decisions to illustrate why courts are likely to uphold ECRA. The remainder of Part III explains how ECRA has expanded the definition of national security, created explicit jurisdiction over emerging and foundational technology, and created a three-prong test to evaluate future regulations.

A. COURTS WILL UPHOLD EXPORT-RELATED AGENCY DECISIONS

Courts typically uphold export-related decisions, not only because they have historically applied a deferential standard for agency decisions, but also because judicial precedent supports agency decisions grounded in a national security rationale. Therefore, even though few explicit export controls currently exist for AI, courts will likely uphold those controls that do exist.[125]

Courts apply a deferential standard to export laws, recognizing that sensitive, national-security decisions require expert analysis.[126] They follow an "arbitrary and capricious" standard, examining agency decisions for rationality and procedure.[127] As long as an agency demonstrates a rational basis and correctly implements an export control, courts uphold the attached penalty.

Additionally, cases involving export decisions under ECRA's predecessors typically required two elements to trigger government liability: (1) a civilian plaintiff needed either a waiver of sovereign immunity or an *ultra vires* claim to pursue action against the government; and even if the case went to court, (2)

124. Shenai et al., *supra* note 20.

125. *See* Glimp v. Dep't. of Com.'s Bureau of Indus. & Sec., No. 22-CV-02708-GPG-KAS, 2023 WL 6622736, at *3–5 (D. Colo. Oct. 10, 2023) (granting a motion to dismiss for failure to identify a waiver of sovereign immunity); *see also* United States v. Shih, 73 F.4th 1077, 1094 (9th Cir. 2023) (holding that "rated for operation" is not unconstitutionally vague); United States v. Lachman, 387 F.3d 42, 48–50 (1st Cir. 2004) (holding that the term "specially designed" was not unconstitutionally vague); United States v. Geissler, 731 F. Supp. 93, 98–101 (E.D.N.Y. 1990) (holding that the export regulation applied to unlicensed export of F-14 aircraft tires to Iran was not "unconstitutionally vague"); United States v. Gregg, 829 F.2d 1430, 1436 (8th Cir. 1987) (showing that the defendant likely understood the export regulation); United States v. Mechanic, 809 F.2d 1111, 1112–14 (5th Cir. 1987) (upholding the President's constitutional power to "prohibit or curtail" the export of technology to protect national security); United States v. Helmy, 951 F.2d 988, 993–95 (9th Cir. 1991) (holding that lack of statutory opportunity for defendants to challenge regulations is not a due process violation).

126. 15 C.F.R. § 766.21.

127. 15 C.F.R. § 766.21(a)(4).

to win, the civilian party had to prove the government violated a fundamental right.[128] Generally, civilian parties alleged a due process violation based on "unconstitutional vagueness" in existing export law.[129] Even if the civilian party survived step one, the civilian party almost never won on Fifth Amendment grounds.[130] Most cases ended either when the court granted the government's motion to dismiss or affirmed the government's allegation of civilian wrongdoing.[131]

Since ECRA's enactment, its application has been challenged in only one case, *Fed. Express Corp. ("FedEx") v. U.S. Department of Commerce*. The government imposed strict liability fines on FedEx for shipping packages that contained export-restricted items. FedEx sued in an *ultra vires* claim, arguing that the regulations forced FedEx to "police the content of its packages on an almost infinitely broad scale," to which FedEx's "sophisticated proprietary risk-based compliance system" could not perfectly conform.[132] These restrictions required FedEx to stop business activities with certain foreign entities or risk penalties, depriving FedEx of "liberty and property."[133] The trial court dismissed in favor of the government, holding FedEx strictly liable in "aiding and abetting" illegal exports within individual shipments of mail.[134] FedEx then lost again on appeal.[135] The court applied to *FedEx* the same playbook as previous courts in previous export decisions.

The court held that the "strictly economic burdens" of FedEx's shipping enterprise did not implicate fundamental, constitutional rights.[136] Under the arbitrary and capricious standard, the court then evaluated only whether ECRA and its ensuing regulations were "rationally related to a legitimate

128. *See Glimp*, 2023 WL 6622736, at *3–5 (granting a motion to dismiss for failure to identify a waiver of sovereign immunity); *see also Shih*, 73 F.4th at 1094 (holding that "rated for operation" is not unconstitutionally vague); *Lachman*, 387 F.3d at 48–50 (holding that the term "specially designed" was not unconstitutionally vague); *Geissler*, 731 F. Supp. at 98–101 (holding that the export regulation applied to unlicensed export of F-14 aircraft tires to Iran was not "unconstitutionally vague"); *Gregg*, 829 F.2d at 1436 (showing that the defendant likely understood the export regulation); *Mechanic*, 809 F.2d at 1112–14 (holding that export controls did not exceed executive authority under the Export Administration); *Helmy*, 951 F.2d at 993–95 (holding that lack of statutory opportunity for defendants to challenge regulations is not a due process violation).

129. *See supra* note 125.

130. *See id.*

131. *See id.*

132. Fed. Express Corp. v. U.S. Dep't of Com., 486 F. Supp. 3d 69, 74 (D.D.C. 2020), *aff'd sub nom.*, 39 F.4th 756 (D.C. Cir. 2022).

133. U.S. CONST. amend. V.

134. 50 U.S.C. § 4811(1).

135. *Fed. Express Corp.*, 486 F. Supp. 3d at 72.

136. *Id.* at 75.

government interest."[137] Because the export regulations promoted "national security and foreign policy interests," the court found them to be legitimate.[138] Moreover, the court held that it was not irrational for the government to create a strict liability regime that held common carriers, like FedEx, to a higher standard.[139] This decision underscores that ECRA grants expansive regulatory authority—courts generally will uphold export decisions that advance a legitimate national security interest. ECRA's powers are vast.

B. ECRA's Economic Focus Expands and Limits Existing Law

Although courts will generally uphold agency decisions regarding exports, AI regulations must still fall within ECRA's scope. Sections III.B, III.C, III.D, and III.E discuss specific provisions of ECRA that pertain to AI export controls.

1. *ECRA Emphasizes Economic Considerations in Addition to the Nonproliferation of Military Technology*

Historically, export controls primarily restricted adversary military capabilities and limited domestic inflation.[140] However, ECRA recognizes the increasingly globalized nature of worldwide manufacturing and emphasizes market leadership as a national security consideration, thereby expanding upon what is deemed an appropriate economic consideration under export law.[141] Whereas before, export controls were enacted in war or to protect against the inflationary effects of foreign demand,[142] they can now be enacted whenever U.S. market leadership is threatened.

For dual-use technology, which inherently has commercial elements, ECRA must balance national security concerns with market interests. ECRA recognizes that national security requires maintaining technological leadership and that U.S. technological leadership is predicated on U.S. supremacy in global markets.[143] 50 U.S.C. § 4811(3) states the following:[144]

137. *Id.*; Empresa Cubana Exportadora de Alimentos y Productos Varios v. U.S. Dep't of Treasury, 638 F.3d 794, 800 (D.C. Cir. 2011).

138. 15 C.F.R. § 730.6.

139. *Fed. Express Corp.*, 486 F. Supp. 3d at 76.

140. *See* Export Administration Act of 1979, Pub. L. No. 96-72, 93 Stat. 503, at 503–505; *see* discussion *supra* Section II.B.1.

141. KERR & CASEY, *supra* note 11, at 4 (showing how Congress liberalized export controls to compete with foreign competitors in global markets).

142. *See* discussion *supra* Section II.B.1.

143. David H. McCormick, Charles E. Luftig & James M. Cunningham, *Economic Might, National Security, and the Future of American Statecraft*, 3 TEX. NAT'L SEC. REV. 51, 53 (2020).

144. 50 U.S.C. refers to the section of the United States Code where ECRA is codified.

> The national security of the United States requires that the United States maintain its leadership in the science, technology, engineering, and manufacturing sectors . . . . Such leadership requires that United States persons are competitive in global markets. The impact of [export controls] on such leadership and competitiveness must be evaluated on an ongoing basis . . . to avoid negatively affecting such leadership.[145]

As stated above, under § 4811(3), U.S. technological leadership, economic competitiveness, security, and broader economic health are pillars of national security strategy.[146] Market factors must be evaluated against military deterrence-related constraints to ensure export controls balance economic and security priorities.[147]

For emerging technologies, well-balanced controls are still speculative.[148] Although controls can proactively prevent the proliferation of dangerous dual-use technologies that affect the physical security of the American people, controls can also place excessive emphasis on applications that may never prove militarily practicable while failing to consider how such controls might affect American competitiveness in global markets.[149]

ECRA provides regulatory agencies with broad latitude to balance control intensity, evaluating security and nonproliferation against economic flexibility and global competitiveness.[150] When placing controls on AI, regulators must balance economic and military concerns and determine whether such controls, on balance, are reasonable.

2. Economic Considerations Restrain ECRA's Power

Although courts generally uphold ECRA-based decisions, ECRA's expanded national security outlook is not limitless. ECRA aims to restrict dual-use items only when necessary to *significantly* protect national security or further foreign policy, with an eye on contributions to foreign military potential, economic impact, and international obligations.[151] 50 U.S.C. § 4811(1) states the following:

---

145. 50 U.S.C. § 4811(3).

146. *Id.*

147. *Id.*

148. Jones, *supra* note 61, at 57–59.

149. *See* P.R. Rajeswari, *Economics of Export Controls: A Study of US Export Control Mechanism*, 23 COLUM. U.: STRATEGIC ANALYSIS (1999), https://ciaotest.cc.columbia.edu/olj/sa/sa_99rap02.html [https://perma.cc/45C5-G6J6].

150. *See* Jones, *supra* note 61, at 56–57; Allen, *supra* note 123.

151. 50 U.S.C. § 4811(1).

> The purpose of ECRA is "to use export controls only after full consideration of the impact on the economy of the United States and only to the extent necessary—[] to restrict the export of items which would make a significant contribution to the military potential of any other country or combination of countries which would prove detrimental to the national security of the United States; and [] to restrict the export of items if necessary to further significantly the foreign policy of the United States or to fulfill its declared international obligations."[152]

Thus, ECRA prefers restraint, authorizing export controls only as necessary to meet national security threats.[153] Before imposing export controls, ECRA requires regulators to consider the economic effects of the action and to only (1) restrict the capability of a foreign military or (2) enforce an obligation to an international ally.[154] Consequently, controls on AI should account for these factors and only be implemented after conducting an economic impact assessment. The government in 2018 lacked the requisite data to adequately assess AI for its economic and national security impacts, however, renewed interest in 2024 and 2025 has resulted in more regulations.[155]

C. ECRA Expanded Its Jurisdiction Over Emerging and Foundational Technologies

ECRA also expanded prior export law by emphasizing the importance of emerging and foundational technologies in national security. Although ECRA has explicit jurisdiction to curtail transfers of emerging and foundational technologies, the government nevertheless must limit controls of these technologies to maintain market dominance in key sectors.

1. *ECRA Expanded its Focus on Emerging and Foundational Dual-Use Technologies*

Under § 4817(a)(1), regulators must "identify [and control] emerging and foundational technologies . . . that are essential to the national security of the United States."[156] However, Congress did not define what constitutes an "emerging and foundational technology."[157] Emerging technologies are

152. *Id.*
153. *Id.*
154. *Id.*
155. *See* Jones, *supra* note 61, at 56–57; Shenai et al., *supra* note 20.
156. 50 U.S.C. § 4817(a)(1).
157. Emma Rafaelof, *Unfinished Business: Export Control and Foreign Investment Reforms*, U.S.-China Econ. & Sec. Rev. Comm'n 4 (June 1, 2021), https://www.uscc.gov/sites/default/files/2021-06/Unfinished_Business-Export_Control_and_Foreign_Investment_Reforms.pdf [https://perma.cc/32MH-6Y9N].

typically defined as those with the potential to transform society, have a growing role in the economy, give rise to subfields with breakthroughs, and give way to trends that further contribute to growth.[158] Many iterative technologies are both emerging and mature.[159] For example, graphics processing units (GPUs) are uniquely suited for AI software because they have parallel processing capabilities, which are necessary for simultaneously managing large data sets and performing complex mathematical computations.[160] GPUs continue to develop and improve; however, GPUs have been available since 1999.[161]

Foundational technologies refer to core technological infrastructures that support and drive product development.[162] They are technologies that provide a base upon which to build digital products or advance other scientific fields.[163] AI hardware is foundational as it runs AI software. AI software is foundational if it is used to advance fields like machine learning, computer vision, among other fields.

Although the U.S. government continues to define "emerging and foundational" technology, GPUs and other AI-related hardware such as field-programmable gate arrays (FPGAs),[164] application-specific integrated circuits (ASICs),[165] and more recently, GAAFETs[166] are currently considered "emerging and foundational."[167] AI software is likewise both emerging and foundational. AI software is rapidly developing (emerging), and its core

158. Daniele Rotolo, Diana Hicks & Ben R. Martin, *What Is an Emerging Technology?*, 44 RSCH. POL'Y, 1827, 1827–30 (2015).

159. *Id.*

160. *Id.*

161. Audrey Reznik, Troy Nelson, Kaitlyn Abdo & Christina Xu, *Why GPUs Are Essential for AI and High-Performance Computing*, RED HAT DEV. (Nov. 21, 2022), https://developers.redhat.com/articles/2022/11/21/why-gpus-are-essential-computing [https://perma.cc/RKT4-PJGG].

162. Colin Dowling, *How Foundational Technology Accelerates Product Development*, APOLLO21, https://www.apollo21.io/transmissions/how-foundational-technology-accelerates-product-development [https://perma.cc/2TNQ-XXF4] (last visited Feb. 22, 2025).

163. *Id.*

164. *See What Is an FPGA?*, LATTICE SEMICONDUCTOR, https://www.latticesemi.com/en/What-is-an-FPGA [https://perma.cc/68RC-44VF] (last visited Feb. 22, 2025).

165. *See* BAE SYSTEMS, *What are ASICs?*, https://www.baesystems.com/en-us/definition/what-are-asics) [https://perma.cc/QNK4-QZQX] (last visited Feb. 22, 2025).

166. *See Gate-All-Around FET (GAA FET)*, SEMICONDUCTOR ENG'G, https://semiengineering.com/knowledge_centers/integrated-circuit/transistors/3d/gate-all-around-fet [https://perma.cc/PD4E-E3VU] (last visited Feb. 22, 2025). GAAFETs have a special transistor design that enables AI software.

167. MICHAELA D. PLATZER, EMILY G. BLEVINS & KAREN M. SUTTER, CONG. RSCH. SERV., R46581, SEMICONDUCTORS: U.S. INDUSTRY, GLOBAL COMPETITION, AND FEDERAL POLICY 3 (2020).

algorithms can be applied to many technologies and underpin a multitude of disparate applications (foundational).[168] Therefore, AI software is also within ECRA's regulatory scope.

2. *Economic Considerations Restrain ECRA's Emerging & Foundational Dual-Use Focus*

Despite ECRA's explicit authorization to control broad swaths of "emerging and foundational technologies," these dual-use technologies are sold in global markets and involve significant economic considerations. "Emerging and foundational technologies" are inherently research-intensive, and such research depends on domestic and international funding.[169] ECRA must therefore balance dual-use technology controls with the realities of the global marketplace.[170]

The computer age and globalized supply chains have created powerful commercial technologies, independent of government-funded research.[171] Companies developing "emerging and foundational technologies" fund their R&D more often through product sales than through government contracts.[172] Although the U.S. government remains the world's top R&D spender, devoting $806 billion to R&D in 2021 alone, many companies prefer to obtain R&D funds from global sales as these funds come with fewer restrictions and avoid years of bureaucratic red tape.[173] Commercial growth in computers and AI has, for decades, surpassed government-funded growth.[174]

Commercially funded R&D for items with military applications creates unprecedented export issues. Items produced by commercially funded research fall under ECRA's more lenient provisions rather than AECA's stricter weapons sales laws.[175] The United States must allow companies to fund

---

168. *What Are Foundational Models?*, AMAZON WEB SERS., https://aws.amazon.com/what-is/foundation-models [https://perma.cc/76ED-84ZZ] (last visited Feb. 22, 2025); Dowling, *supra* note 162.

169. *See* Francisco Moris & Alexander Rhodes, *R&D: U.S. Trends and International Comparisons*, NAT'L SCI. BOARD: SCI. AND ENG'G INDICATORS 2024 1, 7 (May 21, 2024), https://ncses.nsf.gov/pubs/nsb20246 [https://perma.cc/2UGA-EVFP].

170. *See* discussion *supra* Sections III.B.2.

171. Paul Scharre & Ainikki Riikonen, *Defense Technology Strategy*, CTR. FOR NEW AM. SEC. 1, 6–7 (2020), https://www.cnas.org/publications/reports/defense-technology-strategy [https://perma.cc/X67N-WG5X].

172. *See* MARCY E. GALLO, CONG. RSCH. SERV., R45403, THE GLOBAL RESEARCH AND DEVELOPMENT LANDSCAPE AND IMPLICATIONS FOR THE DEPARTMENT OF DEFENSE 4–6 (2021).

173. Moris & Rhodes, *supra* note 169, at 7.

174. *Id.*

175. *See* International Traffic in Arms Regulations, 22 C.F.R. § 120.41 (2025). Items specially designed for military use fall under the AECA/ITAR. Commercially funded products

R&D through commercial sales because it helps the United States maintain market dominance—more commercial sales translate to more American presence in global markets.[176] Simultaneously, licensing agreements allow the military to benefit from modern technology without spending military money—they reduce military R&D expenditures.[177] However, when the government does not develop militarily applicable products, the government has less control over the product. Historically, the government could curtail the proliferation of military-use technologies because (1) it directly funded their development, and (2) it did not have to directly compete with commercial companies' need for market dominance.[178] Today, the government must consider the economic effects of commercial export controls on global market dominance and U.S. innovation, balancing companies' R&D needs with military risks.[179] This economic accounting limits export controls on many "emerging and foundational technologies."[180]

D. ECRA HAS OVERSEAS REACH VIA CATCH-ALL CONTROLS AND THE FOREIGN DIRECT PRODUCT RULE

Under ECRA, BIS can expand unilateral U.S. export regulations to activities in foreign countries. Through catch-all controls and the Foreign Direct Product Rule (FDPR), BIS extends U.S. jurisdiction to items neither produced in nor passing through the United States. In this way, the United States controls not just physical items but also the activities of people using those items, both domestically and internationally.

1. *Section 4817(b) Gives Authority for U.S. Regulatory Bodies to Extend Export Jurisdiction to Foreign Countries*

ECRA is a unilateral export law that asserts U.S. regulatory jurisdiction abroad.[181] Under § 4817(b)(1), ECRA authorizes BIS to "establish appropriate

---

are generally not "specifically designed" for military use, especially if the creator intends to sell that product in commercial markets. These products therefore fall under ECRA/EAR.

176. Christopher S. Chivvis & Ethan B. Kapstein, *U.S. Strategy and Economic Statecraft: Understanding the Tradeoffs*, CARNEGIE ENDOWMENT FOR INT'L PEACE (Apr. 28, 2022), https://carnegieendowment.org/research/2022/04/us-strategy-and-economic-statecraft-understanding-the-tradeoffs?lang=en [https://perma.cc/F44N-9AGS].

177. *See* Thomas Mulkern & Troy Carter, *Private Sector Helps Army and National Economy*, U.S. ARMY (Feb. 15, 2018), https://www.army.mil/article/200705/private_sector_helps_army_and_national_economy [https://perma.cc/WKQ9-9GTF].

178. *See* Robert Kuttner, *How 'National Security' Hurts National Competitiveness*, HARVARD BUSINESS REVIEW (Jan.–Feb. 1991), https://hbr.org/1991/01/how-national-security-hurts-national-competitiveness [https://perma.cc/8Q3W-G9XS].

179. *Compare* discussion *supra* Section III.B.1, *with* discussion *supra* Section III.C.2.

180. *Compare* discussion *supra* Section III.B.1, *with* discussion *supra* Section III.C.2.

181. 50 U.S.C. § 4817.

controls [under EAR] on the *export, reexport, or in-country transfer of technology*."[182] Therefore, § 4817(b) grants BIS authority to impose controls not only on exports leaving the United States, but also on any U.S. item that is reexported or transferred within a foreign country.[183] ECRA's jurisdiction extends to any country and any person or company (regardless of citizenship) that exports items incorporating U.S.-origin products and software.[184] Moreover, if the foreign product contains a *de minimis* percentage (usually 25 percent) of a U.S. product, the foreign product (and the originating country or company) is also subject to U.S. export controls.[185]

2. *The Export Control Reform Act Expanded Upon the Authority of Catch-All Rules*

Typically, export controls fall into two categories: list-based controls and catch-all controls.[186] ECRA gives EAR the power to create lists of controlled items that are pre-identified by the U.S. government as export threats.[187] ECRA also permits the United States to create lists of military end-users and end-uses to whom exporters may not ship sensitive items.[188] The explicit controls described, *supra*, in Section II.B.3 are such list-based controls.

Ex ante, list-based controls simplify the export process by proactively identifying risky technologies; however, these lists cannot anticipate every potential harmful use.[189] Moreover, list-based controls risk overregulating items whose benefits outweigh their harms. Catch-all controls address gaps by "catching" harmful exports not flagged by explicit lists or directed toward sanctioned countries.[190] Even though few explicit AI-related list-based controls exist, catch-all controls still apply to AI.

In the 1990s, the United States created catch-all controls, providing a legal basis to require export licenses even for previously uncontrolled "weapons."[191]

182. 50 U.S.C. § 4817(b) (emphasis added).

183. *Id.*

184. Emily S. Weinstein & Kevin Wolf, *For Export Controls on AI, Don't Forget the "Catch-All" Basics*, CTR. FOR SEC. AND EMERGING TECH. (July 5, 2023), https://cset.georgetown.edu/article/dont-forget-the-catch-all-basics-ai-export-controls/ [https://perma.cc/F8S4-GGM6].

185. *See* BATEMAN, *supra* note 18, at 20.

186. Weinstein & Wolf, *supra* note 184.

187. *Id.*

188. 15 C.F.R. § 744.21.

189. Weinstein & Wolf, *supra* note 184.

190. *Id.*

191. U.S. Dep't of State, *Catch-All Controls*, U.S. DEPARTMENT OF STATE: A RESOURCE ON STRATEGIC TRADE MANAGEMENT AND EXPORT CONTROLS, https://2009-

ECRA and EAR create a net of catch-all controls that extend U.S. export jurisdiction to exports potentially used for nefarious purposes, regardless of whether an explicit list-based control exists. The remainder of this Section discusses specific catch-all controls relevant to Part IV.

a) End-User & End-Use Controls

If the supplier knows or has reason to know that their export may be sold to a prohibited end-user or for a prohibited end-use, the sale is subject to export controls and may require a license.[192] Under 15 C.F.R. § 744.6(b), military end-users include individuals who "support" prohibited uses.[193] The term "support" is broadly defined, encompassing not only direct export actions but also any "facilitation" of shipments, contracts, or services that might enable a prohibited end-use.[194] Therefore, foreign individuals might be subject to U.S. export laws and penalties if they facilitate the sale of foreign-made items that contain more than a *de minimis* amount of U.S.-origin components.[195]

Under 15 C.F.R. § 744.1(b)(1) and § 744.3(b), even if an end-user is not on an end-user list, an exporter is still liable if they "know or have reason to know" that the exported item may be used improperly.[196] Typically, the government interprets "to know" broadly, so if an exporter had reason to be aware (i.e., should have known) that the exported item could be used for prohibited purposes, they can be subject to U.S. sanctions.[197] For example, in *FedEx*, BIS imposed strict liability on FedEx, despite FedEx lacking direct knowledge of each parcel's content.[198] The court held that FedEx's institutional knowledge allowed for application of a stricter standard than that for the average person.[199] According to the court, FedEx should have been aware that their packages could contain export-limited items.

b) Entity List

To help streamline licensing procedures, BIS administers the Entity List, an end-user-based list that targets foreign companies considered to have

2017.state.gov/strategictrade/practices/c43179.htm [https://perma.cc/Z6N4-D7RM] (last visited Feb. 22, 2025).

192. *See* 50 U.S.C. §§ 4813(a)(4), 4813(2), 4817(b)(1).

193. 15 C.F.R. § 744.6(b); *see* Weinstein & Wolf, *supra* note 184.

194. *See* Weinstein & Wolf, *supra* note 184.

195. *See id.*; BATEMAN, *supra* note 18, at 20.

196. 15 C.F.R. §§ 744.1(b)(1), 744.3(b).

197. *See* Fed. Express Corp. v. U.S. Dep't of Com., 486 F. Supp. 3d 69, 80–82 (D.D.C. 2020), *aff'd sub nom.*, 39 F.4th 756 (D.C. Cir. 2022).

198. *Id.*

199. *Id.* at 76.

interests counter to those of the United States.[200] An entity need not be on the Entity List to be subject to U.S. export controls, but the Entity List expedites the review process.[201] From 2018 to 2022, the share of Chinese companies with military affiliations on the Entity List grew from 14 percent (130 entries) to 29 percent (532 entries).[202] To export to listed entities—for example, Chinese technology companies that create AI-adjacent products—companies must obtain a license from the U.S. government, subject to a presumption of denial.[203]

c) Deemed Exports

Finally, EAR § 734.13(b) states that "[a]ny release in the United States of 'technology' or source code to a foreign person is a deemed export to the foreign person's most recent country of citizenship or permanent residency."[204] In other words, any transfer of information or software source code to a non-U.S. citizen is considered an export and can be subject to export law if that foreigner is a citizen of a restricted country.

In sum, catch-all controls broadly apply to any domestic export or foreign reexport that may go toward any "foreseeable" prohibited end-user or end-use.[205] ECRA's catch-all rules give the executive branch the power to regulate the activities of a person (American citizen or not) who assists with the sale of any U.S.-origin "emerging or foundational technology" that *could be* used in a foreign weapon (which is almost all such technologies).[206] These rules emphasize the export act or the exporter's citizenship rather than the item itself, regardless of whether the exporter predicted the final end-use of the item.[207] Thus, U.S. companies must proactively supervise their market to prevent U.S. government sanctions for potential, even unintended, end-uses.

Because most AI products have foreseeable warfighting end-uses, nearly all American-developed AI software and hardware could be subject to ECRA's catch-all controls. Thus, any seller—American or not—who supports the sale of an American-origin AI could be investigated or penalized by the U.S.

200. *See* BATEMAN, *supra* note 18, at 19–20.

201. *Id.*; Weinstein & Wolf, *supra* note 184.

202. BATEMAN, *supra* note 18, at 19–20.

203. 15 C.F.R. § 742.4(b)(7)(i) (stating that for certain countries such as Burma, Cambodia, China, or Venezuela, "[t]here is a presumption of denial for license applications to export[,] reexport, or transfer items that would make a material contribution to the 'development,' 'production,' maintenance, repair, or operation of weapons systems . . . ."); *see also* BATEMAN, *supra* note 18, at 19–20.

204. 15 C.F.R. § 734.13.

205. *See* Weinstein & Wolf, *supra* note 184.

206. *Id.*

207. *Id.*

government if it can be proven that enough of that American-origin AI was found in prohibited weaponry or used by an enemy combatant.

3. *The Foreign Direct Product Rule Further Expands Upon Catch-All Rules in Foreign Countries*

ECRA authorizes EAR to enforce the Foreign Direct Product Rule (FDPR).[208] The FDPR is a narrowly tailored regulatory regime with broad consequences.[209] There are eight versions of FDPR, each listing new ECCNs, countries, and criteria.[210] The FDPR restricts the transfer of certain ECCNs to specific end-users, even if the product contains no U.S.-origin content or has never entered the United States, *because its production involved U.S.-origin software or equipment*.[211] In this way, FDPR extends the United States' jurisdiction to certain foreign products (if they fall within a listed ECCN) even if they fall below *de minimis* export thresholds.[212] Unlike catch-all rules, which apply only if products contain at least 25 percent U.S.-origin components, FDPR applies even when products do not contain any U.S.-made subcomponents because the products were created with U.S. software or equipment. FDPR's goal is to impose controls on every part of a supply chain, to use export controls to choke both U.S. and foreign flow of certain ECCNs, preventing the global proliferation of certain ECCNs at a near embargo.[213] This ensures that no trickle of water escapes the metaphorical "dam."[214]

Figure 1: Example of U.S. Jurisdiction Under Foreign Direct Product Rule

---

208. 15 C.F.R. § 734.9.

209. *See Understanding the Foreign Direct Product Rule*, EXPORT COMPLIANCE TRAINING INST. (Dec. 20, 2022), https://www.learnexportcompliance.com/understanding-the-foreign-direct-product-rule/ [https://perma.cc/K7WY-8NT8].

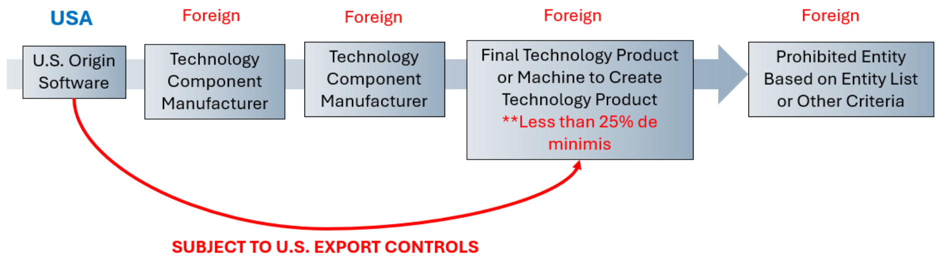
210. *Id.*

211. *Id.*

212. *Id.*

213. *Id.*; Matthew Schleich & Thibault Denamiel, *Why US Semiconductor Export Controls Backfire*, DIPLOMAT (May 23, 2024), https://thediplomat.com/2024/05/why-us-semiconductor-export-controls-backfire [https://perma.cc/7CJD-Z8GT].

214. *Id.*



For example, FDPR 7.0 and 8.0 impose controls on ECCNs related to advanced computing products, including semiconductors, going to China.[215] As a result, in 2020, Huawei Technologies Co., Ltd., a Chinese telecommunications and consumer electronics company that also develops AI chips, needed permission from the U.S. government to import chip-related technology made with U.S. software.[216] The United States used FDPR to prevent ASML, a Dutch photolithography manufacturer, from selling microchip manufacturing equipment to Huawei because U.S.-origin software was used to build ASML's semiconductor manufacturing equipment somewhere in ASML's multi-country supply chain.[217]

Typically, FDPR only applies to items that are (1) listed under certain ECCNs and (2) destined for certain countries or companies; however, FDPR can, under EAR99, apply to any direct product of U.S. technology—products that, at some stage of manufacturing, involve U.S.-origin technology or equipment.[218] These include emerging technologies such as closed-weight AI models and quantum computing.[219]

FDPR has significant consequences for non-U.S. companies.[220] Successful application of FDPR requires international coordination between the United

215. EXPORT COMPLIANCE TRAINING INST., *supra* note 209.
216. *Id.*
217. *Id.*
218. Ishan V. Nagpal, *Decoding the Foreign Direct Product Rule (FDPR)*, SUBSTACK: COMPLIANCE IN AN INTEGRATED NETWORK (Feb. 11, 2025), https://ishanvnagpal.substack.com/p/decoding-the-foreign-direct-product?utm_campaign=post&utm_medium=web [https://perma.cc/2PJL-4X48].
219. *Id.*
220. *See* Jane Lee & Stephen Nellis, *Explainer: What Is "FDPR" and Why Is the U.S. Using It to Cripple China's Tech Sector?*, REUTERS (Oct. 8, 2022), https://www.reuters.com/technology/what-is-fdpr-why-is-us-using-it-cripple-chinas-tech-sector-2022-10-07/ [https://perma.cc/K3GD-ZZ8P].

States and affected U.S. allies.[221] Countries whose supply chains involve U.S. products must preemptively disclose their entire supply chain, often many layers deep, to ensure compliance.[222] U.S. allies must obey U.S. export restrictions whenever a U.S software touches their manufacturing process, even if the foreign product has no other relation to the United States.[223]

An embargo of U.S. products against one country can effectively backfire into an embargo against the United States, as allied countries may forego U.S. imports in favor of less cumbersome foreign offerings.[224] FDPR constrains allied countries' ability to sell products in international markets, forcing allies to choose between using U.S. supply chains, subject to U.S.-imposed limitations, or declining certain U.S. products in favor of less restrictive, and potentially less expensive foreign products.[225] Overly restrictive FDPR provisions—which operate as an "us versus them" demand—can cause the United States to lose market share not just to those embargoed countries or companies, but also to allied countries that sell products to embargoed countries.[226] Thus, the United States could lose export revenue at every step of the supply chain.

Because FDPR extends to advanced computing products, FDPR applies to technologies that enable AI.[227] Overseas companies that create AI hardware and software must consider their relationships with the United States at every

221. Schleich & Denamiel, *supra* note 213; CHRISTOPHER A. CASEY, CONG. RSCH. SERV., R47684, EXPORT CONTROLS—INTERNATIONAL COORDINATION: ISSUES FOR CONGRESS 6–7 (2023).

222. *See* EXPORT COMPLIANCE TRAINING INSTITUTE, *supra* note 209; Patrick Kurniawan, *YL Blog #71 – China's Pursuit of Semiconductor Independence: US Foreign Direct Product Rule (FDPR) in Effect*, PACIFIC FORUM (June 27, 2024), https://pacforum.org/publications/yl-blog-71-chinas-pursuit-of-semiconductor-independence-us-foreign-direct-product-rule-fdpr-in-effect [https://perma.cc/7DJG-SKP5].

223. *See* Schleich & Denamiel, *supra* note 213; Kurniawan, *supra* note 222.

224. *See* Robert D. Atkinson, *Stronger Semiconductor Export Controls on China Will Likely Harm Allied Semiconductor Competitiveness*, INFO. TECH. & INNOVATION FOUND. (Oct. 12, 2023), https://itif.org/publications/2023/10/12/stronger-semiconductor-export-controls-on-china-will-likely-harm-allied-semiconductor-competitiveness/ [https://perma.cc/3435-2CRT].

225. *Id.*

226. *See* Jack Whitney, Matthew Schleich & William Alan Reinsch, *The Double-Edged Sword of Semiconductor Export Controls* 3–12, CTR. FOR STRATEGIC & INT'L STUDS. (Oct. 4, 2024), https://csis-website-prod.s3.amazonaws.com/s3fs-public/2024-10/241004_Whitney_Export_Controls.pdf?VersionId=1333avUXqn8.aHkwy1hPw2PQzPHU.UG [https://perma.cc/F9TW-5QXW].

227. *See* Foreign-Produced Direct Product Rule Additions, and Refinements to Controls for Advanced Computing and Semiconductor Manufacturing Items, 89 Fed. Reg. 96790 (Dec. 5, 2024) (to be codified at 15 C.F.R. pts. 732, 734, 736, 740, 742, 744, 746, 758, 762, 772, 774).

point of their supply chain.[228] U.S. companies must also consider whether their products could, at any point, be used in manufacturing an AI-adjacent product, and if so, how that affects their global market sales.

E. EXPORT REGULATIONS FOR ARTIFICIAL INTELLIGENCE ARE SUBJECT TO A THREE-PRONG TEST

In considering whether to create list-based and explicit export controls for AI, regulators use a three-prong test to assess whether a given technology is suitable for export controls. Under 50 U.S.C. § 4817(a)(2)(B), executive agencies consider (1) the development of an AI technology outside the United States; (2) the effect of an export control on the development of an AI technology in the United States; and (3) the effectiveness of an export control in limiting the proliferation of an AI technology outside the United States.[229] Section 4817(a)(2)(B) requires that executive agencies consider the following:

> (i) the development of emerging and foundational technologies in foreign countries; (ii) the effect export controls imposed pursuant to this section may have on the development of such technologies in the United States; and (iii) the effectiveness of export controls imposed pursuant to this section on limiting the proliferation of emerging and foundational technologies to foreign countries.[230]

This three-prong test, provided by law, is the balancing test to ascertain whether a certain AI can and should be subject to U.S. export controls. Part IV applies this three-prong test to AI hardware and software.

IV. EVALUATING AI UNDER ECRA

Part IV combines the technological and geopolitical considerations discussed in Part II with the statutory considerations discussed in Part III to consider whether explicit controls for AI are effective or advisable. Section 4817(a)(2)(B)'s three-prong test provides the framework for evaluating the benefits and drawbacks of explicitly regulating AI under ECRA. This evaluation concludes that export controls should be narrowly written and consider the second and third order effects of each action. The lack of AI regulation is not an ECRA problem, but a problem with the ripeness of AI technology.

228. *Id.*
229. 50 U.S.C. § 4817(a)(2)(B)(i)–(iii).
230. *Id.*

A. EXPORT CONTROLS OF AI, UNDER SECTION 4817(A)(2)(B), AT BEST, HAVE MARGINAL BENEFITS AND AT WORST, ARE COUNTERPRODUCTIVE

Section IV.A evaluates AI under the § 4817(a)(2)(B) three-prong balancing test. Applying the three-prong balancing test to AI hardware and software counsels against broad export controls.

1. *Under Section 4817(a)(2)(B), Export Controls of AI Hardware Might Have Marginal Short-Term Benefits, but May Be Counterproductive Overall*

This analysis focuses primarily on semiconductor-related controls, particularly those restricting exports to China. These conclusions may provide insight into the potential effects of exports on other, more recently controlled AI hardware, such as quantum computers, GAAFETs, and additive manufacturing technology.[231]

a) Export Controls Must Consider the Development of AI Hardware in Foreign Countries

Section 4817(a)(2)(B)(i) requires the United States, before imposing export controls, to consider the foreign development of "emerging and foundational technologies."[232] For semiconductors, the United States and other U.S.-allied countries have a developmental advantage over China.[233]

According to the Semiconductor Industry Association (SIA), in 2023, the United States controlled 50.2 percent of global semiconductor industry sales and market share, whereas South Korea accounted for 18.8 percent, the European Union for 12.7 percent, Japan for 9 percent, Taiwan for 7 percent, and China for 7 percent.[234] U.S.-allied nations also have a virtual monopoly on semiconductor manufacturing equipment, with the United States producing 47 percent, Japan producing 30 percent, the Netherlands producing 17 percent, South Korea producing less than 3 percent, and Germany producing less than 3 percent of semiconductor manufacturing equipment.[235] These

231. *See* Cinelli et al., *supra* note 19.

232. 50 U.S.C. § 4817(a)(2)(B)(i).

233. Allen, *supra* note 123.

234. Stephen Ezell, *How Innovative Is China in Semiconductors?*, INFO. TECH. & INNOVATION FOUND. (Aug. 19, 2024), https://itif.org/publications/2024/08/19/how-innovative-is-china-in-semiconductors [https://perma.cc/X5JP-3YMY].

235. Carrick Flynn, *Recommendations on Export Controls for Artificial Intelligence,* CTR. FOR SEC. & EMERGING TECH. 1, 7 (Feb. 2020), https://cset.georgetown.edu/wp-content/uploads/Recommendations-on-Export-Controls-for-Artificial-Intelligence-1.pdf [https://perma.cc/PJ9M-6NAC].

statistics show that U.S.-allied nations likely control over 90 percent of semiconductor and associated technologies.

Although China currently relies on western computer chips, the Chinese government has prioritized its domestic semiconductor sector, seeking self-sufficiency while building its own competitive products.[236] Although Chinese semiconductor firms lag behind U.S.-allied countries, they appear to be catching up in certain pockets through a mix of both innovation and replication.[237] The Chinese government has considered semiconductors one of the country's key long-term innovation priorities.[238] China recognizes semiconductors as a foundational technology that underpins its economy and national security posture and aims to gain self-sufficiency in this sector.[239]

In the last decade, China has increased its chip manufacturing and design industry manifold and is projected to account for the most significant share of available chip-making capacity within the next several years.[240] China currently outpaces the United States in semiconductor R&D spending, semiconductor patent applications, and is on par with the United States in the volume and quality of semiconductor-related research publications.[241] China's chip subsidies artificially lower prices and have helped the Chinese gain market share at the expense of non-Chinese firms.[242] Although the United States and its allies currently hold a significant lead, the long-term sustainability of this advantage will largely depend on the pace and effectiveness of China's innovation and self-sufficiency efforts.

b) Export Controls Must Consider the Effects of Those Controls on AI Hardware Development in the United States

In addition to considering the development of emerging technologies abroad, ECRA requires BIS to consider the effect of export controls on the development of "emerging and foundational technologies," such as AI, in the United States.[243] Currently, semiconductor exports impede Chinese AI development while reinforcing domestic semiconductor capabilities.[244]

236. Ezell, *supra* note 234.
237. *Id.*
238. *Id.*
239. *Id.*
240. *Id.*
241. *Id.*
242. *Id.*
243. 50 U.S.C. § 4817(a)(2)(B)(ii).
244. Allen, *supra* note 123.

However, these restrictions might deny U.S. firms the profits and market share needed for U.S. semiconductor growth.[245]

China is the largest semiconductor market in the world, accounting for 31.4 percent of global semiconductor purchases, with U.S. firms supplying 53.4 percent of those sales.[246] Export controls not only cause U.S. firms to lose direct revenue from China but, due to the catch-all rules, may also disrupt U.S. revenue streams from other countries that have sales relationships with China, compounding losses.[247] Lost revenue leads to lost stock market capitalization and undermines economies of scale that offset the upfront costs of semiconductor manufacturing and R&D.[248] Semiconductor manufacturing and research are expensive, and many of these costs cannot be borne by the government alone.[249] Chip sales bolster revenues that sustain research for better products.[250]

Proponents of semiconductor controls argue that these controls buy the United States time to strengthen its domestic semiconductor fabrication abilities and maintain a lead over Chinese AI development.[251] The United States can capitalize on this newfound "breathing room" to improve its onshore manufacturing capabilities, reduce supply chain dependency on foreign suppliers, ensure a steady supply of advanced chips needed for AI software applications, and further its AI-related military research.[252] Meanwhile, export controls prevent adversaries from using U.S. chip

245. *Id.*

246. Kirti Gupta, Chris Borges & Andrea Leonard Palazzi, *Collateral Damage: The Domestic Impact of U.S. Semiconductor Export Controls*, CTR. FOR STRATEGIC & INT'L. STUDS. (July 9, 2024), https://www.csis.org/analysis/collateral-damage-domestic-impact-us-semiconductor-export-controls [https://perma.cc/BW36-D3JQ].

247. *See* discussion *supra* Sections III.D.2, III.D.3.

248. *Id.*

249. *See* Gallo, *supra* note 172, at 1 (showing that in 1960, the U.S. Government funded twice as much R&D as businesses, but now businesses fund 71% of R&D).

250. *See* Gupta et al., *supra* note 246.

251. Owen J. Daniels & Will Hunt, *Sustaining and Growing the U.S. Semiconductor Advantage: A Primer*, CTR. FOR SEC. & EMERGING TECH. 5 (2022), https://cset.georgetown.edu/wp-content/uploads/CSET-Sustaining-Growing-US-Semiconductor-Advantage-A-Primer.pdf [https://doi.org/10.51593/20220006].

252. *See* Vishnu Kannan & Jacob Feldgoise, *After the CHIPS Act: The Limits of Reshoring and Next Steps for U.S. Semiconductor Policy*, CARNEGIE ENDOWMENT FOR INT'L PEACE (Nov. 22, 2022), https://carnegieendowment.org/research/2022/11/after-the-chips-act-the-limits-of-reshoring-and-next-steps-for-us-semiconductor-policy?lang=en [https://perma.cc/4A5S-P39R]; Justin Badlam, Stephen Clark, Suhrid Gajendragadkar, Adi Kumar, Sara O'Rourke & Dale Swartz, *The CHIPS and Science Act: Here's What's in It*, MCKINSEY & CO. (May 16, 2024), https://www.mckinsey.com/industries/public-sector/our-insights/the-chips-and-science-act-heres-whats-in-it [https://perma.cc/YG5E-MATJ].

technologies to develop competing products.[253] The CHIPS and Science Act (CHIPS), enacted at the same time as the October 2022 Semiconductor Controls, is intended to work in concert with these controls, providing funding to improve semiconductor production within the United States.[254]

Critics of semiconductor export controls argue that they are "a double-edged sword."[255] Although controls can stifle technological advancement of U.S. competitors, they can also "strain the very businesses that propelled the United States into technological leadership" by causing the United States and allied businesses to lose market share.[256] Semiconductor export controls can deny domestic firms access to export-affected markets without providing adequate alternatives to compensate for their lost profits.[257]

Since the October 2022 Semiconductor Controls, affected U.S. firms have terminated relationships with Chinese firms but have not formed equally profitable relationships elsewhere.[258] After the October 2022 Semiconductor Controls, U.S. semiconductor firms saw a 2.5 percent drop in stock market valuation that persisted for 20 days, translating to an aggregate loss of $130 billion in market capitalization.[259] Additionally, the chilling effect on the market seems to have extended beyond the semiconductor industry, with businesses in unrelated sectors becoming wary of new relationships that may, in the future, be subject to restrictions.[260]

c) Export Controls Must Consider the Effectiveness of Such Controls in Limiting the Proliferation of AI Hardware in Foreign Countries

ECRA requires the United States to consider the effectiveness of export controls on "limiting the proliferation of emerging and foundational technologies to foreign countries."[261] Through catch-all controls and FDPR, the United States believes it can touch almost every part of the semiconductor supply chain and throttle Chinese AI development, preventing Chinese access

253. Daniels & Hunt, *supra* note 251, at 5.
254. H.R. 4346, 117th Cong. (2022).
255. Schleich & Denamiel, *supra* note 213.
256. *Id.*
257. Gupta et al., *supra* note 246.
258. *Id.*
259. Matteo Crosignani, Lina Han, Marco Macchiavelli & André F. Silva, *Securing Technological Leadership? The Cost of Export Controls on Firms*, FED. RSV. BANK OF N.Y. (Feb. 2025), https://www.newyorkfed.org/research/staff_reports/sr1096 [https://doi.org/10.59576/sr.1096].
260. Gupta et al., *supra* note 246.
261. 50 U.S.C. § 4817(a)(2)(B)(iii).

to foundational technologies and thereby "cooling" the competitive landscape.[262]

For U.S. export controls to be effective, allies must willingly comply with U.S. controls. The United States currently maintains compliance agreements with its allies, but some allies have pushed back.[263] When the United States imposed unilateral controls on semiconductor manufacturing equipment in 2022, its allies hesitated to comply.[264] In the months that followed, U.S. controls barred U.S. firms from selling to China while Dutch and Japanese companies delivered the same products to China in record quantities, anticipating future restrictions.[265]

It was not until the United States applied pressure that these companies stopped gaining market share at the United States' expense.[266] Although Japan and the Netherlands eventually implemented similar controls, Chinese firms like Huawei and SMIC—major Chinese semiconductor foundries—had already acquired large amounts of semiconductor manufacturing equipment, and they now use these machines to produce their own semiconductors.[267] Without international collaboration, unilateral export controls do little to limit the proliferation of emerging technologies, such as AI semiconductors in competitor economies.[268]

Many of the United States' Asian allies, such as South Korea, Japan, and Taiwan, have historic trading relationships with China.[269] South Korea is the world's second-largest exporter of semiconductor products after the United States.[270] Japan and the Netherlands both have lynchpin semiconductor industries, and they also sell semiconductor manufacturing machines to China.[271] When U.S. export controls undermine allied interests or challenge established trade relationships, the economic costs of allyship can outweigh the benefits of continued cooperation with the United States.[272] Allies may,

---

262. *See* EXPORT COMPLIANCE TRAINING INSTITUTE, *supra* note 209; Allen, *supra* note 123.

263 Nisarg Jani, *The 'Fab 4' Allies Are Pushing Back on US Export Controls on China*, DIPLOMAT (Oct. 29, 2024), https://thediplomat.com/2024/10/the-fab-4-allies-are-pushing-back-on-us-export-controls-on-china [https://perma.cc/FJ32-BS9F].

264. Schleich & Denamiel, *supra* note 213.

265. *Id.*

266. *Id.*

267. *Id.*

268. *Id.*

269. *See* André Brunel, *A Proposal for a Semiconductor Export Control Treaty*, 19 J. BUS. & TECH. L. 1, 25 (2023).

270. Ezell, *supra* note 234.

271. Shivakumar et al., *supra* note 64.

272. *See* Jani, *supra* note 263.

instead, prefer to step into the United States' vacated market position, increasing their market share at the United States' expense.[273] As the SIA noted, "companies not affected by U.S. export controls are . . . able to use that income for research and development to out-compete those companies affected by the unilateral controls. They are also delivering to the restricted country or end-user the exact technology the U.S. has intended to restrict, undermining the national security objectives the U.S. government set out to achieve."[274]

Semiconductor export controls remain effective if adversaries cannot obtain comparable technology elsewhere.[275] This requires the United States and its allies to adhere to unilateral American export controls—controls subject to complicated catch-all rules and FDPR.[276] Export controls will be ineffective if allies fail to maintain a united front or if they fail to prevent black market chip sales.[277]

Finally, export controls will be ineffective if adversary countries can rely on expanding Chinese markets that create comparable and inexpensive semiconductor products.[278] The Chinese government has responded to recent U.S. export controls by pouring money into export-limited sectors.[279] Reports show that China has invested billions in state-backed chipmaking entities.[280] If the Chinese find ways to accelerate the development of their own domestic alternatives, they will be able to capitalize on the United States' self-imposed ban and fill the United States' vacated market position.[281] Semiconductor export controls can therefore propel Chinese innovation and advancement at the expense of American firms, who lose substantial sales from China, one of the world's largest semiconductor customers.

273. Semiconductor Industry Assoc., *Comments of the Semiconductor Industry Association on The Interim Final Rule Entitled "Additional Export Controls: Certain Advanced Computing and Semiconductor Manufacturing Items; Supercomputer and Semiconductor End Use, Entity List Modification"*, SEMICONDUCTOR INDUS. ASSOC. 1, 6 (2023), https://www.semiconductors.org/wp-content/uploads/2024/07/SIA-Comments-to-BIS-on-October-2022-IFR.pdf [https://perma.cc/P9J2-26A6].

274. *Id.*

275. Brunel, *supra* note 269, at 25–26.

276. *See* Schleich & Denamiel, *supra* note 213.

277. John Villasenor, *The Tension Between AI Export Control and U.S. AI Innovation*, BROOKINGS INST. (Sep. 24, 2024), https://www.brookings.edu/Articles/the-tension-between-ai-export-control-and-u-s-ai-innovation/ [https://perma.cc/TVB7-GRBX].

278. Flynn, *supra* note 235, at 8.

279. *See* Shivakumar et al., *supra* note 64.

280. *Id.*

281. *See* Gupta et al., *supra* note 246.

There are multiple historic examples where American exports reinforce Chinese innovation and market dominance. In 2016, export controls prevented Intel from shipping Xeon processors to China for use in the Sunway TaihuLight supercomputer.[282] China later locally designed Sunway SW26010 processors, which they used as a substitute.[283] The TaihuLight supercomputer was the fastest supercomputer for two years.[284] Here, export controls forced Chinese companies to design around the control and, as a result, accelerated Chinese innovation.

Given China's decade-long innovation focus on computing technologies, even if export controls on tangible technologies have short-term benefits in stemming Chinese production, they may not have long-term use cases. Peter Wennick, CEO of ASML, a Dutch semiconductor lithography firm, said in 2021 "if you shut out the Chinese with export control measures, you'll force them to strive toward tech sovereignty, in their case real tech sovereignty . . . In 15 years' time, they'll be able to do it all by themselves—and [Western equipment suppliers'] market . . . will be gone."[285] Tudor Brown, former director at Semiconductor Manufacturing International Corporation (SMIC), concurred, stating that semiconductor controls "will slow [China] down for two to five years, not 10."[286]

In sum, U.S. semiconductor controls constrain China, but they also risk harming American and allied semiconductor companies. Among the allied nations that comply with export controls to China, any country that breaks ranks stands to benefit significantly.[287] Alternatively, even if all allies remain united, China can innovate around the issue and gain market share at the expense of those countries constrained by shared agreements.[288] Thus, overly restrictive semiconductor export controls can backfire.

282. Flynn, *supra* note 235, at 8.

283. *Id.*

284. *Id.*

285. Sujai Shivakumar, Charles Wessner & Thomas Howell, *A Seismic Shift: The New U.S. Semiconductor Export Controls and the Implications for U.S. Firms, Allies, and the Innovation Ecosystem*, CTR. FOR STRATEGIC & INT'L. STUDS. (Nov. 14, 2022), https://www.csis.org/analysis/seismic-shift-new-us-semiconductor-export-controls-and-implications-us-firms-allies-and [https://perma.cc/V7QD-K4XY].

286. *Id.*

287. *See* discussion *supra* Section IV.A.

288. *Id.*

2. *Under Section 4817(a)(2)(B), Export Controls for AI Software Have Limited Effectiveness*

Section IV.A.2 applies § 4817(a)(2)(B) to AI software. To date, there are few AI software controls. BIS has imposed a list-based software control for "Deep Convolutional Neural Network[s] [that] automate geospatial imagery and point cloud analysis."[289] On January 13, 2025, BIS announced new export controls on advanced closed-weight AI models.[290] Even in these narrow cases, BIS imposes controls only when the software meets highly specific functional criteria.[291] Nevertheless, it appears that the United States is moving toward stricter AI software controls, and regulators should evaluate further controls under § 4817(a)(2)(B)'s three-prong balancing test.

a) Export Controls Must Consider the Development of AI Software in Foreign Countries

Section 4817(a)(2)(B)(i) requires the United States to consider the development of AI software in foreign countries before imposing export controls.[292] AI software poses unique challenges for export controls because many AI models are open-source, intangible, and globally accessible, which inherently circumvent control mechanisms. Export controls are ineffective for open-source models where data is, by definition, freely shared.[293] The very open-source, intangible nature of many models makes AI development from these models available to both allies and adversaries.[294]

Open-weight and closed-source models are likewise difficult to control. Competitors can reverse engineer open-weight models.[295] Closed-weight code is subject to theft.[296] Unlike nuclear or other weapons systems, software cannot be counted and inventoried—software is information that can be copied, retrained, and easily appropriated by competitor countries and black market smugglers.[297] Export controls for these types of models may not entirely stem the flow of information to foreign countries; instead, they focus on fining

289. LeBeau & Seymour, *supra* note 20.

290. Shenai et al., *supra* note 20.

291. *See supra* note 20.

292. 50 U.S.C. § 4817(a)(2)(B)(i).

293. Claudia Wilson & Emmie Hine, *Export Controls on Open-Source Models Will Not Win the AI Race*, JUST SEC. (Feb. 25, 2025), https://www.justsecurity.org/108144/blanket-bans-software-exports-not-solution-ai-arms-race [https://perma.cc/4248-Z5HA].

294. *Id.*

295. *See* discussion *supra* Section II.A.4.

296. *Id.*

297. Eric Schmidt, *AI, Great Power Competition & National Security*, 151 J. AM. ACAD. ARTS & SCIS.: DÆDALUS 288, 295 (2022), https://www.amacad.org/publication/daedalus/ai-great-power-competition-national-security [https://doi.org/10.1162/daed_a_01916].

American companies, shifting the policing burden to these American companies.[298]

The reality is that countries around the world prioritize AI development.[299] Currently, most—but not all—of them are American allies.[300] As AI offerings become more internationally pervasive, these AI products will also become more difficult to track and enforce.

b) Export Controls Must Consider the Effects of Such Controls on AI Software Development in the United States

Just as with hardware, ECRA requires regulators to consider how AI software controls affect domestic AI development.[301] Export controls might, as some policymakers believe, buy time for lagging domestic capabilities to improve.[302] Proponents of these policies, however, fail to recognize that AI development in the United States is interconnected with international and open-source research.[303]

American AI benefits from international collaboration.[304] U.S. companies have built popular and expansive open-source libraries for general-purpose AI software.[305] These open-source ecosystems advance U.S. economic interests while also fostering communities of like-minded experimenters whose contributions further fuel American AI innovation.[306] Export controls risk damaging this ecosystem, undermining the United States' ability to develop, disseminate, control, and profit from its open-source and open-weight AI.[307]

The United States is currently the world's undisputed leader in AI research and draws talent from around the world.[308] Researchers regularly share information and code with international colleagues, but export controls limit

---

298. *See* discussion *supra* Sections II.A.4, III.D.

299. *See* Stanford HAI Staff, *Global AI Power Rankings: Stanford HAI Tool Ranks 36 Countries in AI*, STAN. U.: HUMAN-CENTERED A.I. (Nov. 21, 2024), https://hai.stanford.edu/news/global-ai-power-rankings-stanford-hai-tool-ranks-36-countries-in-ai [https://perma.cc/L6HC-C4T9].

300. *Id.*

301. 50 U.S.C. § 4817(a)(2)(B)(ii).

302. Allen, *supra* note 123.

303. Flynn, *supra* note 235, at 4.

304. Clara Boothby & Benjamin Schneider, *International Collaboration in Selected Critical and Emerging Fields: COVID-19 and Artificial Intelligence*, NAT'L. CTR. FOR SCI. & ENG'G STATS. (Apr. 11, 2024), https://ncses.nsf.gov/pubs/nsf24323 [https://perma.cc/YYE6-PVJ8].

305. Yujian Tang, *23 Open Source AI Libraries for 2023*, MEDIUM (May 11, 2023), https://medium.com/plain-simple-software/23-open-source-ai-libraries-for-2023-6d697010d3e7 [https://perma.cc/A4RW-E998].

306. Flynn, *supra* note 235, at 4.

307. *Id.*

308. *See* Schmidt, *supra* note 297, at 291.

this type of collaboration; foreign researchers are subject to catch-all rules on "deemed exports."[309] Deemed exports restrict the information and software code that U.S. researchers can share with non-U.S. colleagues that are working on the same AI projects.[310] In AI companies, where research is shared between employees to improve algorithmic outcomes and prevent bias, export controls prevent hiring and retaining diverse, foreign candidates.[311]

Finally, as with AI hardware, export controls on AI software can reduce international sales that facilitate AI innovation and research.[312] Most American AI investment comes from private companies that fund research through product sales (and investors).[313] Export controls can trigger a "death spiral" for U.S. firms, reducing competitiveness and revenue, which in turn curtails R&D investment and further slows competitiveness and revenue.[314] Export controls could harm U.S. innovation while China, ranked second in AI development, leaps ahead.[315]

c) Export Controls Must Consider the Effectiveness of Such Controls in Limiting the Proliferation of AI Software in Foreign Countries

Controls for AI software must also consider the effectiveness of limiting the proliferation of AI weapons.[316] As discussed, *supra*, in Section IV.A.2.a, the use of open-source code in many proprietary AI products makes export regulation inherently difficult.[317] Government-imposed catch-all controls also apply.[318] Firms whose AI software is used by prohibited end-users for prohibited end-uses are still subject to U.S. export penalties.[319] BIS may be able to rely on existing catch-all controls to achieve this objective.

It is important to tailor export controls to prioritize specific goals while recognizing export controls' inherent limitations. Adversaries need not have the most advanced AI to do damage—just as commercially available fertilizer

309. 15 C.F.R. § 734.13; BATEMAN, *supra* note 18, at 20.
310. 15 C.F.R. § 734.13; *see* Villasenor, *supra* note 277.
311. BATEMAN, *supra* note 18, at 20.
312. Flynn, *supra* note 235, at 4.
313. *See* Gupta et al., *supra* note 246.
314. Reuters, *California Democrats Fear US Tech Firm "Death Spiral" With More China Curbs*, REUTERS (Aug. 14, 2024), https://www.reuters.com/technology/california-democrats-fear-us-tech-firm-death-spiral-with-more-china-curbs-2024-08-14/ [https://perma.cc/7XUH-PYQZ].
315. *See* Flynn, *supra* note 235, at 5; Gupta et al., *supra* note 246.
316. 50 U.S.C. § 4817(a)(2)(B)(iii).
317. *See* discussion *supra* Section IV.A.2a).
318. *See* discussion *supra* Section III.D.
319. *Id.*

is an ingredient for explosives, relatively basic AI software, combined with other readily available commercial technologies, can wreak havoc.[320] Export controls, here, would be ineffective because foreign offerings can likely supply these ingredients.[321] Instead, the United States should dominate the market for these basic technologies, keeping these technologies open-weight to achieve widespread global adoption of these American products to increase American market share.[322] However, for AI that can be used in high-level warfighting strategy, or for highly technical AI breakthroughs unlikely to be found outside of the United States, the United States may still want to regulate its proprietary IP.[323] The United States must assess the advancement of comparative AI software through every angle to determine whether the control will undermine U.S. innovation and market superiority.[324]

Therefore, although most AI software controls are likely ineffective most of the time, they can still provide an overarching policy that prevents the sale of exceedingly complex, niche, and closed-source AI, such as deep convolutional neural networks for geospatial imagery.[325] Indeed, BIS's new rules pertaining to closed-weight AI models appear to support this sentiment.[326] Policymakers should continue to consider AI controls on a case-by-case basis.

3. *DeepSeek is an Ongoing Case Study on the Efficacy of AI Export Controls*

In January 2025, Chinese AI company DeepSeek released "r1," a large language model that appears to match or surpass U.S. equivalents.[327] Alongside its main language model, DeepSeek released smaller distillations that perform much of the same work as top U.S. models at a fraction of the price.[328]

---

320. *See supra* note 65. Low-cost kamikaze drones, which used readily available drones outfitted with basic AI, operate in networks of drone swarms that identify targets and map terrain with relatively little human input.

321. Ukraine sources its drone swarms through domestic production, the UK, and Latvia, among other international sources.

322. Christina Knight, *Why U.S. Leadership in AI Necessitates Global Collaboration*, LAWFARE (Apr. 2, 2025), https://www.lawfaremedia.org/article/why-u.s.-leadership-in-ai-necessitates-global-collaboration [https://perma.cc/83ZX-UUVR].

323. *See supra* note 20.

324. *See* Knight, *supra* note 322.

325. *See* Flynn, *supra* note 235, at 6; LeBeau & Seymour, *supra* note 20.

326. *See supra* note 20.

327. Dean W. Ball, *What DeepSeek r1 Means—And What It Doesn't*, LAWFARE (Jan. 28, 2025), https://www.lawfaremedia.org/article/what-deepseek-r1-means-and-what-it-doesn-t [https://perma.cc/6ZXM-ZLN5].

328. *Id.*

In response to DeepSeek's announcement, Nvidia (an American company that currently owns between 70 to 95 percent of the global GPU market[329]) experienced an immediate stock selloff, losing nearly $600 billion in market capitalization.[330] After the October 2022 Semiconductor Controls, the U.S government restricted exports of Nvidia's most powerful GPUs (A100 and H100s) to China.[331] As a workaround, Nvidia introduced modified, lower-performance versions of these chips (A800, H800, and H20) specifically for sale in Chinese markets.[332] Despite these limitations, DeepSeek achieved equivalent performance (compared with leading U.S. models) on lower-performance GPUs, triggering the kneejerk stock selloff.[333] This ongoing case study raises two main questions: (1) why, after two and a half years of AI hardware export controls, Chinese companies are able to remain on par with American counterparts, and (2) whether American export controls have in fact spurred Chinese innovation.

On the one hand, it may take more time for the effects of U.S.-imposed AI hardware controls to become apparent. Prior to the October 2022 Semiconductor Controls, DeepSeek acquired a cache of A100 chips from Nvidia.[334] DeepSeek also had access to H800 chips and H100 chips.[335] If the export controls were too little and too late, stricter controls could resource-constrain future Chinese developments. DeepSeek openly acknowledges that its primary obstacle is low computing power caused by U.S. export controls.[336] Assuming companies like Huawei cannot replicate advanced GPUs, continued American efforts to throttle China's computing power, even for a short period, could translate into a durable lead for the United States.[337]

On the other hand, scarcity and necessity fuel innovation. DeepSeek's detailed white papers, which are well-regarded by the scientific community,

329. Kif Leswing, *Nvidia Dominates the AI Chip Market, But There's More Competition Than Ever*, CNBC (June 2, 2024), https://www.cnbc.com/2024/06/02/nvidia-dominates-the-ai-chip-market-but-theres-rising-competition-.html [https://perma.cc/EN8H-PLG8].

330. *Id.*; Steve Kopack, *Nvidia Loses Nearly $600 Billion in Market Value After Chinese AI Startup Bursts Onto Scene*, NBC NEWS (Jan. 27, 2025), https://finance.yahoo.com/news/nvidia-loses-more-500-billion-193121486.html [https://perma.cc/UT9B-FSSY].

331. Dylan Patel, AJ Kourabi, Doug O'Laughlin & Reyk Knuhtsen, *DeepSeek Debates: Chinese Leadership on Cost, True Training Cost, Closed Model Margin Impacts*, SEMIANALYSIS (Jan. 31, 2025), https://semianalysis.com/2025/01/31/deepseek-debates [https://perma.cc/CA69-S7Q8].

332. *Id.*

333. Ball, *supra* note 327.

334. Patel et al., *supra* note 331.

335. Ball, *supra* note 327; Patel et al., *supra* note 331.

336. Ball, *supra* note 327; Patel et al., *supra* note 331.

337. Dario Amodei, *On DeepSeek and Export Controls*, DARIO AMODEI (Jan. 2025), https://darioamodei.com/on-deepseek-and-export-controls [https://perma.cc/D7AZ-H2HN].

demonstrate that it has created a cutting-edge AI that uses less money and less computing power, despite U.S.-imposed limitations.[338] DeepSeek's computational advancements establish China as more than just an imitator—China is emerging as an innovator that has improved AI efficiency.[339] DeepSeek's ability to acquire A100 and H100 chips also proves that so long as alternative product streams exist, whether via other countries, the black market, or even pre-export control caches, such streams will continue to undermine U.S. export controls.

Finally, DeepSeek's rise raises questions about the American AI strategy. DeepSeek is an open-weight AI model that developed proprietary code from an open-source foundation.[340] In contrast, American AI firms have, in recent years, shifted toward closed-source, proprietary models to safeguard IP and maintain technological advances.[341] DeepSeek's open-weight approach not only democratizes AI advancement, permitting researchers from around the world to reverse engineer DeepSeek's contributions, but also establishes DeepSeek as a cost-effective, reliable, and transparent alternative to American offerings, whose low cost and availability may prove advantageous in global markets.[342] Because r1's open-weight structure allows companies to run it on their own GPU clusters, organizations can process data locally without sending their inputs to third-party AI companies.[343] Thus, DeepSeek's choice to open its weights may be a tactical move to have a stronger competitive edge against closed-weight American AI labs, thereby giving DeepSeek greater reach in global markets.[344] This may be useful for companies that want to keep their inputs private, such as medical companies that store sensitive information.

In sum, as DeepSeek has acknowledged, U.S. export controls tangibly limit Chinese computing power and may, in time, prove effective.[345] However, Chinese companies have time and again actively and successfully innovated around U.S. controls.[346] Export controls are predicated on U.S. superiority—they matter only when the United States has something worthy of protecting. If open-source algorithms can achieve comparable, if not superior, results compared to closed-source models, the United States faces a critical question:

338. Ball, *supra* note 327.
339. Amodei, *supra* note 337.
340. Ball, *supra* note 327.
341. *Id.*
342. *See supra* note 83 and accompanying text.
343. *See* Kolluru, *supra* note 80; Miller, *supra* note 76; Weil, *supra* note 82.
344. *See* Ball, *supra* note 327.
345. *See* Ball, *supra* note 327; Patel et al., *supra* note 331.
346. *See* discussion *supra* Section IV.A.1.

(1) whether the U.S. government can realistically control AI, and (2) if not, whether American hubris will lead to its decline.

B. AI EXPORT CONTROLS MUST BE NARROWLY WRITTEN AND SUBJECT TO BALANCING CONSIDERATIONS

Weakness and strength are relative in interconnected markets. An action intended to weaken another country may weaken the initiating country more, ultimately leading to the relative strength of the second. U.S. efforts to gain technological supremacy could trigger a cycle of diminishing economic leverage.[347] As the United States contemplates its appropriate role in world governance, it must consider whether excessive intervention in the fickle global ecosystem could lead to outsized and negative consequences. If China outmaneuvers the United States in the global technology race, it will establish a digital foundation on which to challenge the U.S.-led geopolitical order on both military and economic grounds.[348] This scenario could become reality if the United States loses market dominance through overly strict export policies that destroy its current sales relationships.

Based on the § 4817(a)(2)(B) three-prong test, U.S. regulators can draw a few conclusions. First, list-based export controls for commercial AI may be counterproductive if the controls are overly broad and apply a one-size-fits-all approach.[349] AI is a multi-domain product with multiple applications across different industries, varying levels of complexity, and diverse IP structures.[350] Broad AI export controls may disqualify U.S. companies from selling commercially desirable products and could prove difficult to enforce. They can restrict U.S. businesses, prevent foreign innovation and investment in the United States, and prevent foreign sales of U.S. products.[351] Export controls that prevent commercial sales not only reduce revenue, but also restrain companies from controlling the market for that product.[352] Such controls therefore have a negative impact on national security.

Broad catch-all controls can transform reasonable restrictions into detrimental ones. Far-reaching catch-all controls on broad swaths of AI products can disincentivize foreign companies from buying and using such products in their supply chains.[353] Products subject to broad catch-all controls carry with them the stink of current or future restrictions, creating a myriad of

347. *See* discussion *supra* Sections III.B, III.D, IV.A.
348. Schmidt, *supra* note 297, at 296.
349. Flynn, *supra* note 235, at 4–5.
350. *See* discussion *supra* Sections II.A.2, II.A.3, II.A.4.
351. *See* discussion *supra* Section IV.A.
352. *See* Knight, *supra* note 322.
353. *See* Jani, *supra* note 263; Schleich & Denamiel, *supra* note 213.

second- and third-order effects—considerations that require extensive rule parsing by global legal teams and affect the size of the product's end market.[354] Overly strict controls can also alienate allies, who in turn undermine U.S. priorities.[355] Therefore, narrow controls for specific AI products, subject to narrowly applied catch-all controls, is good policy.

List-based controls for AI should be narrowly written, have short-term goals, and be limited only to those sectors where the technology's military uses outweigh its civilian uses. A good example of this is geospatial analysis AI—AI that uses satellite imagery combined with deep neural networks to create insights about the locations of certain targets, presumably anywhere in the world, and can tell an adversary where a U.S. military asset is at any place and time.[356] Imagine if such an AI were combined with a long-range missile system to identify and neutralize high-value targets in real-time: there would be nowhere in the world left to hide. Even if there were an equivalent civilian use-case for such technology, it would pale in comparison to its military applications. Here, a narrowly written export control for this specific technology limits foreign access to a highly dangerous, technical, and exclusive AI; it is reasonably likely that an export control can limit the proliferation of this technology, moreover, the reasons for nonproliferation outweigh the benefits of widespread commercial sales.

All AI export controls should be assessed for effectiveness before enactment. The success of list-based controls hinges on two main factors: (1) securing foreign cooperation and enforcement mechanisms in an interdependent, global economy,[357] and (2) preventing adversaries from accessing alternative supply chains, stealing IP, or developing comparable AI products.[358] The former requires the United States to negotiate plurilateral agreements, which is generally feasible.[359] The latter is difficult to execute,

354. *See* discussion *supra* Section III.D.

355. *See* discussion *supra* Section III.D.

356. *AI for GIS: Unlocking New Possibilities in Geospatial Analysis*, PRIUS INTELLI (Sep. 8, 2023), https://priusintelli.com/ai-for-gis-unlocking-new-possibilities-in-geospatial-analysis [https://perma.cc/UD38-3L3H].

357. *See* discussion *supra* Sections IV.A.1, IV.A.2.

358. *See* Shivakumar et al., *supra* note 64.

359. *See* Peter L. Flanagan, Kimberly A. Strosnider, Peter Lichtenbaum, Eric Carlson, Stephen Rademaker, Corinne A. Goldstein, Eric Sandberg-Zakian, Stephen C. Bartenstein, Joshua N. Willians, A. Seth Atkisson & Lisa Ann Johnson, *U.S. Implements Plurilateral Export Controls Framework and Additional Controls on Semiconductor, Quantum, and Additive Manufacturing Items*, COVINGTON & BURLING (Sep. 9, 2024), https://www.cov.com/en/news-and-insights/insights/2024/09/us-implements-plurilateral-export-controls-framework-and-additional-controls [https://perma.cc/M9TH-5934].

especially for intangible strings of software code that can be copied and redistributed.[360]

If these two factors weigh against export controls—i.e., allies are unwilling to comply with catch-all controls and FDPR, or competitors have a high likelihood of innovating around the control, or otherwise circumventing the control via the black market—the United States should consider whether the export control will affect U.S. market share.[361] If the control affects market share, the second and third order effects of lost market share might be unreasonably detrimental to U.S. innovation and R&D.[362] Where export controls are unlikely to be effective and may even prove to be dangerous—typically because the controlled item has become widely available—the United States should reverse course and seek to dominate the market for that product. In this situation, export controls are no longer preventing proliferation—it has happened. When nonproliferation is no longer a balancing consideration, then market dominance is the only remaining option.[363] Market clout, used as leverage in economic statecraft, becomes the last line of defense.[364] Here, the United States should seek to control the availability of the product, not by preventing sales, but by encouraging sales, dominating the market, and then controlling those products that enter the market.

For AI software products, regulators should consider additional factors, such as the extent to which closed-source, proprietary AI can be replicated with open-source options.[365] Controls should also consider human capital in areas that conduct AI research, for example, the percentage of AI engineers who are dual-citizens or on work visas, who may be considered "deemed exports."[366] If, on balance, these considerations weigh against stricter list-based controls, the government should redirect its focus on relationship building between AI companies and the Department of Defense, focusing on deterrence—via economic statecraft—over nonproliferation.

If the United States chooses to pursue a short-term export control on a particular item to stem adversary innovation while creating domestic "breathing room," it must couple these controls with an achievable, benchmark-oriented domestic innovation strategy that revitalizes U.S. productivity in critical areas.[367] For example, the CHIPS and Science Act

360. *See* discussion *supra* Sections II.A.4, IV.A.2a).
361. *See* Shivakumar et al., *supra* note 64.
362. *See* discussion *supra* Sections IV.A.1, IV.A.2.
363. *See* discussion *supra* Section III.B.
364. *See* Chivvis & Kapstein, *supra* note 176.
365. *See* discussion *supra* Section IV.A.2.
366. *See* discussion *supra* Section IV.A.2; 15 C.F.R. § 734.12.
367. *See* Schmidt, *supra* note 297, at 296.

complemented the October 2022 Semiconductor Controls to fund U.S.-based semiconductor manufacturing.[368] It remains to be seen whether the CHIPS Act will prove effective; nevertheless, other AI export controls should have similar push-pull levers. Because export controls are often a double-edged sword, they must be tailored for specific outcomes.[369] Any attempts to restrict foreign development, at the expense of U.S. companies, should include equally tailored R&D incentive structures to catalyze domestic military and economic capacities.[370] In other words, using export controls to stall overseas AI development must have the effect of a well-placed timeout used to call a game-winning play. Failure to adequately leverage the temporary pause created by export controls will only prolong domestic mediocrity, while previously successful U.S. companies lose market share.[371]

In the long term, U.S. export controls and sanctions are unlikely to cripple Chinese innovation and may, in fact, accelerate it.[372] Self-imposed trade embargos create opportunities for Chinese market expansion.[373] When American export controls inadvertently accelerate Chinese innovation in disputed fields, they not only trigger deeper geopolitical tensions but also further decouple the two nations' economies.[374] Successful Chinese innovations could escalate the ongoing AI race by reducing both countries' economic bargaining leverage.[375] This may push the United States and China toward militarized, rather than economic, use of force to settle conflict.[376] Regardless of which country started the cycle of economic decoupling and who is more at fault, U.S. policymakers must consider whether export controls drive both countries closer to heightened conflict.

C. REGULATORS SHOULD CONTINUE TO CONSIDER AI EXPORT CONTROLS UNDER ECRA

Even though the U.S. export control regime has its share of shortfalls, policymakers have struggled to find better alternatives. Historically, export law

368. *See* Kannan & Feldgoise, *supra* note 252.

369. *See* discussion *supra* Section IV.A.

370. *See* Cindy Levy, Matt Watters, Shubham Singhal, Bryce Bittner, Isabella Bennett & Doron Hindin, *Restricted: How Export Controls Are Reshaping Markets*, MCKINSEY & CO. (Apr. 3, 2025), https://www.mckinsey.com/capabilities/geopolitics/our-insights/restricted-how-export-controls-are-reshaping-markets [https://perma.cc/2DYY-MQLQ]; Badlam et al., *supra* note 252.

371. *See* discussion *supra* Section IV.A.1c).

372. *See* discussion *supra* Section IV.A.1.

373. *See* discussion *supra* Section IV.A.1.

374. BATEMAN, *supra* note 18, at 50–52.

375. *Id.*

376. *Id.* at 57–60.

has managed great power relationships by using ex ante nonproliferation principles to complement military deterrence.[377] However, proactive and ex ante controls are speculative, unrealistic, and can cause outsized economic harm.[378] Reactive, ex post controls arrive too late, after disaster has struck.[379] Dual-use technologies do not fit cleanly under traditional nonproliferation concepts because they carry economic consequences that preclude harsh nonproliferation measures; simultaneously, dual-use technologies have destructive wartime applications.[380]

Dual-use technologies must account not only for the militaristic elements in a country's national security posture but also for the role economic statecraft plays in regional stability.[381] ECRA expanded upon previous export laws, increasing government control of commercial products for national security reasons.[382] However, ECRA is neither fully military nor fully commercial.[383] Instead, ECRA balances economic and military nonproliferation factors, requiring policymakers to continuously weigh the effectiveness and validity of export decisions.[384] This tricky middle ground between "avoiding protectionism and compromising national security"[385] means that ECRA must choose the lesser evil while appeasing no one.

Export controls, in some form or another, must exist to provide centralized frameworks that curtail risky, profit-driven business practices. ECRA, EAR, and other parts of the U.S. export regime create a framework under which businesses can align their common export practices and avoid ambiguity.[386] Catch-all controls, although painful for companies and foreign allies alike, are decentralizing controls that shift enforcement responsibilities to companies, by providing a framework under which companies must understand their market and self-police.[387] Catch-all controls allow the

377. Hosuk Lee-Makiyama & Badri Narayanan Gopalakrishnan, *Economic Costs of Ex Ante Regulations*, EUR. CTR. FOR INT'L. POL. ECON. (Oct. 2020), https://ecipe.org/publications/ex-ante/ [https://perma.cc/26GA-JQQ2].

378. *See* discussion *supra* Sections II.B, IV.A.

379. CFI Team, *Ex-Ante vs. Ex-Post*, CORP. FIN. INST., https://corporatefinanceinstitute.com/resources/equities/ex-ante-vs-ex-post/ [https://perma.cc/VW2L-6Q58] (last visited Feb. 22, 2025).

380. *See* discussion *supra* Sections IV.A.1, IV.A.2, IV.B.

381. *See* discussion *supra* Sections III.B, III.C.

382. *See* discussion *supra* Section III.

383. *Id.*

384. *Id.*

385. Maria Shagina, *The Role of Export Controls in Managing Emerging Technology*, *in* THE IMPLICATIONS OF EMERGING TECHNOLOGIES IN THE EURO-ATLANTIC SPACE 57, 58 (Julia Berghofer et al. eds., 2023).

386. *See* discussion *supra* Section III.

387. *See* discussion *supra* Section III.D.

government to provide a centralized command option while deferring to companies' decentralized control.[388] Because evolving technologies are difficult to capture on control lists, controls that regulate an activity, rather than a product, are better for AI, which often changes form and function.[389]

Even though ECRA's balancing test currently shows that most AI should not be expressly regulated, regulators should continue considering AI controls under ECRA's framework, particularly for dangerous or destabilizing commercial AI. ECRA's limitations stem not from shortfalls in the law but from uncertainties in AI.[390] On a case-by-case basis, with deference to ECRA's balancing factors, narrowly crafted AI regulations may not only be reasonable, but also justified. Conversely, in many cases, existing government authorities sufficiently address AI risks, and examining existing laws can save time, reduce costs, and avert regulatory overreach.[391] Regulations not on AI itself, but on adjacent technology might bypass broad AI regulations while still achieving the same objectives.

V. CONCLUSION

The United States currently leads the world in AI innovation because it has some of the best technical talent, a good reputation in global markets, and a flourishing and decentralized open-source software ecosystem that fosters experimentation. However, export controls risk driving away domestic talent, preventing international research-sharing, and damaging revenue streams that fuel the United States' R&D investment. ECRA authorizes broad and far-reaching controls that fully encompass AI, but these controls are subject to balancing factors that consider potential export harms. Based on these considerations, BIS has enacted AI regulations sparingly. Future AI regulations should continue to balance potential economic and military risks.

Looming in the background is the great power competition between the United States and China. Focused decoupling in certain sectors may reduce unacceptable vulnerabilities, curb IP theft, and limit the development of unconstrained and destructive military capabilities.[392] Extensive regulations, however, can harm U.S. development while further deepening tensions,

388. *See* Clint Hinote, *Centralized Control and Decentralized Execution: A Catchphrase in Crisis?*, AIR FORCE RSCH. INST. 1, 13–18 (Mar. 2009), https://media.defense.gov/2017/Jun/19/2001764937/-1/-1/0/AP_0006_HINOTE_CENTRALIZED_CONTROL_DECENTRALIZED_EXECUTION.PDF [https://perma.cc/M9P5-2VY4].

389. *See* discussion *supra* Section III.D.2.

390. *See* discussion *supra* Section IV.A.

391. Weinstein & Wolf, *supra* note 184.

392. Schmidt, *supra* note 297, at 296.

drawing both countries toward a near-peer conflict between two highly technical militaries. Failure to correctly navigate these controls in either direction could tip the international community into a global conflict of catastrophic proportions.