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Modeling Economic Warfare Between China and the West **Over Taiwan**

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Introduction

Tensions in Asia have risen over the past few years as China has become more bellicose toward its neighbors. Nowhere have relations been more strained than across the Taiwan Strait. Speculation has grown with regards to China's plan to invade Taiwan.[1] General Secretary Xi Jinping has explicitly linked his vision of "great rejuvenation of the Chinese nation" to China's "reunification" with the self-governing island of Taiwan.[2] Meanwhile, U.S. intelligence assessments suggest that Xi has instructed his military to be "ready" for a kinetic conflict by 2027[3]. In Washington, there is strong bipartisan consensus on the need to deter Beijing from aggression using the full spectrum of U.S. military, diplomatic, and geoeconomic tools. This has raised questions about the extent to which the U.S. would go to sanction China. Western coercive economic measures against Russia offer one template. But China's centrality to global supply chains and deep interconnectedness to every sector of the U.S. economy makes it a far more complex target.

In this project, we seek to model geoeconomic warfare between the U.S. and China over Taiwan. The project proceeds in six phases:

1. First, we examine the theory of economic statecraft, drawing mainly from Schelling's ideas on coercion theory and Farrell and Newman's work on weaponized interdependence.
2. Next, we review the range of Western sanctions against Russia, analyze Russia's response to them, and examine how lessons drawn from the Russian case may be applied to that of China.
3. Third, we map the economic, financial, and technological interdependencies between the U.S. and China, highlighting specific U.S. and Chinese vulnerabilities that can be leveraged by both sides in a hypothetical geoeconomic game.
4. During a Taiwan contingency, any U.S. or Western sanction on China will depend on the severity and nature of the scenario at hand. As such, in our fourth section, we identify three possible Chinese actions against Taiwan, each scenario varying in severity. Our analysis of U.S.-China geoeconomic warfare will be based on these three different scenarios.
5. Fifth, we develop a logic model for response selection within a geoeconomic game. Our framework examines the intent of sanctions under each scenario and evaluates specific actions that can be employed by each actor. Actions are chosen based on two considerations: (1) their **economic effectiveness** – that is, the asymmetric pain that it can deliver, its speed of implementation, the immediacy of its impact, its scalability, and whether it can be reversed; and (2) their **political feasibility**, which encompasses alliance and domestic politics, concerns

[1]Hope Yen, "CIA chief: China has some doubt on ability to invade Taiwan," accessed March 3, 2023, https://apnews.com/article/russia-ukraine-taiwan-politics-united-states-government-eaf869eb617c6c356b2708607ed15759.
[2] "The Thrid Revolution: Xi Jinping and the New Chinese State," Council on Foregin Relations, accessed March 20, 2023, https://www.cfr.org/excerpt-third-revolution.
[3] Amy Hawkins, "Taiwan foreign minister warns of conflict with China in 2027," accessed May 9, 2023, https://www.theguardian.com/world/2023/apr/21/taiwan-foreign-minister-warns-of-conflict-with-china-in-2027#:~:text=US percent20intelligence percent20believes percent20that percent20Xi,be percent20reunited percent20with percent20the percent20mainland.

about conflict escalation, and enforcement costs. This logic model serves as a "smell test" for selecting sanctions, allowing us to evaluate whether a certain sanction is both effective and desirable for the imposing state.

6. Sixth, applying our map of U.S. and Chinese vulnerabilities as well as our framework for response selection, we conduct a geoeconomic "game" for each of our three scenarios. This exercise generates specific U.S. sanctions and Chinese countermeasures.

Literature on military responses to a Taiwan contingency has grown considerably in the past decade, but few have considered the economic dimensions of a U.S.-China conflict over Taiwan. Our paper adds to the existing literature by exploring how economic tools may be used by both the U.S. and China in the event of a cross-Strait crisis. While this project does not seek to predict or prescribe specific responses, our analysis sheds light on the kind of economic tools that U.S. and Chinese policymakers may use. By mapping the economic interdependencies between the U.S. and China, considering different conflict scenarios, and assessing the economic effectiveness and political feasibility of sanctions, we provide valuable insight into the specific operational and political contexts under which different sanctions could be employed.

Theory

Economic statecraft involves the use of economic means to attain foreign policy ends.[4] This includes the use of instruments such as trade, investment, and sanctions to influence state behavior, promote national security objectives, and advance economic interests without the use of military force. Although states have used economic tools coercively throughout history, the past fifty years have been marked by an unprecedented degree of trade and financial globalization, laying the groundwork for "weaponized interdependence" as well as "asymmetric interdependence."[5] In a bilateral relationship, an actor that is less dependent on the other can make bargaining concessions at a lower cost than the actor that is more dependent.[6] Asymmetric interdependence with some particular stakeholders functioning as "hubs" creates power imbalances where some states are "able to leverage interdependent relations to coerce others."[7] In other words, states that control the "central nodes" in international networks can exploit their power over the flow of goods, money, and information to manipulate economic and information flows, gather information, exploit vulnerabilities, and shape other countries' behaviors. States can gain from weaponized interdependence in two ways: (1) through the panopticon effect, which involves gaining an informational advantage; or (2) the chokepoint effect, which involves cutting off adversaries from network flows.

States can use weaponized interdependence in various ways. The first is through compellence, which uses economic measures to force a target state to change its behavior by creating incentives for a target state to comply with a state's demands. Robert A. Pape defines compellence as "the use of threats and actual economic punishment to persuade an adversary to change its policies."[8] Pape suggests that the success of these measures depends on factors such as the degree of the target state's economic dependence, availability of alternatives, and the resilience of its economy. Successful compellence requires credibility, the demonstration of resolve and ability to follow through on threats. Next, sanctions may be used to deter future actions through threats of retaliation or infliction of costs that limit the target state's ability to act in the future. Unlike compellence, which aims to make an opponent comply to take a certain action, deterrence seeks to prevent an action from being taken. Alternatively, sanctions can be used to degrade the adversary by undermining their capability to fight. This could involve targeting a regime either directly or indirectly, through means like inciting popular pressure to coerce a government to step down. Finally, a sanction can serve as a formal condemnation of unacceptable behavior. Its imposition helps reassert rules and conventions that have been violated. By instituting visa bans and freezing foreign assets, for instance, sanctions penalize those responsible for aggression and censure the violation of norms in hopes that they may be restored.

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[4] David A. Baldwin, "Economic statecraft: New edition," *Princeton University Press*, 2020.
[5]Daniel W. Drezner, Henry Farrell, and Abraham L. Newman, "The uses and abuses of weaponized interdependence," *Brookings Institution Press*, 2021.
[6] Robert O. Keohane, and Joseph S. Nye Jr., "Power and interdependence," *Survival 15*, no. 4 (1973): 158-165.
[7] Henry Farrell, and Abraham L. Newman, "Weaponized interdependence: How global economic networks shape state coercion," *International Security* 44, no. 1 (2019): 42-79.
[8] Robert A. Pape, "Why economic sanctions do not work." *International security* 22, no. 2 (1997): 90-136.

Key Definitions	
Economic Statecraft	The use of economic means to achieve foreign and security policy objectives
Weaponized Interdependence	A condition under which an actor can exploit its position in an embedded network to gain a bargaining advantage over others in a contained system (Farrell and Newman)
Asymmetric Interdependence	An unequal economic relationship that shapes leverage and bargaining power
Chokepoint Effect	The ability to cut off target economies from key financial and informational networks
Panopticon Effect	An information advantage granted by a state's jurisdiction over key networks
Compellence	The use of statecraft to coerce a policy modification from a target state
Degradation	The use of economic statecraft to weaken a target's material capacity to sustain conflict
Condemnation	The use of economic statecraft to punish unacceptable behavior and to uphold international norms

Russia as a Case Study

Western Sanctions Against Russia

Following Russia's full-scale invasion of Ukraine on February 24, 2022, the U.S., along with a coalition of thirty allies and partners, imposed punitive economic sanctions against Russia.[9] These measures amount to an unprecedented economic pressure campaign. In the past, U.S. sanctions targeting Iran and North Korea have employed comparable tools of economic coercion, but these campaigns did not target an economy as large and globally integrated as that of Russia. Western sanctions have sought to isolate Russia from the global financial system, reduce its revenues from energy exports, degrade its ability to wage war in Ukraine, and inflict long-term damage on Russia's growth potential by starving it of key technologies. This section reviews the major actions taken by the U.S. and its allies against Russia since the outbreak of the war, analyzes Russia's response, and details key lessons from the sanctions campaign against Russia that the U.S. may apply to its competition with China.[10]

Financial sanctions

- The U.S., in coordination with the European Union, United Kingdom, Canada, and Japan, blocked the Russian central bank's access to $300 billion in foreign reserves, which accounted for roughly half of Russia's total reserves in 2022.
- The EU, with the support of G7 countries, removed several Russian financial institutions, including Russia's largest bank, Sberbank, from the global financial messaging system SWIFT, severely limiting Russia's ability to process cross-border payments. (Not all Russian banks were removed to allow for continued payments for EU imports of Russian natural gas.)
- The U.S. imposed full blocking sanctions on Russia's financial institutions. This included two of Russia's largest banks, Sberbank and VTB Bank, as well as five other important banks that contribute to 80 percent of bank deposits in Russia. These sanctions made it nearly impossible for Russian financial institutions to process transactions in U.S. dollars. The EU has implemented similar restrictions on non-energy Euro transactions.
- The U.S. and EU also restricted transactions with key Russian corporations. These include: Rostec, a defense and industrial conglomerate; Alrosa, the world's largest diamond-mining company; Severstal and MMK, large steel producers; Skolkovo, a Moscow-based technology park; and dozens of aerospace and defense industrial firms.
- The U.S. prohibited new equity investment and financing to several Russian companies including Gazprom, the state-owned gas company and Russia's largest firm; Sovcomflot, a maritime and freight shipping firm; and Russian Railways.

[9] These efforts significantly expanded upon U.S. and EU sanctions against Russia implemented in 2014, which were in response to Russia's illegal annexation of Crimea and its occupation of the Donetsk and Luhansk regions of eastern Ukraine. For a full account of U.S. sanctions against Russia, see [link], Congressional Research Service.
[10] For a comprehensive list of U.S. and European actions taken since February 2022, see: Cory Welt, "Russia's War Against Ukraine: Overview of U.S. Sanctions and Other Responses," Congressional Research Service, December 20, 2022: https://sgp.fas.org/crs/row/IN11869.pdf

- The U.S. and EU froze the assets of and restricted transactions with Russian officials, including President Vladimir Putin, Prime Minister Mikhail Mishustin, members of Russia's Security Council and Administration (including ministers of foreign affairs, defense, and finance, and heads of the armed forces and central bank), regional governors, Russian Duma members, and dozens of Kremlin-connected business elite (so-called oligarchs).

Trade measures

- The U.S. imposed export controls targeting Russia's defense, aerospace, energy, and maritime sectors. These expand upon "sectoral sanctions" on the Russian energy sector that have been in place since 2014. New restrictions on the transfer of U.S.-origin technologies to Russia now extend to telecommunications and electronics equipment, sensors and lasers, and navigation, avionics, marine, aerospace, and propulsion technologies. The EU, South Korea, Japan, and Canada imposed similar export controls.
- The U.S. also banned the provision of select service exports to Russia such as accounting, management consulting, and quantum computing.
- The U.S. issued an embargo prohibiting Russian imports of crude oil and petroleum products, which had accounted for 8 percent of U.S. fossil fuel imports in 2021.
- On April 8, 2022, the U.S. Congress suspended permanent normal trade relations with Russia.
- Since December 5, 2022, the EU has banned most imports of Russian oil products.

Oil price cap

- In December 2022, the United States, in coordination with the EU, UK, Canada, Japan, and Australia, imposed a price cap of $60/barrel on seaborne exports of crude oil from Russia. The sanctions prohibit the provision of shipping and insurance services to Russian oil shipments bought at prices above $60/barrel. The measure aims to limit revenue earned by the Russian government from oil exports without removing Russian supply from global markets.[11]

Self-sanctioning

- In addition to state-imposed sanctions, more than a thousand U.S. and international companies have curtailed operations in Russia or exited the market altogether, according to data compiled by researchers at the Yale School of Management.[12] Such corporations include Apple, EY, FedEx, Formula One, HarleyDavidson, H&M, John Deere, Lego, Mastercard, Mattel, McDonald's, McKinsey, Netflix, Nike, PayPal, PwC, Rolls Royce, Rolex, Starbucks, TikTok, UPS, Vanguard, and Visa.

Impact and Russia's Response

It is difficult to assess the "success" of Western sanctions on Russia. On the one hand, sanctions have inflicted undeniable pain on Russia. Export restrictions are eroding Russia's industrial base and

[11] "Russia's War on Ukraine: Financial and Trade Sanctions," Congressional Research Service, February 22, 2023: https://crsreports.congress.gov/product/pdf/IF/IF12062
[12] "Over 1000 companies have curtailed operations in Russia," *Yale School of Management,* https://som.yale.edu/story/2022/over-1000-companies-have-curtailed-operations-russia-some-remain

technological potential. Restrictions on certain components have devastated Russia's aviation and auto manufacturing industry, whose output declined by 67 percent in 2022.[13] Although Russia recorded windfall profits of over $800 million per day in 2022 from oil and gas, its highest in a decade, oil revenues declined sharply in Q42022 and have roughly halved in the space of a year, suggesting the price cap is having an effect. As the war drags into its second year, Western economic pressure has begun to restrict Russian federal budget revenues, raising the specter of uncomfortable trade-offs between social support to pensioners and families and defense spending.

On the other hand, sanctions have neither led to a widespread economic collapse in Russia nor persuaded Putin to reverse his policy towards Ukraine. Early projections of a 10 percent GDP contraction in 2022 proved overly pessimistic: Russia's economy contracted by 3 percent in 2022, and the IMF forecasts a return to meager growth of 0.3 percent in 2023. The ruble has stabilized to pre-war levels following a sharp depreciation in the early months of the invasion. Inflation peaked at 18 percent in April but eased to 12 percent in December, 2022. While the long-term prospects of Russia's economy are greatly diminished, Russia's economy has proved surprisingly resilient to Western sanctions in the short-run.

This reflects, in part, the inherent difficulty of using economic tools to target a large and globally integrated economy like that of Russia. But it also hints at the ingenuity of Russian economic policymakers in blunting the worst impacts of sanctions and engineering workarounds to Western export restrictions. Key Russian responses are outlined below:

Currency measures

- In the first weeks of the invasion, Russia's financial institutions were cut off from SWIFT, and it lost access to nearly half of its foreign reserves. A collapse in global demand for the ruble sent Russia's economy into a tailspin. The Russian central bank moved to shore up the ruble by raising interest rates from 9.5 percent to 20 percent and instituted strict capital controls that banned Russian residents from moving foreign currency abroad. Russian corporations earning revenue in foreign currency were required to convert 80 percent of it into rubles.
- Russia has also substantially increased the share of gold and RMB in its foreign reserves. The share of Russian exports paid for in renminbi rose to 14 percent in September 2022 from 0.4 percent before the war.[14]

Energy

- In response to the RePowerEU energy package, which aimed to quickly reduce the EU's reliance on imports of Russian oil and gas, Russia preemptively cut gas exports to Europe and eventually reduced volumes along the Nord Stream 1 pipeline to below 10 percent. These cuts contributed to a painful surge in energy prices in Europe in spring 2022.
- Russia responded to the G7 price cap by assembling a "ghost fleet" of retired, uncredentialed oil tankers without transponders or the insurance typically required of legitimate commercial vessels,

[13] "Fact Sheet: One Year of U.S. Sanctions on Russia and Its Enablers," U.S. Department of Treasury, February 24, 2023: https://home.treasury.gov/news/press-releases/jy1298
[14] "Russia says gold hoard grew as West imposed sanctions," Bloomberg, March 22, 2023: https://www.bloomberg.com/news/articles/2023-03-22/russia-says-gold-stash-grew-during-war-lifting-veil-on-reserves

with the goal of carrying oil to market at prices above the price-cap while still avoiding Western sanctions. The fleet is estimated at 443 ships as of March 2023.[15]

Other trade measures

- Russia leveraged its naval dominance in the Black Sea to blockade Ukrainian grain exports. This reduced Ukraine's revenues and contributed to a sharp increase in global wheat prices. The increase in global wheat prices became a bargaining chip for Moscow in its bilateral relations with much of the developing world, especially those with Egypt and Tunisia.
- In spite of Western export controls, key technologies such as semiconductors and microchips continue to find their way to the Russian market through non-aligned third countries such as Turkey, China, Armenia, and Kazakhstan.[16] Russia has helped obfuscate these trade flows by forming new subsidiary import companies, subsidizing critical war-time technologies (such as semiconductors) at higher prices, and withholding customs and trade data.

Lessons from U.S. Sanctions against Russia

Many lessons can be learned from Western sanctions on Russia and Russia's response to them. Below, we discuss how some of these lessons may be applied to the U.S.'s economic warfare vis-à-vis China:

1. **To deter with sanctions, talk big**. In the months leading up to the invasion, a buildup of Russian forces along its border with Ukraine provoked concern in Washington that Moscow was planning an all-out invasion of Ukraine. In an effort to deter Moscow, policymakers in the U.S. and EU issued public and private warnings to the Kremlin that an invasion would prompt powerful new sanctions on Russia. But the sanctions the West ultimately implemented were significantly stronger than what was expected. American and European measures to freeze Russia's access to its foreign reserves or to remove Russian banks from SWIFT caught Moscow – and the world –off guard. Had the West signaled the full scope and intensity of sanctions it was prepared to implement, it may have been more successful in deterring a Russian invasion. One caveat, however, is that Russia may not have believed that the West would implement such punitive measures against it. Credibility is a key to the success of deterrence.

2. **Beware of price effects.** Sanctions contributed to a surge in global energy prices that yielded record revenues for the Kremlin in 2022. This demonstrated the difficulty of applying sanctions against an export-oriented economy that serves as a crucial source of commodities for the rest of the world. The demand for energy is inelastic, meaning economies will pay for it even when prices rise. The increase in energy prices more than offset the loss of federal budget revenue from lower total gas exports and allowed the Kremlin to maintain relative economic stability throughout 2022. The cautionary lesson for the U.S. may be to avoid targeting China's

[15] S&P Global Market Intelligence: https://www.offshore-energy.biz/sp-global-russias-ghost-fleet-estimated-at-434-vessels/
[16] "Russia shifting import sources amid U.S. and allied export restrictions," Silverado Policy Accelerator," January 2023: https://silverado.org/news/report-russia-shifting-import-sources-amid-u-s-and-allied-export-restrictions

commodity exports, in particular critical minerals and metals, and to prepare in advance for the possibility that China may preemptively reduce its exports of critical commodities.

3. **Non-alignment fosters evasion.** Western export controls have been "leaky." Restricted goods, including those with war-time applications such as semiconductors, continue to make their way to Russia through non-aligned third countries. The critical lesson is that the effectiveness of sanctions improves with a larger coalition, even if larger coalitions require compromises to accommodate a broader array of interests. Weaker sanctions that are strongly enforced may be preferable to strong sanctions that fail to secure buy-in from key players and create new markets for sanctions evasion.

4. **Sanctions rarely undo invasions.** Western sanctions against Russia have sought to accomplish three objectives at different points in time. First, the initial threat of sanctions aimed to *deter* Russia from invading Ukraine. Next, the rapid imposition of financial sanctions aimed to force the Russian economy into a state of crisis and *coerce* Russia into reversing its invasion. These first two objectives have failed. Sanctions now seek to accomplish a third task: to *degrade* Russia's ability to conduct war. The evolution in the intent of Western sanctions offers two lessons:
    a. Once a state commits to an invasion, it has likely factored in the economic costs that it will bear for that action and will unlikely reverse course once those costs are imposed. As painful as sanctions might be, a policy reversal may carry even higher political, strategic, and reputational costs that it cannot bear.
    b. Understanding this, to maximize the deterrent power of sanctions against an invasion, Western policymakers should place more emphasis on designing – and signaling in advance – measures that would *degrade* warfighting capabilities in order to deprive a target of its aims, rather than impose high costs. Rather than focusing on cost-imposition, policymakers could consider sanctions that deny the target of its war aims. This might make sanctions more intolerable and credible to risk-seeking autocrats.

Mapping U.S.-China Economic Interdependencies

China's Vulnerabilities

Semiconductors

Semiconductors have become an essential hardware in almost all modern electronic devices and emerging technologies. It has also become an important geopolitical tool in the U.S.-China strategic competition.[17] While chips manufactured at mature process nodes, or "technology generation," are used in almost all electronic devices and nearly every type of military weapon system, leading-edge chips are essential in areas such as artificial intelligence (AI), quantum computing, and hypersonics. These latter chips are expected to revolutionize the conduct of warfare.[18] [19] [20] [21] Cutting-edge semiconductors are critical vulnerabilities to countries from both security and trade perspectives. This section focuses on semiconductors used in the technological sector.

In terms of consumption, China is the largest market for semiconductors worldwide. In 2020, China accounted for about half of the worldwide chip sales.[22] In 2021, the size of China's semiconductor market was roughly $186.5 billion in value. Of this $186.5 billion market, around $31.2 billion, or 16.7 percent, worth of chips were produced by both foreign and Chinese companies in China.[23] Nevertheless, only $12.3 billion worth of chips were manufactured by China-headquartered companies, which only makes up 6.6 percent of domestic Chinese consumption. This suggests that China's self-sufficiency with regards to semiconductors remains significantly low.

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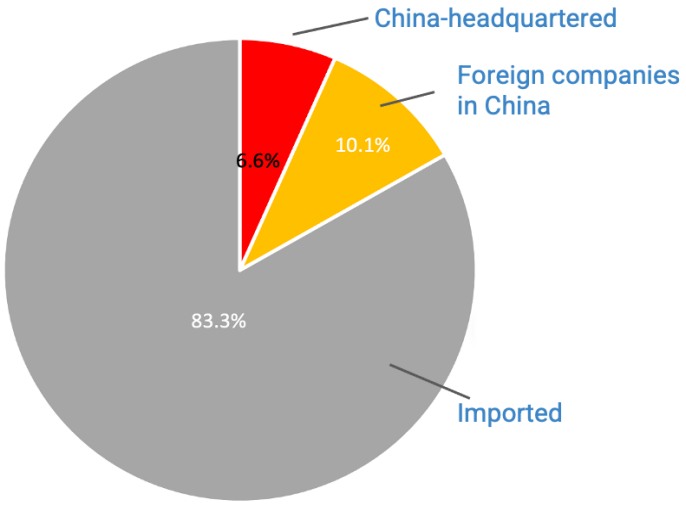
[17] Justin Feng, "The Costs of U.S.-China Semiconductor Decoupling," Center for Strategic & International Studies, June 8, 2022, May 25, 2022, https://www.csis.org/blogs/new-perspectives-asia/costs-us-china-semiconductor-decoupling.
[18] Shubham Dwivedi and Gregory D. Wischer, "Not All Semiconductors Are Created Equal," *National Interest,* April 27, 2022, https://nationalinterest.org/blog/techland-when-great-power-competition-meets-digital-world/not-all-semiconductors-are-created?page=0 percent2C1
[19] Mark Lapedus, "Chip Shortages Grow for Mature Nodes," *Semiconductor Engineering*, July 22, 2021, https://semiengineering.com/chip-shortages-grow-for-mature-nodes/.
[20] Che-Jen Wang, "China's Semiconductor Breakthrough," *The Diplomat,* Aug 19, 2022, https://thediplomat.com/2022/08/chinas-semiconductor-breakthrough/.
[21] Sujai Shivakumar and Charles Wessner, "Semiconductors and National Defense: What Are the Stakes?," Center for Strategic & International Studies, June 8, 2022, https://www.csis.org/analysis/semiconductors-and-national-defense-what-are-stakes.
[22] Mark Lapedus, "China Accelerates Foundry, Power Semi Efforts," *Semiconductor Engineering*, November 22, 2021, https://semiengineering.com/china-accelerates-foundry-power-semi-efforts/.
[23] Wang, "China's Semiconductor Breakthrough."

Figure 2. China's Consumption of Semiconductors and its Origin, 2021.



Source: Wang, "China's Semiconductor Breakthrough."

Taiwan and South Korea are two of the largest exporters of semiconductors to China. Both Taiwan and South Korea have begun 3-nm chip production in 2022. In particular, Taiwan plays a pivotal role in advanced semiconductor manufacturing, as it produces 90 percent of the world's sub-10 nm logic chips. By contrary, China's most advanced chipmaker, the Semiconductor Manufacturing International Corporation (SMIC), is still producing 7-nm semiconductors, putting China at a distance from the so-called "technology frontier."[24] [25] Forecasts by Goldman Sachs suggest that China will not be able to produce 5-nm chips by 2025 and will require substantial time before it can produce the most advanced chips by itself.[26] To be sure, China is quickly developing capabilities, especially in mature-node semiconductors, which are not subject to U.S. export control rules.[27] But it also has significant vulnerabilities with regard to semiconductors manufactured at mature nodes. Manufacturing turns design into chips, relying on various semiconductor manufacturing equipment (SME).[28] While the U.S., Japan, and the Netherlands dominate the production of SME in the world, China's own semiconductor equipment sector accounts for only about 2 percent of the global market, and its chip equipment sector currently has a self-sufficiency ratio of at most 10 percent.[29]

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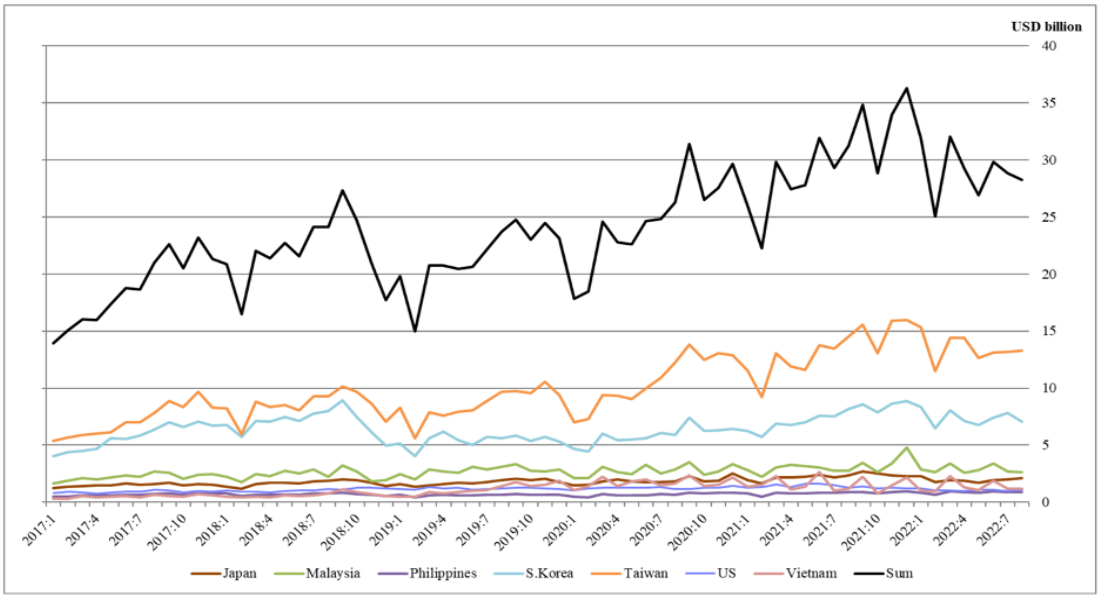
[24] Majeed Ahmad, "TSMC's 3-nm progress report: Better than expected," *EDN*, March 8, 2023, https://www.edn.com/tsmcs-3-n,m-progress-report-better-than-expected/.
[25] Michael Funke and Adrian Wende, *Modeling Semiconductor Export Restrictions and the US-China Trade Conflict.* St. Louis: Federal Reserve Bank of St Louis, 2022, 6, http://ezproxy.cul.columbia.edu/login?url=https://www.proquest.com/working-papers/modeling-semiconductor-export-restrictions-us/docview/2746614871/se-2.
[26] Dwivedi and Wischer, "Not All Semiconductors."
[27] Chad P. Bown and Kevin Wolf, "National Security, Semiconductors, and the US move to cut off China," *Peterson Institute for International Economics*, November 22, 2022, https://www.piie.com/blogs/realtime-economics/national-security-semiconductors-and-us-move-cut-china.
[28] Alexander Mann, and Dahlia Peterson, Saif M. Khan, "The Semiconductor Supply Chain: Assessing National Competitiveness," *Center for Security and Emerging Technology*, (January 2021), https://cset.georgetown.edu/publication/the-semiconductor-supply-chain/.
[29] Cheng Ting-Fang and Lauly Li, "China's SMIC Stockpiles Chip Equipment to Counter US Restrictions," *Nikkei Asia,* September 30, 2020, https://asia.nikkei.com/Politics/International-relations/US-China-tensions/China-s-SMIC-stockpiles-chip-equipment-to-counter-US-restrictions.

Figure 2. China's Imports of Semiconductors, 2017 - 2022



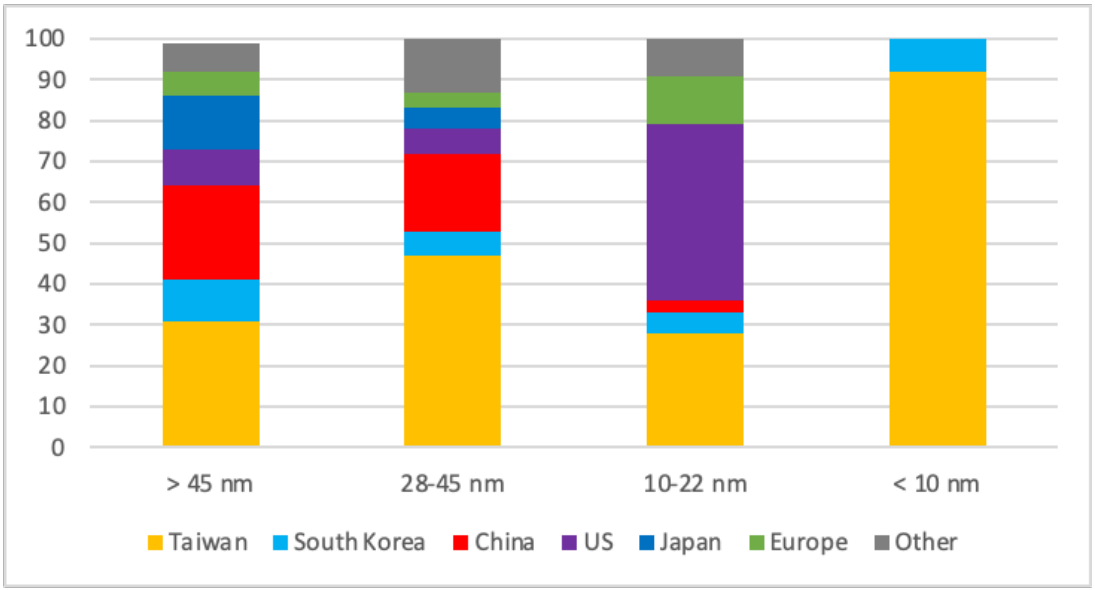
Source: Funke and Wende, "Modeling Semiconductor Export," 7.

Figure 3. Logic Chips Process Technology Roadmaps[30]

Year	2013	2015	2017	2019	2021	2023	2025
TSMC (Taiwan)	28-nm	10	7	5	3		2
Samsung (South Korea)	28-nm	10		7	5	3	2
Intel (US)		14-nm		10		7 4 3	2
SMIC (China)	28-nm				14	7	5

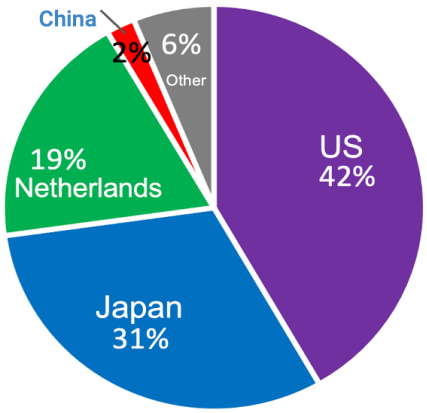
[30] *Source*: Anton Shilov, "Intel: 4nm, 3nm-Class Nodes on Track, 1.8nm Technology Pulled in," *Tom's Hardware*, December 6, 2022, https://www.tomshardware.com/news/intel-4nm-and-3nm-class-nodes-on-track-18nm-pulled-in.; Cheng Ting-Fang, Kim Jaewon, and Lauly Li, "TSMC says it will make ultra-advanced 2nm chips by 2025," Nikkei Asia, June 17, 2022, https://asia.nikkei.com/Business/Tech/Semiconductors/TSMC-says-it-will-make-ultra-advanced-2nm-chips-by-2025; Majeed Ahmad, "Samsung unveils plans for 2-nm and 1.4-nm process nodes," *EDN*, October 7, 2022, https://www.edn.com/samsung-unveils-plans-for-2-nm-and-1-4-nm-process-nodes/; "Semiconductor Foundry Process Roadmap", Anysilicon, accessed May 24, 2023, https://anysilicon.com/semiconductor-foundry-process-roadmap/.
Notes: For reasons such as the definition of process generation may vary from company to company, this roadmap should only be used as a very general guideline.

Figure 4. Breakdown of Logic Chips Production Capacity by Region, 2019



Source: Antonio Varas, Falan Yinug, Jimmy Goodrich, and Raj Varadarajan. *Strengthening the Global Semiconductor Supply Chain in an Uncertain Era*. Boston: Boston Consulting Group Boston, MA, 2021.

Figure 5. Production of SME Country Shares by Firm Headquarters, 2019.



Source: Khan, Mann, and Peterson, "The Semiconductor Supply Chain."

China sees its digital economy as a major growth engine for the country, and it needs semiconductor chips to ensure its continued development.[31] According to a white paper issued by China's State Council Information Office in 2022, China values its digital economy at around 39.8 percent of its

[31] Frank Tang and Siqi Ji, "Tech War: Starved of Chips, China's Bid to Topple US as No 1 Economy Faces 'Unprecedented' Pressure," *South China Morning Post,* Feb 8, 2023, https://www.scmp.com/economy/china-economy/article/3209385/tech-war-starved-semiconductors-chinas-bid-topple-us-no-1-economy-faces-unprecedented-pressure.

GDP.[32] [33] In the worst-case scenario of a complete cutoff of semiconductor supply, the Chinese economy would suffer catastrophic damage. Moreover, as semiconductors, found in almost all types of military weapon systems, are essential for breakthroughs in military technology, a shortage of semiconductors would greatly hinder China's military buildup. In particular, China has set a goal of building a fully modern military by 2027 based on "informatization," "intelligence," and "mechanization." [34]

Expertise in technical areas like AI, which require cutting-edge chips, is necessary to fulfill China's military objectives. Since China needs several years before it can achieve the technology to produce the most advanced semiconductors, a lack of supply of leading-edge chips would hinder China's ambitions to modernize the People's Liberation Army. For China, this is exacerbated by the fact that SME is almost exclusively produced by the U.S. and its allies. In other words, if SME exports from the U.S. and its partners to China were to stop, China would be forced into a situation where it can no longer manufacture semiconductors. China's means of obtaining semiconductors and SME from sources other than the U.S. and its partner states – that is, its ability to substitute semiconductors and SME from U.S.-aligned countries – is extremely limited. There is limited data on China's semiconductor stockpiles, China appears to be purchasing more equipment than it requires in anticipation of possible export controls on SME.[35] Hence, even if semiconductor export controls are imposed on China, there is a chance that China may use stockpiles to ease short-run shortages. That said, with regard to SME, there is often a constant need for equipment providers to be on-site to offer advice, troubleshoot problems, and repair equipment. Relationships with equipment providers are cultivated over time and are not limited to one-time purchases, something which the U.S. has an advantage over China, which has yet to cultivate such enduring relationships.[36] In the medium to long-term, sanctions would certainly deplete China's semiconductor assets. For these reasons, sanctions targeting semiconductors could be an effective way to alter China's decision-making calculus.

Among other sectors discussed in this paper, China is by far the least self-sufficient in semiconductors, and its technology lags far behind that of the U.S. and its allies. Although China is gradually gaining market size for semiconductors produced at mature nodes, it is still forced to depend on other countries for design and SME in the semiconductor supply chain. It should be noted, however, that the U.S. alone cannot ensure thorough regulation of semiconductors in China, and cooperation from partners with deep trade relations with China, such as Taiwan, South Korea, the Netherlands, and Japan, is indispensable. There are unavoidable cooperation costs related to semiconductor sanctions, and partners may be hesitant to cooperate with the U.S. Still, vulnerabilities in China's semiconductor

[32] "Digital Economy Becomes China's Major Growth Engine: White Paper," The State Council The People's Republic China, Last updated November 7, 2022, http://english.www.gov.cn/news/topnews/202211/07/content_WS6368728dc6d0a757729e291b.html.
[33] The digital economy is "an umbrella term that describes an economy in which information and communication technologies (ICT) are used to transform traditional brick-and-mortar economic activities (production, distribution, trade, and so on), products, and services into digital form." Source: Yi Wu, "Understanding China's Digital Economy: Policies, Opportunities, and Challenges," China Briefing, August 11, 2022, https://www.china-briefing.com/news/understanding-chinas-digital-economy-policies-opportunities-and-challenges/.
[34] Shivakumar and Wessner, "Semiconductors and National Defense."
[35] Gregory C.Allen, "Choking Off China's Access to the Future of AI," Center For Strategic & International Studies, October 11, 2022, https://www.csis.org/analysis/choking-chinas-access-future-ai.
[36] Allen, "Choking Off China's Access."

sector are significant, given the huge negative economic and military impact that a shortage of semiconductors would have on China.

Energy

Despite record investments in renewable energy generation, China remains reliant on imports of fossil fuels, particularly oil. In 2019, China imported 72.5 percent of the oil it consumed, 40.6 percent of the natural gas, and 7.7 percent of the coal.[37] If the U.S. and its partners cut off China's access to foreign oil, it would cause severe harm to the Chinese economy and the Chinese people. The basis of a potential Chinese oil blockade lies largely on China's reliance on Middle Eastern oil shipped through sea lanes that run through the Straits of Malacca and a handful of other passages that could be sealed off by the U.S. Navy.[38] This ability to enforce a distant oil blockade on China has been referred to as the "great anti-China weapon" in the United States.[39] While gas is not addressed in our analysis, our assessment of an oil blockade can be applied to the case of gas, though the latter will likely occur on a smaller scale. China holds large domestic reserves of coal, so a coal blockade is unlikely to be an effective option for the U.S.China is heavily dependent on imported oil, surpassing the U.S. as the world's largest oil importer in the 2010s.[40] The size of this dependency is also increasing – while China was the fifth-largest petroleum producer in the world in 2021, most of this production came from legacy fields that require expensive enhanced oil recovery techniques to sustain production.[41] Given difficulties in increasing its domestic crude oil production, China may be dependent on imports for 80 percent of its oil consumption by 2030.[42] Countries in the Middle East constitute approximately 50 percent of China's oil imports in 2021, of which 17 percent came from Saudi Arabia, the largest oil exporter to China in 2021. Russia was the second-largest oil exporter to China in 2021, constituting 15 percent of total Chinese imports of oil. Since there is significant Chinese investment in Russian oil producing capacity and pipeline connections, China's oil import shares from Russia may rise in coming years.[43]

A U.S. oil blockade of China would have damaging effects on the Chinese economy. It would likely lead to rapid increases in Chinese energy prices, its transport systems would come under pressure due to petrol shortages, and industrial users would struggle to maintain their output. For an oil blockade to achieve maximum impact, however, it would likely need to be in place for at least 12 months (and maybe significantly more) before it can cause severe economic damage. This is because Beijing can likely offset a significant portion of blockaded oil, albeit at a high cost. Despite its reliance on foreign

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[37] *International Energy Agency*, "Oil, gas and coal import dependency in China, 2007-2019", October 26, 2022, https://www.csis.org/analysis/how-chinas-energy-footprint-changing

[38] Gabriel Collins. "A Maritime Oil Blockade Against China – Tactically Tempting by Strategically Flawed", *Naval War College Review*, Vol. 71, No. 2, 2018

[39] Douglas Peifer, "China, the German Analogy, and the New AirSea Operational Concept", *Foreign Policy Research Institute*, January 1, 2011

[40] *China Power CSIS*, "How is China's Energy Footprint Changing?", https://chinapower.csis.org/energy-footprint/#:~:text=About percent2067.3 percent20percent percent20of percent20China's,will percent20be percent20sourced percent20from percent20elsewhere.

[41] *US Energy Information Administration*, "Country Analysis Executive Summary: China", August 8, 2022, https://www.eia.gov/international/content/analysis/countries_long/China/china.pdf

[42] Qiang Wang, Shuyu Li, Rongrong Li, "China's dependency on foreign oil will exceed 80 percent by 2030: Developing a novel NMGM-ARIMA to forecast China's foreign oil dependence from two dimensions", *Energy*, Vol. 163, pp: 151-167, 2018

[43] *US Energy Information Administration*, "Country Analysis Executive Summary: China"

oil, China is a large producer of oil, with Beijing claiming to have "technically recoverable reserves" of 3.7 billion tons of oil, which would theoretically meet its need for oil for 18 years based on current demand.[44]

While a nation's reserves can be difficult to estimate and their figures are often politicized, one may reliably assume that China can rely on its domestic oil production in the medium-term in the event of a blockade, even though it is unlikely to significantly increase existing levels of production. It is also likely that Beijing could maintain, and even increase, oil imports overland from Russia and Kazakhstan. This would allow it to circumvent a blockade. China also has the capacity to use fuel substitutes such as coal-based methanol to extend gasoline supplies.[45] China can also reduce demand: its oil energy efficiency is about 33 percent lower than the world average, suggesting there may be leeway for Beijing to push for lower oil consumption if imports are restricted.[46] Since roughly a fifth to a third of China's imported oil is used in the manufacture of exports, any embargo that limits Chinese goods exports may also reduce the demand for imported oil, too.[47] Therefore, while China's current oil stockpiles are only at around forty to fifty days of current import levels, the above countermeasures could allow China to meet domestic demand for 10 months to 62 months after an oil blockade is imposed.[48] Even if an oil blockade on China were maintained long enough to seriously undermine its economy, China's domestic production alone would be more than enough to maintain Chinese military operations.[49] This process, however, would likely be costly. China imports approximately $200 billion of crude oil annually; if policies to conserve oil use and boost production saw prices double, that would impose a large economic cost, albeit not a devastating one in the context of a $19 trillion economy.

If the U.S. does not wish to pursue a full-scale oil blockade on China, it can consider other measures that can impose costs on Beijing's energy sector. It could pressure critical countries into banning oil exports to China, limit U.S. companies and those of allies from providing key services like insurance to oil tankers headed to China, or coerce oil-producing countries to impose a price floor on China (as opposed to the price cap imposed on Russia, with some success). These alternative measures would have less adverse effects on China's economy than those of a oil blockade.

One notes that, while an oil blockade would have a major economic impact on China, its imposition by the U.S. would come at large economic and diplomatic costs. After all, China is a large integrated economy and cutting it off from global markets would lead to systemic consequences on the rest of the world. Oil shortages in China would detriment Chinese economic development, thereby generating

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[44] *Ministry of Natural Resources, PRC*, "China Mineral Resources", Geological Publishing House Beijing, 2022, https://www.mnr.gov.cn/sj/sjfw/kc_19263/zgkczybg/202209/P020220921322252399161.pdf; *bp*, Statistical Review of World Energy, 2021, https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2021-oil.pdf

[45] Gabriel Collins, "A Maritime Oil Blockade Against China – Tactically Tempting by Strategically Flawed"

[46] Qiang Wang, et al. "China's dependency on foreign oil will exceed 80 percent by 2030: Developing a novel NMGM-ARIMA to forecast China's foreign oil dependence from two dimensions"

[47] Wencheng Zhang, Rui Wei, and Shuijun Peng, "The oil-slick trade: An analysis of embodied crude oil in China's trade and consumption", *Energy Economics*, Vol. 88, 2022

[48] Frank Tang, "How big are China's crude oil reserves and how do they compare with the US' SPR?", *South China Morning Post*, November 23, 2021 https://www.scmp.com/economy/china-economy/article/3156952/how-big-are-chinas-crude-oil-reserves-and-how-do-they-compare

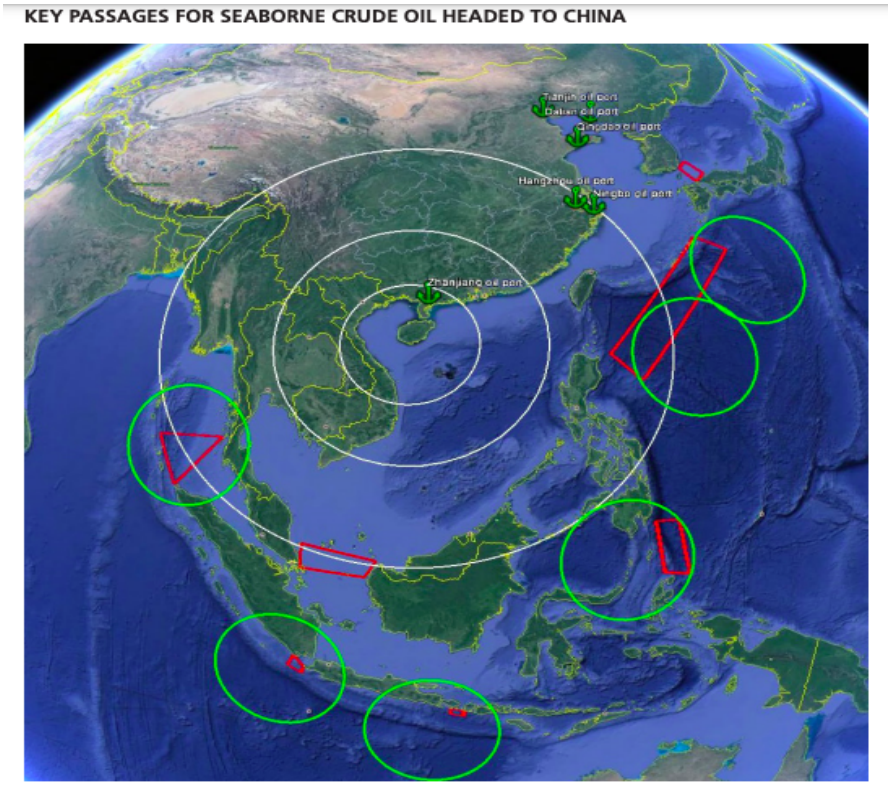
[49] Gabriel Collins, "A Maritime Oil Blockade Against China – Tactically Tempting by Strategically Flawed"

cascading economic effects across the world. China's exports would be disrupted, commodity prices would fall, and there will be severe consequences on global economic growth. Additionally, the sudden removal of more than five million barrels per day of demand from global oil markets would lead to a dramatic fall in oil prices. This would cause havoc in oil-producing countries.

Finally, to enforce an oil blockade, the U.S. would need to closely control the supply of oil to Southeast and East Asian nations to ensure oil isn't then sold on to China, something that would likely cause significant anger in these countries. The longer the blockade goes on, the greater the mounting pressure on the U.S. to relent, especially if it appears the blockade is unlikely to achieve a backdown in Beijing in the short- to medium-term.

A U.S.-led blockade of oil could severely damage the Chinese economy. While China could potentially maintain its oil consumption for years, it will undoubtedly come at a large economic cost. We note that this policy would come at significant cost to the U.S. (discussed later). Overall, China's energy sector is very vulnerable given its reliance on foreign oil (and, to a lesser extent, gas).

Figure 6: Key Passages for Seaborne Crude Headed to China

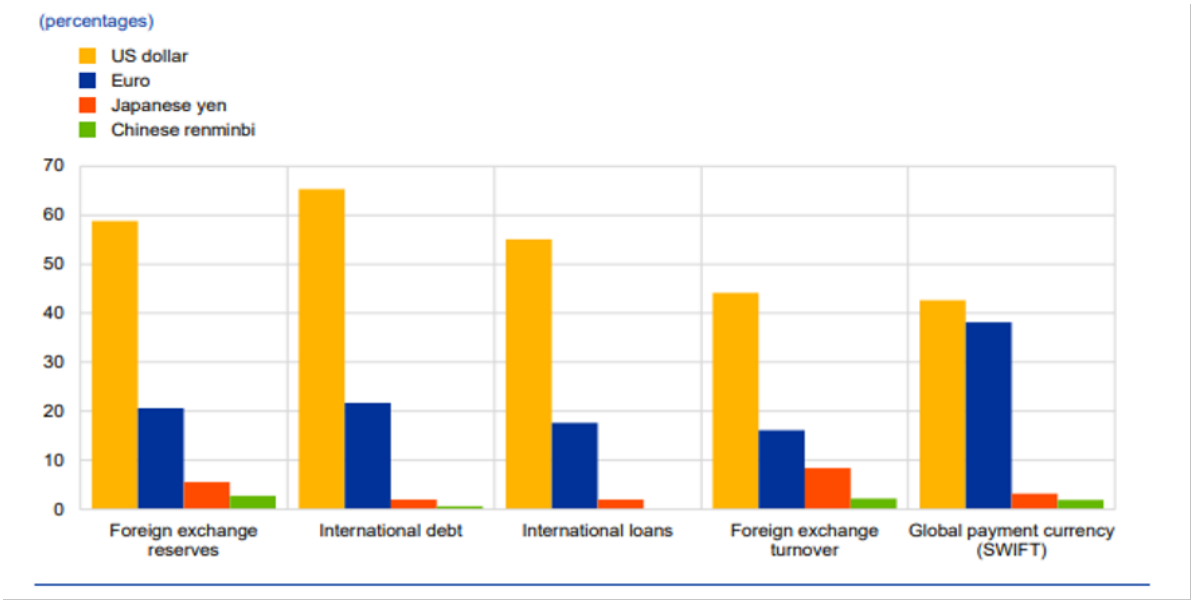


Source: Gabriel Collins, "A Maritime Oil Blockade Against China"

Finance

China's reliance on Western financial infrastructure stems primarily from the dollar's dominance as a global reserve currency, coupled with the depth and strength of U.S. capital markets. Through control of these levers, the West can exert pressure on China by restricting Chinese trade as well as the functioning of China's own financial markets. Western strength in traditional financial infrastructure is amplified when the dollar is considered alongside the euro, pound sterling, and yen. In particular, China is vulnerable in its foreign exchange reserves and in Chinese private investment abroad, and thus these would be the likely main targets for any financial sanctions. Sanctions on foreign exchange reserves would prevent China from accessing much of its stored wealth, which could in turn affect its ability to wage a long-term war or prop up a battered economy. Sanctions on private investment abroad, alternatively, could affect the health of Chinese economic growth, as most of these investments are made by corporations as a means to improve their economic functioning.

Figure 7: Dominance of the U.S. dollar and Western-aligned currencies



Source: European Central Bank

Foreign Exchange Reserves

China has the world's largest stock of foreign exchange reserves at $3.2 trillion.[50] While the exact composition of China's reserves are classified, most recent data suggests that over half of these reserves are denominated in USD, with over $1 trillion in the form of US Treasury securities.[51] Roughly a quarter of reserves are thought to be held in euros, while the Japanese yen and British pound make up

[50] Tran Hung, "Wargaming a Western Freeze of China's Foreign Reserves," Atlantic Council, May 2, 2022, https://www.atlanticcouncil.org/blogs/econographics/wargaming-a-western-freeze-of-chinas-foreign-reserves/.
[51] Tran Hung, "Wargaming a Western Freeze of China's Foreign Reserves," Atlantic Council, May 2, 2022, https://www.atlanticcouncil.org/blogs/econographics/wargaming-a-western-freeze-of-chinas-foreign-reserves/.

significant shares as well.[52] Thus, likely over 80 percent, equivalent to over $2.5 trillion, of China's reserve holdings are in currencies that are liable to sanction them in the event of a Taiwan contingency.

China recognizes its reliance on western currencies and assets and has attempted to diversify. Today, China's share of dollar reserves has dropped significantly from its peak of 79 percent in 2005, when it began increasing holdings of gold and other currencies.[53] In addition, it has also decreased its stock of foreign exchange reserves, which has declined from a peak of $4 trillion in 2014.[54] China has increased investments in tangible assets in friendly countries, with the Belt and Road Initiative a major example, as another attempt at investment diversification.

Despite China's attempts to diversify, it cannot adequately reduce its dependence on the West's financial infrastructure. China may continue to increase its gold holdings, but there is only $6.7 trillion worth of investable gold in the world, much of which is already held by other central banks.[55] And gold, while more resilient against sanctions, is less liquid and convertible than typical financial assets. Similarly, investments in tangible assets in friendly countries cannot fully replace investments in western securities. Since the Belt and Road Initiative (BRI) was announced in 2013, total investment in the initiative has amounted to roughly $880 billion, which is about the same amount that China's foreign exchange reserves have fallen in the same period of time.[56] Like gold, these investments are highly illiquid and also susceptible to business and political risks.

China has attempted to address these issues in part by promoting the use of the yuan internationally such that it may rival the U.S. dollar. So far, it has been able to make little inroads in this project, with the yuan accounting for less than 3 percent of both global central bank reserves and global payments.[57] Yuan internationalization faces a fundamental problem associated to China's capital controls: the yuan is not a free-floating currency and is not fully convertible to other currencies. In order for the yuan to enjoy true internationalization to rival the dollar, the Chinese Communist Party (CCP) would have to reduce its control over the currency, something that it is highly unlikely to do. Thus, China is ultimately, in the short and medium-run, highly reliant on Western financial assets as a basis for its national wealth. These assets then are highly susceptible to Western sanctions and likely among the first targets of western powers in an attempt to coerce China or degrade its ability to wage war.

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[52] Gabriel Wildau, "China's large forex reserves constitute both a blessing and a curse," Financial Times, Septemeber 29, 2014. https://www.ft.com/content/9dfa88ce-2ea1-11e4-afe4-00144feabdc0
[53] Tran Hung, "Wargaming a Western Freeze of China's Foreign Reserves," Atlantic Council, May 2, 2022, https://www.atlanticcouncil.org/blogs/econographics/wargaming-a-western-freeze-of-chinas-foreign-reserves/.
[54] Gabriel Wildau, "China's large forex reserves constitute both a blessing and a curse," Financial Times, Septemeber 29, 2014. https://www.ft.com/content/9dfa88ce-2ea1-11e4-afe4-00144feabdc0
[55] Chen, Zhao, "China's national wealth remains vulnerable to Western financial sanctions, no matter what it does," South China Morning Post, March 26, 2022. https://www.scmp.com/comment/opinion/article/3171501/chinas-national-wealth-remains-vulnerable-western-financial
[56] C Textor, "Chinese investments in countries of the Belt and Road Initiative (BRI) from 2013 to 2021," Statista, November 25, 2022. https://www.statista.com/statistics/1274991/china-total-investment-in-belt-and-road-countries/
[57] Frank Tang, "China's yuan needs 'bold breakthroughs' to make inroads as an international currency," South China Morning Post, March 27, 2023. https://www.scmp.com/economy/china-economy/article/3214989/chinas-yuan-needs-bold-breakthroughs-make-inroads-international-currency-economist

Private Investment

Apart from the wealth held and invested by China's central government, many Chinese companies and enterprises also hold investments in the West that could be targeted by Western sanctions. It has been estimated that Chinese companies have invested $145 billion in foreign direct investment (FDI) in the U.S. and $83 billion in the EU.[58] Not only are these investments vulnerable to sanctions, countries in the West may also nationalize or liquidate any Chinese investments in their country.

Sanctions on these investments could also have a more direct impact on the health of the Chinese economy. Most of these investments are made by corporations as a means to improve their economic functioning. This is as opposed to central bank reserves which, while earning a modest yield, are primarily held as insurance against shocks and not central to the everyday functioning of the economy. The West also plays a crucial role in providing capital and investment into China. If sanctions were placed on China, all western FDI would most likely cease to flow into the country, extenuating any shortage of capital crisis that might result from sanctions. China will need an estimate of $210 billion a year in net capital inflows between 2019 and 2030 in order to finance its current account deficit, not accounting for any sanctions scenarios.[59] If the West were to cease investing in China, it could become much more difficult for China to continue to receive adequate capital inflows.

Ultimately, however, Chinese private investment abroad does not pose the same level of vulnerability as do China's foreign exchange reserve holdings. Chinese has less private investment abroad than its FX reserves, and this investment is varied and dispersed, making it less susceptible to a sanctions regime.

Currency

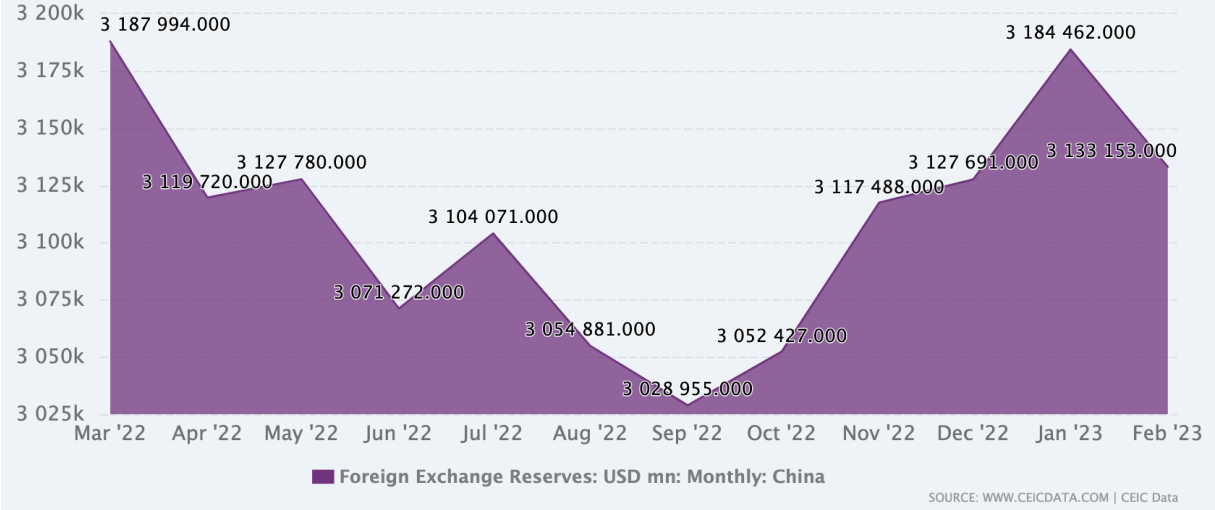
Currency represents one of China's most significant vulnerabilities. China has made many attempts to internationalize the renminbi, but this has led to limited progress due to its significant use of capital controls. As such, the RMB still accounts for a relatively small share of global transactions. This implies that China requires substantial foreign currency reserves, especially U.S. dollars, to trade with other countries. This exposes China to various forms of currency weaponization, including manipulations.

China's position as a major exporter has increased its dollar-denominated reserves. Only 40 swap deals have been signed for international trade in RMB, and international trade conducted in RMB only represents 3 percent of global trade. As such, most of China's trade revenues are in U.S. dollars. As of February 2023, China's USD-denominated reserves accounted for approximately one-third of its total $3.133 trillion foreign exchange reserve. Its reserve composition is classified information, but a 2018 report from China's State Administration of Foreign Exchanges (SAFE) suggested that China had decreased its USD-denominated reserves from 79 percent to 58 percent of total reserves between 2005 and 2014.

[58] Tran Hung, "Wargaming a Western Freeze of China's Foreign Reserves," Atlantic Council, May 2, 2022, https://www.atlanticcouncil.org/blogs/econographics/wargaming-a-western-freeze-of-chinas-foreign-reserves/.
[59] "Facing Current Account Deficit, China Looks Abroad for Capital," Morgan Stanley, March 13, 2019. https://www.morganstanley.com/ideas/china-foreign-capital

In addition to having significant dollar reserves, China also holds many U.S.-issued assets, including $1.1 trillion U.S. Treasury Securities, $273 billion of equities, and $217 billion of Asset Backed Securities (ABS).[60] In this regard, it also holds significant euro-denominated assets. China's state-owned enterprises have made a total of $83 billion in Foreign Direct Investment in the European Union and in 2010, SAFE had stated that close to 26 percent of its international reserves consisted of euros, a figure which has certainly changed since but which highlights the euro's importance to China and China's vulnerability to euro manipulations, in addition to aforementioned dollar manipulations.[61] [62] China's heavy reliance on Western currencies is a sign that it is vulnerable to Western sanctions that could undermine its economy and financial systems.

Figure 8: China's Foreign Exchange USD Reserves over time[63]



Lessons from the freeze of Russia's forex following its invasion of Ukraine suggest that China's large dollar holdings similarly exposes it to dollar-denominated assets freezing if the U.S. weaponized the dollar to sanction China. It would be doubly challenged should European allies follow the U.S. in freezing the euro. A freeze of China's foreign reserve would significantly affect the country's macroeconomic landscape, even as it has sought to reduce the size of its foreign reserves. A freezing of China's dollar holdings would cut China from trading with most of its commercial partners. The United States is China's largest trading partner, so 16.2 percent of its exports China is paid in dollars. The dollars received as a payment for exports would be useless to China if the U.S. exerted a freeze on China's dollar

[60] Tran Hung, "Wargaming a Western Freeze of China's Foreign Reserves," Atlantic Council, May 2, 2022, https://www.atlanticcouncil.org/blogs/econographics/wargaming-a-western-freeze-of-chinas-foreign-reserves/.
[61] Tran Hung, "Wargaming a Western Freeze of China's Foreign Reserves," Atlantic Council, May 2, 2022, https://www.atlanticcouncil.org/blogs/econographics/wargaming-a-western-freeze-of-chinas-foreign-reserves/.
[62] Pau Ruiz Guix and Mario Esteban, "The Euro for China: Too Big to Fail and Too Hard to Rescue," Elcano Royal Institute, January 17, 2022, https://www.realinstitutoelcano.org/en/analyses/the-euro-for-china-too-big-to-fail-and-too-hard-to-rescue/#:~:text=Taking percent20into percent20account percent20that percent20China,big percent20to percent20fail percent20for percent20China.
[63] "China Foreign Exchange Reserves," China Foreign Exchange Reserves, 1989 – 2023 | CEIC Data (CEIC Data), accessed March 30, 2023, https://www.ceicdata.com/en/indicator/china/foreign-exchange-reserves.

holdings and/or prohibited dollar use in international current and capital transactions. Preventing China from using the dollar for transactions would deprive it of trade revenues.[64]

China's reliance on the dollar for exports could also expose it to monetary sanctions from the United States. To begin, China trades with the dollar, and the RMB is pegged to the dollar. Next, the U.S. and the Federal Reserve have almost total control over dollar supply. By simply reducing the dollar supply, the U.S. could make the RMB appreciate which would have three effects. First, it would destabilize the RMB, since it is pegged to the dollar. Second, it would make China's exports look more expensive worldwide, making them less competitive. And finally, it would limit the availability of dollars in China. In other words, a monetary decision by the U.S. to limit its currency supply could severely challenge China's macroeconomic landscape.

For the United States, currency freezes and currency manipulations are highly effective tools in sanctioning China. Not only can they be easily applied, they are also fast and efficient currency measures, giving it the score of a 3.5. Nonetheless, as this report shall elaborate in greater detail, Western currency manipulations may not be practical sanctions against China, even if they are predicted to deliver significant economic impact. Western nations must expect sizable retaliation from China should they weaponize their currency against China. Liabilities to China (foreign investment in China) outdo the size of foreign assets China owns abroad giving China enough leverage to strike back at the West. Moreover, currency manipulations would likely cause significant harm to economic exchanges on which both the U.S. and China are very dependent. China's exports to the U.S. and Europe account for 6 percent of China's total GDP and would severely decline in the event of a currency freeze. On the other hand, the U.S. and Europe import massively from China and would suffer significant shortages should China retaliate against them. Consequently, currency measures shall be employed with parsimony and care to ensure that they inflict the most harm abroad while generating minimal cost to the U.S. and Europe.

Other Goods and Services

There are some aspects of the Chinese economy that are economically vulnerable but are less viable targets for U.S. sanctions. This includes its pharmaceutical industry and technological development. An export-led economy, China relies heavily on foreign markets, and the U.S. is one of its most important trading partners. U.S. demand for Chinese goods is substantial. China's pharmaceutical industry is also vulnerable due to the way in which it is entangled in global supply chains. The industry relies heavily on U.S. suppliers and intellectual property.

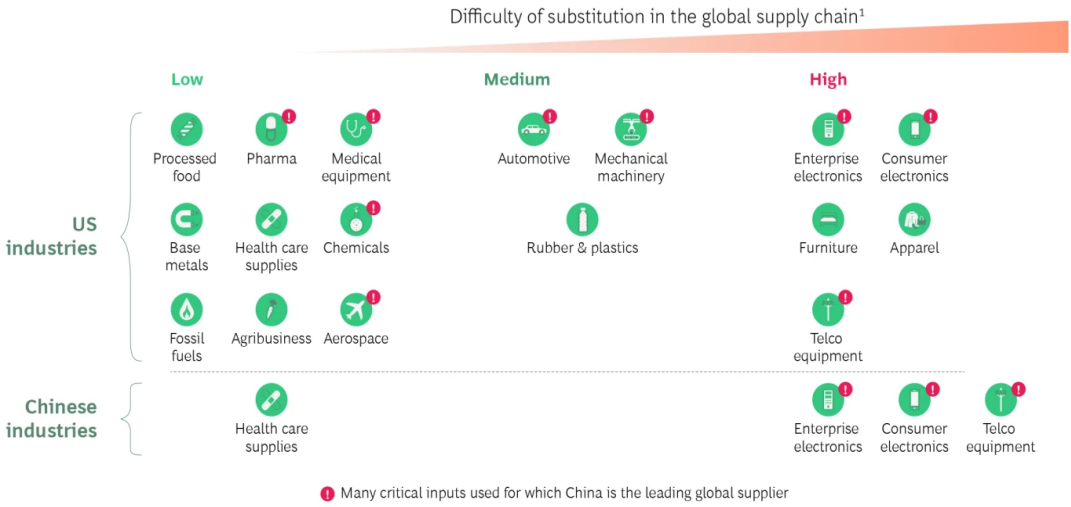
During the U.S.-China trade war of 2018, China's exports to the U.S. still reached a staggering $536 billion in 2022. This demonstrates the importance of the U.S. market to China's economic growth.[65] If Chinese companies are unable to sell in the U.S. or face export ban due to a deterioration of their commercial relationship, Chinese industries could potentially lose up to $140 billion.[66] Indeed, China's

[64] Markus Jaeger, "Why China Is Stuck with the US Dollar," German Council on Foreign Relations, May 2, 2022, https://dgap.org/en/research/publications/why-china-stuck-us-dollar.
[65] U.S. Census Bureau, accessed April 20.2023, https://www.census.gov/foreign-trade/balance/c5700.html#2022.
[66] "What's at Stake If the US and China Really Decouple," Boston Consulting Group, accessed April 20, 2023, https://www.bcg.com/publications/2020/high-stakes-of-decoupling-us-and-china.

machinery, enterprise electronics, and medical-supplies sectors rely on the U.S. for 6 percent to 8 percent of their revenue. Intubation equipment such as catheters and bougies accounted for 80 percent of the $16 billion in medical supply sales by Chinese companies in the U.S.

On the import side, Chinese pharmaceuticals are equally vulnerable. As of 2022, China imports of pharmaceuticals from the U.S. amounted to $9.2 billion, which is around 17 percent of all Chinese imports of such products.[67] Additionally, Chinese medical facilities still depend heavily on American firms for biological materials, technical information, and lab equipment. A prohibition on intellectual property and data transfers from the U.S. to China in the field of medicine would thus have a strongly negative impact on China.

Figure 9: U.S.-China supply chain substitution comparison



Last, China's dependence on U.S. technologies makes it vulnerable to U.S. sanctions. The U.S. has already imposed sanctions on several Chinese organizations. This has affected China's ability to develop advanced technology. The number of Chinese organizations on the Entity List, which restricts their ability to purchase vital components from U.S. suppliers and limits their access to U.S. technology, has increased four-fold from 130 to 532 since 2018.[68] Many Chinese companies in industries requiring advanced technology like AI, drones, and supercomputers, including Huawei, SenseTime, and DJI, are already on this list. Recent information and communications technology (ICT) supply chain security rules have also allowed the U.S. Department of Commerce to reassess Chinese software and hardware used in the U.S. This may affect China's ability to expand its technology reach into the U.S. market. The U.S. Congress's investigation into TikTok, for instance, is a case in point.

[67] Global Trade Atlas, accessed April 23, 2023, https://www.gtis.com/gta.
[68] Jon Bateman, "U.S.-China Technological Decoupling: A Strategy and Policy Framework," Carnegie Endowment For International Peace, accessed April 23, 2023, https://carnegieendowment.org/files/Bateman_US-China_Decoupling_final.pdf

U.S. Vulnerabilities

Critical Minerals

China controls supply chains for various critical minerals, including lithium and cobalt, which are key to advanced manufacturing, renewable energy power generation assets, and numerous defense technologies. As such, the U.S. is highly susceptible to Chinese export bans on critical minerals. The number of critical minerals is too great for careful individual examination, so we have limited our analysis of the U.S.'s critical mineral vulnerability to rare earth minerals (REEs). These are minerals that are key inputs to batteries, wind turbines, advanced weaponry, and other manufactured goods. Our choice of REEs is based on two observations. First, given China's domination of both the production and mining of REEs, it is likely to have greater leverage over global REE supply than other minerals that are mined outside of of China but refined in the country. Second, since the refining and processing of REEs is more difficult than that of other critical minerals, we posit that REE imports from China will be difficult for the U.S. and its allies to replace once they become subject to Chinese sanctions. For the United States, then, REEs are one of the critical minerals that is most vulnerable to Chinese sanctions. Our analysis will focus on REEs, but we will also make predictions about the U.S.'s vulnerability in critical minerals more broadly.

China is the world's lead processor and miner of REEs. In 2010, China's global share of REE production peaked at 95 percent owing to its natural endowment of critical minerals, state financial support, and lax environmental regulations. Since 2010, however, the U.S. and its allies have become more aware of the risks of China's dominance in the REE space. In response, they have prompted investments in REE mining capacity across the globe, reducing China's output in 2021 of raw REEs – that is, unprocessed REEs – to 60 percent of total global production. In 2021, the U.S. mined 15.5 percent of the world's REEs, Myanmar mined 9.4 percent, and Australia mined 7.9 percent.[69]

But efforts at diversifying REE mining aside, REE processing is still concentrated in China. Processing is both complex and highly polluting, and China accounts for 85 percent of rare earth element processing worldwide.[70] The vast majority of the remaining processing globally is undertaken by only one company – Australian firm Lynas – and in only one site – located in Malaysia.[71] Recognizing this vulnerability, the U.S. Department of Defense has invested nearly $200 million to increase domestic rare earth processing. Investments by the governments of Japan, Australia and the EU also seek to

[69] *Government of Canada*, "Rare earth elements facts", https://natural-resources.canada.ca/our-natural-resources/minerals-mining/minerals-metals-facts/rare-earth-elements-facts/20522
[70] Lara Seligman, "China Dominates the Rare Earths Market. This U.S. Mine Is Trying to Change That.", December 14, 2022 https://www.politico.com/news/magazine/2022/12/14/rare-earth-mines-00071102
[71] *Lynas*, "2021 Annual Report", 2021 https://lynasrareearths.com/wp-content/uploads/2021/10/LYC_AR21.pdf

diversify REE processing.[72] The U.S. has also bolstered strategic REE stockpiles in recent years, but these were responses to defense needs and are not intended for economic stockpile.[73]

Beijing could also impose export restrictions on REES at a low cost. While REEs are key inputs to a broad range of industries, the total world trade in REEs in 2021 was worth only $2.7 billion.[74] Although this figure doesn't include the value added by Chinese REE refining and further producing, the direct cost of curtailing the export of REEs would never be more than a small fraction of China's overall economy.

We should note, though, that a Chinese rare earths embargo on the US would meet similar difficulties to other sanctions on fungible commodities – the issue of leakage. China lacks the US navy's ability to blockade US ports so it cannot enforce a REE blockade on the US in the same way the US could cut off China's oil imports. As such, US buyers could easily pay a premium to unsanctioned nations to re-export imports of Chinese REEs (and other critical minerals), thus evading Chinese sanctions, albeit increasing inefficiency and raising costs. China could attempt to use a quota system to fix exports to other nations to prevent re-export to the US, but it is hard to imagine Beijing being able to cut off Chinese-produced REEs to the US fully unless it extends its export ban to US allies. Even then, may have to expand the ban even further to non-aligned countries to cut the US off, given the likely irresistible pull of re-selling REEs to China at a major markup. A ban of this force would still face difficulties due to the likelihood of smuggling, such as across the porous China-Southeast Asia border. While China cutting off REE exports to the world completely in order to sanction the US is not inconceivable, this policy would not be completely effective, would likely cause a significant global economic shock and would come at a huge diplomatic cost to China.

REE leakage from China to the US, investments over the last decade in non-Chinese REE mining, Lynas's existing processing capacity, and U.S. stockpiles suggest a retaliatory Chinese REE embargo will not be devastating to the US economy or warfighting ability. China's attempt to use an REE export ban on Japan in 2010 over territorial claims seems prescient – while the move fuelled fears over the leverage China wielded through REEs, the actual ban was ultimately ineffective. Research suggests three reason for this: the increase in non-Chinese REEs that had begun before the attempted embargo (and have only grown since); administrative difficulties associated with enacting an embargo (including the smuggling of REEs into Japan); and rapid adjustments to manufacturing led to output of advanced goods being maintained, albeit at a higher cost.[75]

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[72] *US Department of Commerce*, "FACT SHEET: Biden-Harris Administration Announces Further Actions to Secure Rare Earth Element Supply Chain", https://www.bis.doc.gov/index.php/documents/section-232-investigations/3142-2022-09-fact-sheet-biden-harris-administration-announces-actions-to-secure-rare-earth-element/file

[73] Mike Stone, "Pentagon to boost rare earths and lithium stockpiles - sources", *Reuters*, February 18, 2022 https://www.reuters.com/world/us/exclusive-pentagon-boost-rare-earths-lithium-stockpiles-sources-2022-02-18/#:~:text=WASHINGTON percent2C percent20Feb percent2018 percent20(Reuters),familiar percent20with percent20the percent20plan percent20said

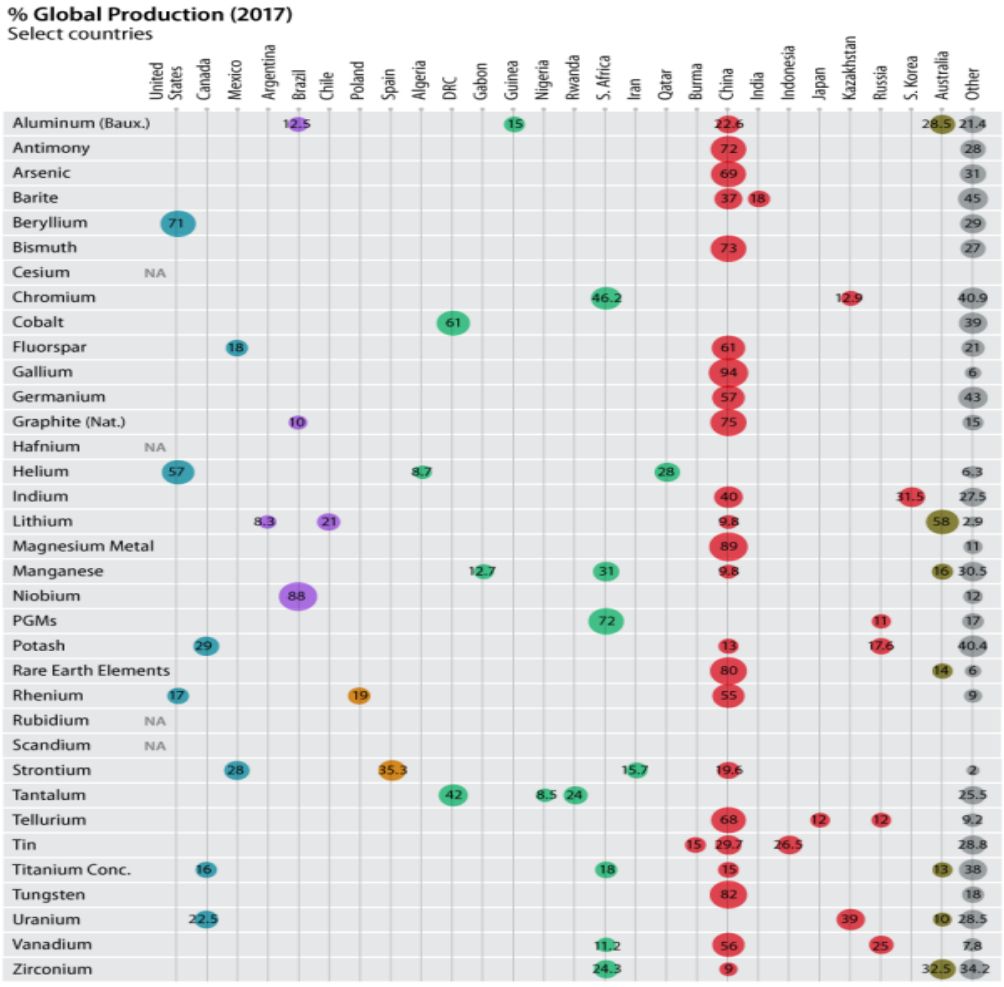
[74] *OEC*, "Rare-Earth Metal Compounds", https://oec.world/en/profile/hs/rare-earth-metal-compounds#:~:text=About&text=Overview percent20This percent20page percent20contains percent20the, percent241.6B percent20to percent20 percent242.71B

[75] Gholz, E. "Rare Earth Elements and national Security", *The Council on Foreign Relations*, October 2014.

It would undoubtedly disrupt U.S. manufacturing, cause supply chain difficulties, and hit economic growth if China managed to cut off the U.S.' REE supply. However, when stepping through the difficulties China would have in fully cutting the US off, the investments made in the last decade in stockpiles and alternative supplies, and the historical example of Japan in 2010, the U.S.' vulnerability to China appears less pronounced than at first glance. While Beijing can and likely would cause harm to the U.S. via its critical mineral supply chains in retaliation to major US sanctions, it is unlikely to be able to affect the U.S. war-fighting ability or cause severe economic repercussions.

Overall, China could cause significant disruption in the US if it weaponized its dominance of critical mineral production supply chains. It could also likely do so at little direct financial cost to Beijing. However, China's export ban will likely be leaky, alternative supplies exist, and the US can likely adapt, making China's action unlikely to affect either the U.S.'s warfighting capability or its medium-term economic outlook. Overall, the US is moderately vulnerable to Chinese restrictions on the export of critical minerals.

Figure 10: Country shares of critical mineral production



Source: *Congressional Research Service*

Agriculture

The U.S. vulnerability in agriculture is its reliance on China as its largest agricultural export market in soybean and corn. China is one of the top three markets for U.S. beef exports. Due to the events of the trade war, China can leverage this asymmetric interdependence again in response to U.S. actions against China.China is less vulnerable in agriculture compared to the U.S., but it is a net importer of U.S. agriculture. Changing diet patterns, a growing middle class, and cheaper imports have driven an increase in China's dependence on food imports. Therefore, China suffers from trade vulnerabilities due to its reliance on other countries for agriculture imports; still, since China is a top exporting market for U.S. agriculture—the U.S.-China agriculture trade represents a trade vulnerability for both countries but even more so for the U.S. Though China currently relies on the U.S. for some of its agricultural supplies, the U.S. and its agricultural sector relies even more heavily on the income generated by U.S. food exports to China due to China's position as the U.S.'s largest agricultural export market by a sizeable margin while the U.S. fails to hold the position as China's largest agricultural trading partner. In recent years, China has decreased its reliance on the U.S. for agricultural products, which has diminished the Chinese vulnerability in agriculture.

The U.S. is the largest food exporter in the world, and China is its main agricultural export market at $33 billion in purchases. Mexico is a close second at $25.5 billion, and Canada and South Korea fall at third and fourth respectively.[76] Therefore, U.S. agricultural vulnerabilities with China lie in the U.S.'s export volume to China rather than in imports since the U.S. has a high food self-sufficiency rate in staple foods, with the exception of fish.

The U.S. does not rely heavily on imports for most staple foods, other than fish and seafood. The U.S. imports approximately 80 percent of the fish it consumes, but it is not heavily reliant on meat imports. Imported meat accounts for 8 to 20 percent of total U.S. meat supply.[77] [78] Given that most of the U.S. 's seafood imports come from China, China may have leverage over the U.S. in this regard. That said, India is a close second largest seafood exporter to the U.S., and we may presume that the U.S. may readily substitute Chinese seafood for Indian seafood should the need arise.[79] U.S. consumption of other less-calorie dense foods are mainly imported, including goods such as coffee, cocoa, and spices. We may preclude discussion of these categories, however, as they are luxury food items that do not mainly come from China. In the event of a crisis, sanctions on necessities, rather than luxuries, are likely to be more effective. Thus, the U.S.'s food import vulnerability is low, since the U.S. does not heavily rely on imports for non-luxury food items with the exception of seafood.

China continues to be the U.S.'s largest agricultural export market and may take actions to limit U.S. food exports. The U.S.'s top export product to China in 2020 was oilseeds and grains at $17.2 billion,

[76] U.S. Department of Agriculture (USDA), "American Agricultural Exports Shattered Records in 2021," USDA, February 2022, https://www.usda.gov/media/press-releases/2022/02/08/american-agricultural-exports-shattered-records-2021.
[77] National Oceanic and Atmospheric Administration (NOAA) Fisheries, "U.S. Aquaculture," U.S. Department of Commerce, September 2022, https://www.fisheries.noaa.gov/national/aquaculture/us-aquaculture.
[78] Kenneth Mathews, Rachel Johnson, and Keithly Jones, "How Much U.S. Meat Comes from Foreign Sources," USDA, September 2012, https://www.ers.usda.gov/amber-waves/2012/september/how-much-us-meat/.
[79] NOAA Fisheries, "Fisheries of United States 2021: FUS Foreign Trade 2021" U.S. Department of Commerce, 2021, https://www.fisheries.noaa.gov/foss/f?p=215:18:14354335694985

with semiconductors and their components coming in second at $12.0 billion.[80] In 2021, the U.S.'s largest agricultural export products to China were soybeans, corn, and beef.[81] These figures suggest that China's attempts to limit U.S. exports to China could have significant economic implications for U.S. farmers.

Notably, the U.S. faces a clear asymmetric vulnerability in agriculture vis-à-vis China. In 2021, China purchased roughly 52 percent of U.S. soybean exports, yet it is not heavily dependent on the U.S., reserving the ability to readily substitute U.S. products for Brazilian ones. In the short run, the U.S. could slightly combat this financial loss through shifting its exports to some of the Brazilian soybean export destinations if Brazil shifts more soybean exports to China. By contrast, the U.S.'s second largest soybean export destination is Mexico, which only purchased 9.74 percent of U.S. soybean exports in 2021.[82] China is also the largest export market for U.S. corn, but Mexico and Japan trail closely behind in second and third place—taking up 27 percent, 25 percent, and 17 percent respectively, so the U.S. could potentially shift losses from less exports to China to other countries[83] In beef exports, China ranked third as the U.S.'s largest export market, trailing behind South Korea and Japan by a sizable margin, so the U.S. is reliant but less so on China as a beef export market. [84]

China could leverage the U.S.'s vulnerability in agriculture. While the U.S. is no longer a top export market for key Chinese agricultural products, the U.S. continues to rely on China as its largest export market. The U.S. has already suffered harmful effects on its economy during the U.S.-China trade war. In 2019, the Chinese Ministry of Commerce announced that China had stopped purchasing some U.S. agricultural products, which led U.S. farmers to lose $24 billion.[85] [86] Soybean prices also dropped by 7 percent from 2018 to 2019 as a result, which could have secondary effects on other crop prices as farmers switch to the production of other agricultural products.[87] In 2018, the number of bankruptcies filed by U.S. farmers reached its peak of nearly a decade, which subsequently prompted the U.S. Congress to pass the Family Farmer Relief Act to increase protections of family farmers in bankruptcy proceedings.[88]

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[80] The U.S.-China Business Council, "2021 State Export report," U.S.-China Business Council, 2021,.
[81] USDA, 2022.
[82] USDA Foreign Agricultural Service, "Soybean 2021 Export Highlights," USDA, 2021, https://www.fas.usda.gov/soybean-2021-export-highlights.
[83] USDA Foreign Agricultural Service, "Corn 2021 Export Highlights," USDA, 2021, https://www.fas.usda.gov/corn-2021-export-highlights.
[84] USDA Foreign Agricultural Service, "Beef & Beef Products 2021 Export Highlights, USDA, 2021, https://www.fas.usda.gov/beef-2021-export-highlights.
[85] Ryan Hass and Abraham Denmark, "More pain than gain: How the US-China trade war hurt America," *Brookings*, August 2020, https://www.brookings.edu/blog/order-from-chaos/2020/08/07/more-pain-than-gain-how-the-us-china-trade-war-hurt-america/.
[86] Koh Gui Qing, "China halts purchase of U.S. farm products," *Reuters*, August 2019, https://www.reuters.com/article/us-usa-trade-china-agriculture-purchase/china-halts-purchase-of-u-s-farm-products-idUSKCN1UV1WY.
[87] Menzie Chinn and Bill Plumley, "What is the toll of trade wars on U.S. agriculture?," *Public Broadcasting Service*, January 2020, https://www.pbs.org/newshour/economy/making-sense/what-is-the-toll-of-trade-wars-on-u-s-agriculture.
[88] Alex Wolf, "U.S. Farm Bankruptcies Spike Amid Trade War, New Debt Cap," *Bloomberg Law*, December 2019, https://news.bloomberglaw.com/bankruptcy-law/u-s-farm-bankruptcies-spike-amid-trade-war-new-debt-cap.

Between 2000 and 2020, China's food self-sufficiency decreased despite producing one-fourth of the world's grain and being the largest producer of meat, vegetables, poultry, cereal, eggs, fishery products, and fruit.[89] China's food self-sufficiency ratio, the percentage of food consumed that China produces by itself, has dropped from 93.6 percent in 2000 to 65.8 percent in 2020.[90] The decrease in China's self-sufficiency stems from multiple factors. First, the growth of China's middle class has led to an increase in desire for higher-quality, safer, and more varied food. It has also corresponded to an increasingly meat-heavy diet. Second, China has long suffered from lax food safety regulations, which has led to some high-profile food safety scandals. As such, many Chinese consumers prefer foreign imports over domestically produced food products. Some food imports, like soybeans, are also cheaper than domestically produced options because China may produce them at lower efficiencies and higher costs. Last, China has experienced a deterioration in their land quality due to land neglect and environmental damage, namely a five percent decrease of arable land between 2013 to 2019.[91] Other compounding pollution factors have also limited domestic food production; for instance, in 2018, 15.5 percent of China's groundwater was classified as unsuitable for any use due to the high pollution level, indicating potential difficulties in increasing food-reliance.[92]

The fall in China's self-sufficiency ratio has led to an increase in import needs. In 2013, Chinese leaders noted that China would need to supplement its domestic food supply with "moderate imports" to meet food security needs.[93] China's reliance on food imports is highest in sectors such as soybeans, beef, and oilseeds. In 2021, China's reliance on soybean imports was 83 percent. Additionally, its ruminant meat—meat that comes from hoofed herbivore grazing mammals—is 17 percent, and its dairy product reliance is 24 percent.[94] China's rising demand for soybean also stems from the country's use of soybeans as a central ingredient in animal feed for livestock. China is the world's largest importer of soybeans, with imports totaling to nearly 38.1 billion dollars.[95] Pork, which is China's main meat source, has also witnessed vulnerabilities within the past few years. After outbreaks of African swine fever in China since 2018, domestic production of pork had rapidly dropped by 21.3 percent in 2019 and pork prices nearly tripled between 2019 to 2020.[96] Chinese beef demand will likely grow due to concerns with Chinese pork safety; Brazil leads beef exports to China, followed by Argentina, Uruguay, and New Zealand. The U.S. ranks 6th in beef exports to China. China's imports of oilseed come mostly from Ukraine, Russia, and Kazakhstan.[97]

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[89] Food and Agriculture Organization of the United Nations (FAO), "China at a glance," FAO in China, 2023, https://www.fao.org/china/fao-in-china/china-at-a-glance/en/.
[90] Orange Wang, "China food security: 'severe challenges' ahead as rising incomes, geopolitical turmoil strain resources," *South China Morning Post*, April 2022, https://www.scmp.com/economy/china-economy/article/3176025/china-food-security-severe-challenges-ahead-rising-incomes
[91] Liu, 2023.
[92] China Power Team, "How is China Feeding its Population of 1.4 Billion?," Center for Strategic & International Studies, August 2020, https://chinapower.csis.org/china-food-security/#easy-footnote-bottom-3-1050.
[93] Fengshi Wu and Hongzhou Zhang, *China's Global Quest for Resources: Energy, Food and Water* (Oxfordshire: Taylor & Francis Group, 2017).
[94] FAO, 2023.
[95] China Power Team, 2020.
[96] Reuters Staff, "China's 2019 pork output plunges to 16-year low as disease culls herd," *Reuters*, January 2020, https://www.reuters.com/article/us-china-economy-output-pork/chinas-2019-pork-output-plunges-to-16-year-low-as-disease-culls-herd-idUSKBN1ZG08H.
[97] Charlotte Forkes-Rees, "Chinese beef imports rise so far in 2022," Agriculture and Horticulture Development Board," December 2022, https://ahdb.org.uk/news/chinese-beef-imports-rise-so-far-in-2022.

China's growing food import reliance signifies a variety of vulnerabilities, but the U.S. may find it difficult to leverage them. China's decreasing food self-sufficiency ratio is due to both decreasing amounts of arable land per capita— currently, this is at 0.08 hectare per capita, which is less than one-third of the OECD average—and shifting demands due to a growing middle class with higher purchasing power.[98] Still, though China's food self-sufficiency ratio has dropped to 65.8 percent, part of the drop is due to changing consumer preference rather than solely production capabilities. China was able to maintain a food self-sufficiency ratio of nearly 95 percent in 2000, when its arable land per capita was 0.09 hectare per capita, which is quite close to the current figure. Therefore, consumer preferences, rather than necessity, contribute to much of the fall in Chinas' self-sufficiency ratio in food. Still, due to problems with environmental degradation, increased population, and food safety issues, China would likely suffer if it is forced to return to 95 percent self-sufficiency.

There are signs that China may ease the effects of U.S.-led sanctions on its agricultural imports. Substitutability, stockpiles, and advancing Chinese food technology could soften the blow of restrictions on food exports to China. Following the U.S.-China trade war, Brazil replaced the U.S.'s position as China's leading agricultural supplier, with Brazilian products comprising 20 percent of China's food imports.[99] The second-largest agricultural exporter to China is the U.S., followed by New Zealand and Australia. China has increased imports of soybeans – one of the most import-reliant crops for China – from Brazil after the trade war, and China nearly halved its soybean imports from the U.S. from 2017 to 2018. However, since Chinese demand exceeds the combination of Brazil's and other non-U.S. countries' soybean production capacities, it relies on the U.S. for the rest.[100] While the U.S. exports a lot of grain to China, China only imports five percent of its grain.[101] Therefore, China has been able to decrease its agricultural vulnerability on the U.S. and the rest of the world; however, if the U.S. could convince Brazil to decrease agricultural exports to China, China would have high vulnerability in agriculture. The likelihood of Brazil and other countries that export agricultural products to China to comply is unclear since China is usually the main export market for them as well.

In addition, official statistics from China suggest that the country's food security is safeguarded well due to its massive stockpiles.[102] Official U.S. statistics indicate that China was projected to possess 69 percent of global corn reserves, 60 percent of rice, 51 percent of wheat, and 37 percent of soybeans by mid-2022.[103] According to China's National Bureau of Statistics, China's 2022 grain output in 2022 hit around 687 billion kilograms, up 0.5 percent from 2021; 2022 is the eighth consecutive year that

[98] The World Bank, "Arable land (hectares per person) - China," *The World Bank*, 2020, https://data.worldbank.org/indicator/AG.LND.ARBL.HA.PC?locations=CN.
[99] Liu, 2023.
[100] China Power Team, 2020.
[101] Evelyn Cheng, "Russia-Ukraine conflict has a limited impact on China's food prices," *CNBC*, March 2022, https://www.cnbc.com/2022/03/03/russia-ukraine-conflict-has-a-limited-impact-on-chinas-food-supply-analysts-say.html.
[102] Genevieve Donnellon-May and Zhang Hongzhou, "What Do We Really Know About China's Food Security?," *The Diplomat*, Feb 7, 2023, https://thediplomat.com/2023/02/what-do-we-really-know-about-chinas-food-security/.
[103] The Economist, "When China worries about food, the world pays," *The Economist*, April 2022, https://www.economist.com/china/2022/04/09/when-china-worries-about-food-the-world-pays?gclid=CjwKCAiAleOeBhBdEiwAfgmXf3w3pHfl__vInliDm4WQeI9Wk625fDpixISwa5ZY6RnwMB_KhdWyrhoCy8MQAvD_BwE&gclsrc=aw.ds.

national grain production exceeded 650 billion kilograms.[104] China's Ministry of Commerce estimated that the country had wheat stockpiles that could last the country 18 months.[105] China's National Food and Strategic Reserves Administration officials stated that the domestic grain market supply is "fully guaranteed" and that reserves have reached a "historical high level."[106] Still, China has not published data regarding its current stockpiles, and many within and outside China have doubts about official Chinese statistics.[107] In recent years, the Chinese government has adopted legislative measures for improving food safety, protection of the seed industry, protection of farmland, and combating food waste. The Chinese government has boosted the amount of high-quality farmland to target amounts in a recent initiative in 2020 and also began exploring more genetically modified crops—specifically corn and soybean.

Thus, China recognizes the import vulnerabilities and has begun projects to combat them. The country's main vulnerability is its status as a net importer of agricultural products, especially in soybeans and meat. The U.S. maintains top spots for contributing to imports in those crops; however, after the trade war, China has successfully transferred its highest reliance to non-U.S. countries though it still relies on the U.S. for some crops. Additionally, since China is by far the largest agricultural export market, the U.S. cannot easily target this vulnerability and is instead vulnerable to Chinese import restrictions.

Other

There are other areas of potential U.S. vulnerabilities, discussed below. Relative to critical minerals and agriculture, we assess that mitigating factors make these areas less concerning for the U.S., but under certain conditions they could be exploited by China.

Semiconductors

The U.S. has several of its own vulnerabilities in the semiconductor sector. China imports a large volume of semiconductors from the U.S., making it an important market for the U.S. semiconductor industry. In addition, the U.S. does not produce leading-edge semiconductors at home, relying mainly on Taiwan. Therefore, if supply from Taiwan were to be cut off due to China's actions, such as military invasion or economic blockade, it is highly likely that the U.S. would face a shortage of the most advanced chips.

[104]National Bureau of Statistics of China, "Bulletin on the National Grain Output in 2022," *National Bureau of Statistics of China*, December 2022, http://www.stats.gov.cn/english/PressRelease/202212/t20221215_1891098.html.
[105] Reuters, "China food security: Beijing assures public vegetable production 'basically normal', enough wheat for 18 months," *South China Morning Post*, November 2021, https://www.scmp.com/economy/china-economy/article/3154853/china-food-security-beijing-assures-public-vegetable.
[106] Xinhua, "China's grain reserves sufficient, supply secure," *CCTV.com*, November 2021, https://english.cctv.com/2021/11/05/ARTI6IkzENAoiM4twsurTom921105.shtml.
[107] Donnellon-May and Zhang, 2023.

U.S. semiconductor imports are on the rise, indicating an increasing dependence on other states to gain semiconductors.[108] While the U.S. "remains the unchallenged world leader in semiconductor design", U.S.-based chip manufacturing has declined to nearly 10 percent of the world total.[109] In general, East and Southeast Asia, especially Taiwan, South Korea, and Malaysia, are critically important regions for U.S. semiconductor trade. It is also critical to note that the U.S. lacks the ability to manufacture the most cutting-edge devices at the seven- and five-nm nodes domestically.[110] U.S. firms rely on sources in Taiwan and South Korea for the production of their most sophisticated designs.

Taiwan is particularly important as it produces about 90 percent of the world's most advanced logic chips. Only Taiwan Semiconductor Manufacturing Co, (TSMC) has the capacity to manufacture the U.S.-designed semiconductors found in the newest Apple smartphones, 5G communications systems, graphics cards, and data center computers.[111] Apart from this, the U.S. currently relies on facilities located in Taiwan for the production of the most advanced semiconductors used in such electrical appliances as well as F-35 fighters and a wide range of military-grade devices used by the U.S. Department of Defense (DOD). China could take various actions, including military actions, which would disrupt the production and delivery of chips.[112]

Additionally, China plays an important role in the semiconductor supply chain "as one of the largest providers of chip assembly, packaging, and testing (APT) services, which is the final stage of the manufacturing process."[113] Overall, 22 percent of the world's APT facilities are in China.[114] The U.S. has very little onshore capability for APT, "holding less than a 5 percent share of these essential functions".[115] Chips that are manufactured in the U.S. are frequently sent to China for final processing.[116] Hence, this situation would present a significant vulnerability to the U.S. if it were no longer able to use China's APT facilities. Lastly, China is one of the important destinations for U.S. exports of chips. Therefore, if semiconductor exports from the U.S. to China were to stop, the U.S. market would suffer economic damage. In a worst-case scenario in which U.S. semiconductor sales to China fall to zero, U.S. companies would lose 18 percent of their global market share and 37 percent of their revenues—leading to the loss of 15,000 to 40,000 high skilled domestic jobs", according to Boston Consulting Group (BCG) estimates.[117] In addition, the American Chamber of Commerce estimates that U.S. companies would face a loss of $83 billion annually, costing 124,000 jobs."[118]

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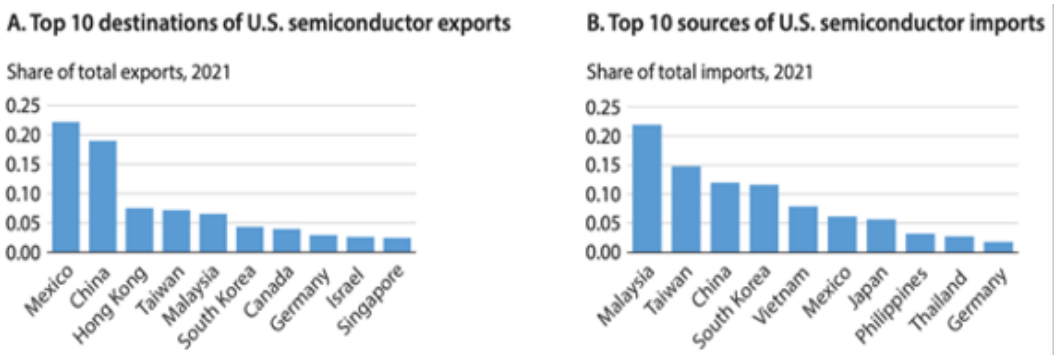
[108] Fernando Leibovici and Jason Dunn, "U.S. Trade of Semiconductors: Cross-Country Patterns and Historical Dynamics," *Economic Synopses*, No. 31, 2022, https://research.stlouisfed.org/publications/economic-synopses/2022/12/07/u-s-trade-of-semiconductors-cross-country-patterns-and-historical-dynamics.
[109] Shivakumar and Wessner, "Semiconductors and National Defense."
[110] Shivakumar and Wessner, "Semiconductors and National Defense."
[111] Ibid.
[112] Ibid.
[113] Dexter Tiff Roberts and Jeremy Mark, "United States- China Semiconductor Standoff: A Supply Chain Under Stress," *Atlantic Council,* (March, 2023): 7, https://www.atlanticcouncil.org/in-depth-research-reports/issue-brief/united-states-china-semiconductor-standoff-a-supply-chain-under-stress/.
[114] Khan, Mann, and Peterson, "The Semiconductor Supply Chain."
[115] Shivakumar and Wessner, "Semiconductors and National Defense."
[116] Mark and Roberts, "United States- China Semiconductor Standoff."
[117] Feng, "The Costs of U.S.-China Semiconductor Decoupling."
[118] Mark and Roberts, "United States- China Semiconductor Standoff," 5.

Figure 10. U.S. Semiconductor Trade.

Source: Leibovici and Dunn, "U.S. Trade of Semiconductors."

Figure 11. U.S. semiconductor export and import destinations



The U.S. has little chip manufacturing capacity and little substitutability, as Taiwan produces most of the cutting-edge semiconductors in the world. By blocking semiconductor deliveries from Taiwan to the U.S., China would cause serious negative damage to U.S. consumer electronics production and military capabilities. However, the U.S. and "its allies are global semiconductor supply chain leaders,"[119] while China is dependent on those states. Furthermore, in August 2022, President Biden signed into the law CHIPS and Science Act of 2022 (Chips Act), which provides $52 billion in federal subsidies for chip manufacturing companies worldwide to build manufacturing facilities in the U.S.[120] The subsidies have led to a boom in investment in U.S. chip manufacturing, particularly in cutting-edge semiconductor manufacturing, from a variety of major firms. These Chips Act-based measures are likely to mitigate U.S. vulnerabilities with respect to cutting-edge chip production in the medium to long term. It is true that the loss of access to China's ATP would leave the U.S. vulnerable in the short term, but the option to rely on countries other than China for ATP could present a longer-term solution.

[119] Khan, Mann, and Peterson, "The Semiconductor Supply Chain," 3.
[120] Aidan Power-Riggs, "Taipei Fears Washington Is Weakening Its Silicon Shield," *Foreign Policy,* Feb 17, 2023, https://foreignpolicy.com/2023/02/17/united-states-taiwan-china-semiconductors-silicon-shield-chips-act-biden/.

In summary, the U.S. is vulnerable to the difficulty of obtaining semiconductors if the supply chain is disrupted by China's actions, including military actions. In particular, the U.S. is most vulnerable with respect to access to the most advanced semiconductors in the event of a contingency in Taiwan, which would likely cause significant damage to the U.S. economy and U.S. military capabilities. However, given that China plays little or no exclusive role in the semiconductor supply chain and the U.S. and "its allies are internationally competitive in every segment in the supply chain,"[121] the vulnerability of the U.S. in the semiconductor sector is much smaller than that of China.

FDI Stocks in China

As one of the fastest growing economies for decades with an abundant and inexpensive labor supply, China has long been an attractive place for foreign direct investment. The total stock of FDI in China is above $2 trillion, with much of it owned by the West.[122] Countless American companies own property and equipment in China. If China were to be hit with financial sanctions from the West, one of the first things China could do in response would be to nationalize this stock of $2 trillion.

Such an action could have dramatic effects on the West, as the FDI in China is a productive investment that is critical for many foreign companies to sustain profitability. Thus, nationalizing this stock of FDI could trigger financial crises abroad. Furthermore, China's role at the center of global supply chains makes Western companies even more vulnerable to possible Chinese nationalization of their FDI. Many entities rely on Chinese manufacturing for all or part of their finished products. Indeed, the sector in China with the highest FDI involvement is manufacturing, accounting for over 25 percent of all 2019 FDI into China.[123] If China were to nationalize just this manufacturing FDI, it could have extreme effects on global trade.

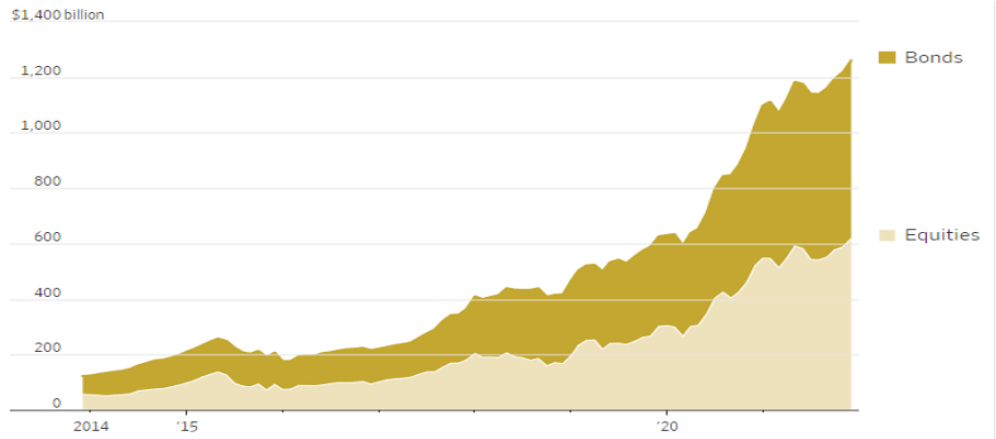
This area is China's primary and most important lever if it wanted to hit the U.S. with retaliatory financial sanctions, however it still is less effective than Western financial sanctions on China, as it would be targeting U.S. private companies and immediately make China an extremely unattractive place for foreign investment, which would hurt Chinese economic growth.

Foreign Ownership of Chinese Bonds and Equities

In addition to heavy FDI into China, foreign investors in recent years have dramatically increased the purchase of Chinese domestic bonds and equities, denominated in renminbi. Current global ownership of Chinese onshore financial assets is above $1.2 trillion, split close to evenly between stocks and bonds.

[121] Khan, Mann, and Peterson, "The Semiconductor Supply Chain," 9.
[122] "China: Foreign Investment," Santander, April 2023. https://santandertrade.com/en/portal/establish-overseas/china/foreign-investment
[123] "China: Foreign Investment," Santander, April 2023. https://santandertrade.com/en/portal/establish-overseas/china/foreign-investment

Figure 12. Foreign holdings of Chinese renminbi-denominated securities[124]

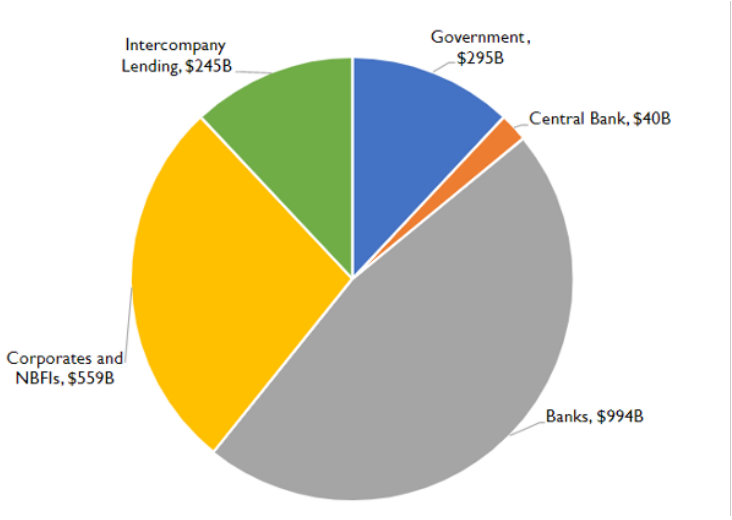


Just as the West can freeze Chinese assets, so too could China freeze this $1.2 trillion in foreign-held Chinese assets. Once again though, as opposed to Western sanctions which would primarily freeze government-held assets, China would be hurting first and foremost private foreign investors and entities that own these Chinese securities.

Chinese External Debt

China also has a leverage point in its amount of external debt. China's external debt currently sits above $2.1 trillion, with the banking sector the largest source of outward facing debt.

Figure 13: Sources of Chinese External Debt[125]



[124] Rebecca Feng, "China's Stock Market Weathers Heavy Foreign Outflows," Wall Street Journal, March 24, 2022. https://www.wsj.com/articles/chinas-stock-market-weathers-heavy-foreign-outflows-11648119780
[125] "Tracking China's Foreign Debt," Seafarer, November 2020. https://www.seafarerfunds.com/prevailing-winds/2019/01/tracking-chinas-external-debt/#:~:text=According percent20to percent20the percent20official percent20statistics,abroad percent2C percent20even percent20those percent20in percent20renminbi percent20.

These trillions in external debt quickly could lead to financial losses for Western creditors, as the likelihood of being repaid would diminish greatly under an increasingly hostile sanctions regime. Indeed, China and Chinese companies could make the same argument that Russia has made to stop servicing debts, which is that they are able to pay but that sanctions put on them by the West have made payment impossible.

If China were to suspend these debt payments, it once again could roil financial markets and cause heavy losses for Western investors, the biggest of whom are investment and pension funds.[126] The losses to pension funds in particular could be critical, as it would be a way for individuals in western countries en masse to feel the brunt of Chinese retaliatory sanctions.
This is likely the West's greatest vulnerability to Chinese financial sanctions, as it would be easy for China to stop servicing its debt and there is already historical precedence set by Russia.

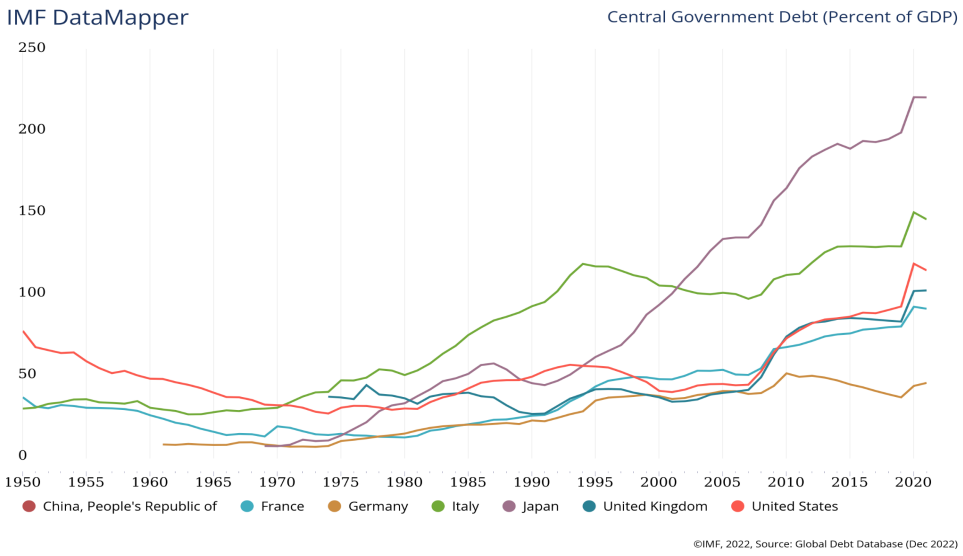
Currency

U.S. currency vulnerabilities have been investigated to decipher whether China could eventually exploit a currency advantage it would have over the U.S. Overall, the current position of the dollar provides the U.S. with very few currency vulnerabilities and a rather stable and secure currency space.

Two potential vulnerabilities may undermine the power of the dollar. First, the quality of U.S. assets' security holders can be doubtful as the largest holders of U.S. assets are also some of the world's largest debtor countries. Japan possesses $1,299.9 billion worth of U.S. securities and is the most indebted country in the world when considering debt-to-GDP, with a debt reaching as high as 257 percent of its GDP.[127] If countries that are large security holders were to experience a period of instability, a "run on the dollar" would be highly likely and force the United States to "make an immediate budgetary decision between national security and other spending" and entail a potential reduction in defense capabilities.[128] It must be noted, however, that most of the U.S.' external debt is held by allied nations and their central banks which would spare the U.S. from adverse currency maneuvers. For instance, it would be unlikely that allies sold their dollar holdings as soon as instability manifested. Therefore, the most significant risk to be mentioned, reiterating China's currency vulnerabilities, is the U.S. and allies' exposure to asset freezes by China. Going back to China's currency vulnerabilities, this report had warned that a weaponization of the dollar may give rise to significant retaliation from China which currently has more than $5 trillion of international investments located inside its borders, many of whom come from Western countries, and which could be leveraged in China's favor.

[126] Tran Hung, "Wargaming a Western Freeze of China's Foreign Reserves," Atlantic Council, May 2, 2022, https://www.atlanticcouncil.org/blogs/econographics/wargaming-a-western-freeze-of-chinas-foreign-reserves/.
[127] Neil C Everingham and David A Anderson, "The Dollar's Vulnerability and the Threat to National Security," Defense Technical Information Center, 2011, https://apps.dtic.mil/sti/pdfs/ADA554536.pdf.
[128] Neil C Everingham and David A Anderson, "The Dollar's Vulnerability and the Threat to National Security," Defense Technical Information Center, 2011, https://apps.dtic.mil/sti/pdfs/ADA554536.pdf.

Figure 14: Central Government Debt (as percentage of GDP)[129]



Very few currency vulnerabilities could hence be leveraged against the United States, except perhaps for a freeze of the $5 trillion of international, and especially Western, investments China possesses. China is additionally significantly indebted to the U.S. and many other Western countries (even though a net creditor overall), a situation China could use to its advantage. Just like Russia over the past year, China could eventually stop servicing its debt which would in turn hurt Western investors. These measures are quick to implement but would probably be risky for China to carry out. First, and as explained above, there are few currency vulnerabilities to be exploited against the United States. Second, any move made by China to sanction the U.S. would be met by significant U.S. retaliation through a weaponization of the dollar and a potential expropriation of U.S. held Chinese assets, which would cause China to risk severe currency devaluation, loss of investment, reduction in access to the U.S. financial system.

Other goods and services

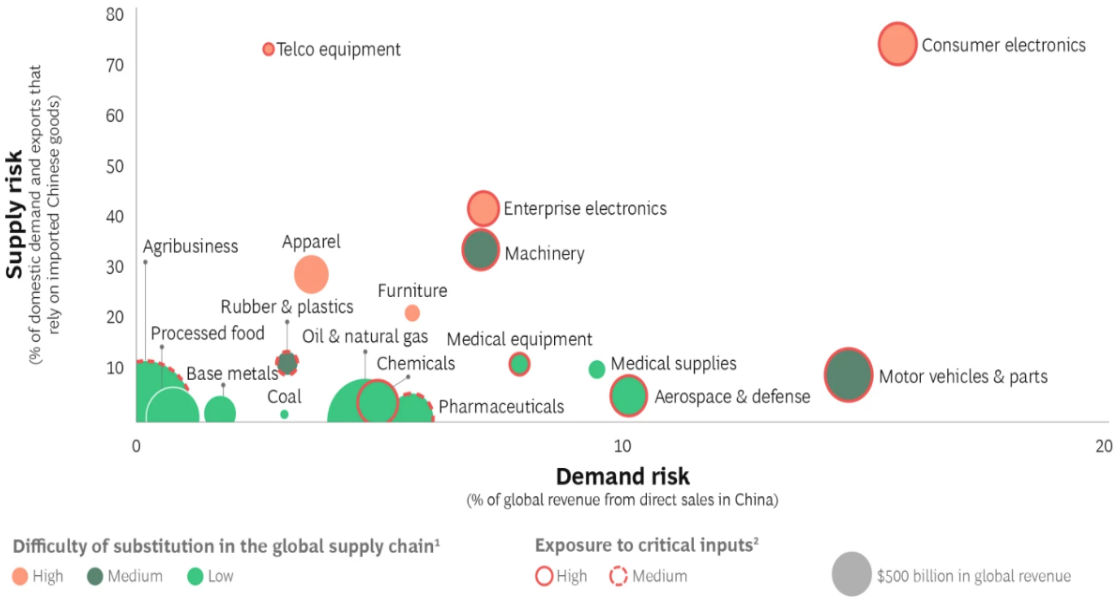
The integrated supply chains between the U.S. and China also poses a significant risk for the U.S. market. In 2022, total U.S. imports from China accounted for around 2.1 percent of U.S GDP, while U.S. exports to China accounted for as high as 6.04 percent of U.S GDP. A high degree of interdependence between the U.S. and China has been fostered in a number of industrial sectors, not only for specific finished products, but also for key intermediate goods and raw materials. While we have previously noted the high volume of exports from China to the U.S., trade statistics also include goods that are manufactured in China on behalf of U.S. firms and subsequently sold in the U.S. market. Therefore, it is important to note that China's trade dependence on the U.S. market also creates vulnerabilities for the U.S.

[129] "Central Government Debt," IMF - International Monetary Fund, accessed March 31, 2023, https://www.imf.org/external/datamapper/CG_DEBT_GDP@GDD/CHN/FRA/DEU/ITA/JPN/GBR/USA.

In terms of demand risk, or the proportion of a company's global income that comes from exports to China, American industries would stand to lose much more revenue than their Chinese counterparts if the commercial relationship deteriorates to the point that U.S. companies cannot sell in China[130]. In an extreme case, cutting all ties with China would risk around $410 billion in annual income for U.S. businesses[131]. Although it only accounts for 5 percent of their overall income, its loss would amount to roughly $2.5 trillion or 15 percent of their market capitalization.

The U.S. consumer electronics industry is the most vulnerable to risk in terms of demand. Sales of consumer electronics by U.S. consumer electronics businesses in China were around $60 billion, accounting for 16 percent of U.S. global revenue in this industry. Apart from this, China is the second-largest source of revenue for the U.S. motor vehicle and components industry, contributing 14 percent ($80 billion) of its overall sales. Similarly, 7 percent to 8 percent of the revenue from the medical supply and medical equipment comes from China.

Figure 15. U.S. supply chain exposure to China, sectoral



Industries that produce highly designed final goods—such as consumer electronics, aerospace, medical technology, and machinery—source a significant amount of these critical inputs from China. China dominates the global consumer electronics export market as the global assembly factory with a capacity share of over 75 percent, making it very challenging to replace. According to import data from the U.S. Census Bureau in 2022, the share of U.S. imported electrical machinery[132] from China accounts for up to 30.78 percent.[133] The U.S. import share of other trading partners were Mexico and Vietnam;

[130] "What's at Stake If the US and China Really Decouple," Boston Consulting Group, accessed April 20, 2023, https://www.bcg.com/publications/2020/high-stakes-of-decoupling-us-and-china.
[131] Ibid.
[132] HS Code 85; goods in this categorization ranges home appliances, smartphones, wire to TV monitors
[133] US Census Bureau

however, the share was far less than China, accounting for only 17.03 percent and 9.76 percent respectively. The most critical goods in this sector are batteries, in which the share of China exports to the U.S. market was as high as 33.89 percent in 2022. Another vulnerability found for the U.S. is in machinery and mechanical parts. In this, the share of U.S. imports of machinery and mechanical parts from China is approximately one quarter[134]. Mexico and Japan were third and largest U.S.'s major trading partners in this industry, with share of imports accounting for 18.64 percent and 8.17 percent respectively.

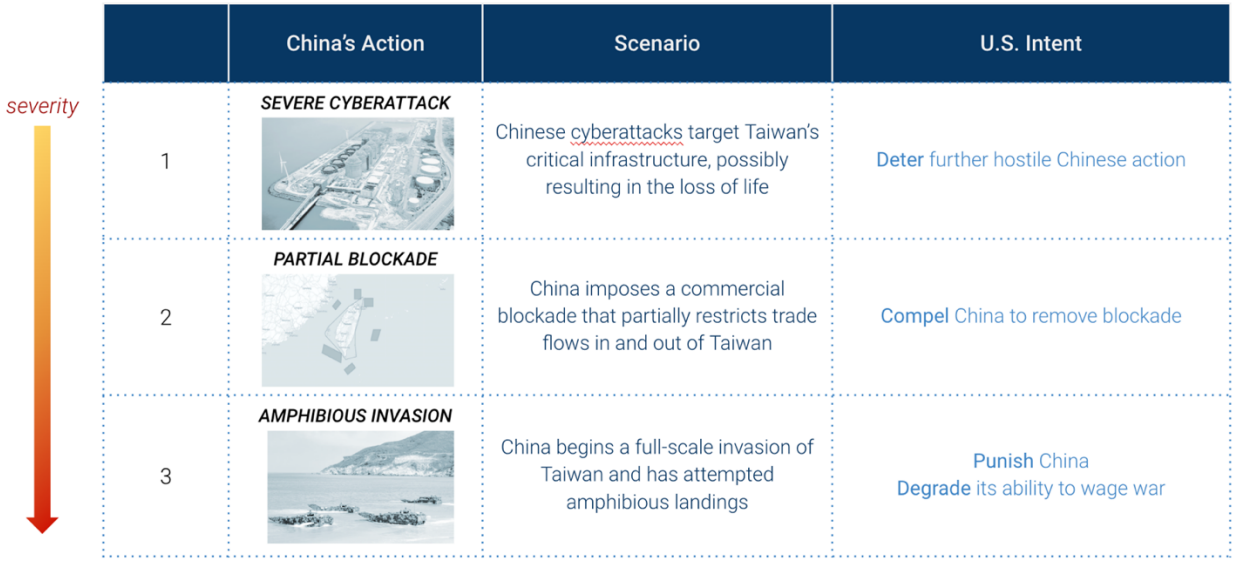
In 2022, the proportion of U.S. imports from China in sectors such as toys, furniture, and apparel were notably high. For instance, China's share of U.S. toy imports was 77 percent, while for furniture and footwear, it stood at 32.87 percent and 38.44 percent, respectively. Despite the dominance of China in these industries, there is potential to diversify supply chains to other countries. However, it is worth noting that complete replacement of China may not be feasible, and any supply shortages could result in increased prices and production delays.

[134] US Census Bureau

Scenarios

Any U.S. or allied response to a Chinese threat against Taiwan is contingent upon the nature and severity of the threat. For instance, U.S. allies will be less inclined to react to non-kinetic attacks of Taiwan, but more likely to respond to situations that have resulted in the loss of life. The intent of U.S. sanctions also varies across scenarios (see Logic Model for Response Selection). In some cases, the U.S. may seek to deter China from further aggression or compel China to return the situation to status quo ex ante. When deterrence and coercion have failed, the intent of sanctions is to degrade China's ability to sustain invasion.

We identify three threat scenarios for analysis: (1) severe cyberattack; (2) blockade; and (3) amphibious invasion. While by no means an exhaustive list, these scenarios represent feasible PRC actions vis-a-vis Taiwan of varying severity that would elicit different U.S. and allied responses. We recognize that these scenarios could play out successively or simultaneously during a PRC campaign against Taiwan. However, we treat them independently to highlight how the *intent* of sanctions as well as the operational and political restraints governing response selection vary across scenarios. The scenarios serve as the basis for three different geoeconomic "games." We outline them in greater detail below.



Severe Cyberattack

Taiwan suffers from billions of cyberattacks from China every year.[135] Following former U.S. Speaker of the House Nancy Pelosi's visit to Taiwan last summer, for instance, official Taiwanese websites like that of the Ministry of Defense and Presidential Office were forcibly shut down, likely due to DDoS attacks from Chinese actors.[136] These low-level cyberattacks have not elicited a response from the U.S. or its allies, as they have not posed serious harm and are resolved by Taiwan without significant difficulty.

In a severe cyberattack, we envision a situation where China targets Taiwan's critical infrastructure, possibly resulting in casualties or the loss of life. This could include, for instance, shutting down Taiwan's electrical grid or cyberattacks that lead to the temporary malfunctioning of hospital systems. In this case, we assume that attribution is not an issue, as China would need to clearly signal that it had launched the attacks to effectively coerce Taiwan. Sources suggest that China may consider using cyber to shut down Taiwan's communications systems in the initial stages of an invasion.[137] As such, a severe cyberattack may also be a kind of attack that is perceived as a precursor to broader and more violent PLA operations. For this reason, the U.S. and its allies may feel compelled to respond, even though it has not formerly reacted to low-level Chinese cyberattacks on Taiwan.

In this light, the purpose of U.S. sanctions is to deter further Chinese aggression. While cyberattacks cannot be undone, the U.S. can signal readiness to effect further punishment on any form of Chinese escalation. Close U.S. allies in the Indo-Pacific, namely Japan and Australia, may consider sanctioning China as well. South Korea and European allies, however, may still hesitate to risk their trade relationship with China. We believe China's severe cyberattack will, at the very least, result in international opprobrium.

Blockade

Security discussions revolving around Taiwan have frequently pointed to a blockade as a possible choice of PLA aggression. In recent years, this has become a sobering possibility. Namely, following former U.S. Speaker of the House Nancy Pelosi's visit to Taiwan in August 2021, the PLA conducted live-fire exercises in six regions around Taiwan that resembled a blockade.[138] We understand that a blockade may take on many forms, ranging from a customs quarantine to a full blockade.[139] In this case, we assume a blockade that restricts Taiwan's ability to import and export but essential goods, like

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[135] Ryo Nemoto, Hideaki Ryugen, and Yu Nakamaura, "China intensifies disinformation cyberattacks on Taiwan: report," *Nikkei Asia*, November 26, 2022, https://asia.nikkei.com/Politics/International-relations/Taiwan-tensions/China-intensifies-disinformation-cyberattacks-on-Taiwan-report.
[136] Maggie Miller, "Taiwan presidential office website hit by cyberattack ahead of Pelosi visit," *Politico*, August 2, 2022, https://www.politico.com/news/2022/08/02/taiwan-presidential-office-website-hit-by-cyberattack-ahead-of-pelosi-visit-00049255.
[137] David Lague and Maryanne Murray, "T-Day: The Battle for Taiwan," *Reuters*, November 5, 2021, https://www.reuters.com/investigates/special-report/taiwan-china-wargames/.
[138] Costas Paris, "China Military Drills Prompt Ships to Leave Taiwan Waters," *The Wall Street Journal*, August 5, 2022, https://www.wsj.com/articles/china-military-drills-prompt-ships-to-leave-taiwan-waters-11659712279?mod=article_inline.
[139] Lague and Murray, "T-Day: The Battle for Taiwan."

energy, are allowed to flow into Taiwan. That is, it is a medium-level crisis that is more acute than a severe cyberattack but less threatening than an amphibious assault.

The purpose of U.S. sanctions in a blockade scenario is to compel China to reverse its course of action to return to the status quo ex ante. There is sufficient reason to believe that many U.S. allies will respond to a blockade with grave concern. First, a blockade of Taiwan will not only cripple supply chains and halt global microchip exports but also severely restrict global shipping through the Taiwan Strait, one of the busiest shipping routes in the world.[140] Taiwan is an important trading partner to many large economies, so a blockade would likely generate worldwide pressure on China to lift it.[141]

Amphibious Invasion

The all-out invasion scenario is the most widely discussed subject of cross-Strait conflict. It would be violent, involving multiple stakeholders and high political stakes. Amphibious operations are notoriously difficult, and scholars have suggested that a Chinese amphibious assault may lead to more bloodshed than the D-Day landings.[142] Additionally, due to Taiwan's island geography and dense population, the people of Taiwan are trapped on the island once war breaks out, implying significant difficulty providing any form of humanitarian assistance to them.

In this worst-case scenario, the purpose of U.S. sanctions is to degrade China's warfighting capabilities and compel China to move out of Taiwan. We believe most democracies will join the U.S. in sanctioning China for launching an attack on Taiwan, much like their response to Russia's war on Ukraine. First, as previous scenarios have outlined, any conflict revolving around Taiwan will have severe consequences for the global economy. Second, a Chinese invasion of Taiwan is highly symbolic, falling perfectly under the authoritarianism vs. democracy discourse. As with the case of Ukraine, many democracies may feel compelled to support Taiwan.

[140] Chun Han Wong and Yang Jie, "What a Chinese Blockade of Taiwan Would Mean For Global Business," *The Wall Street Journal*, August 15, 2022, https://www.wsj.com/articles/what-a-chinese-blockade-of-taiwan-would-mean-for-global-business-11660557601.
[141] David Uren, "A blockade of Taiwan would cripple China's economy," ASPI *The Strategist*, August 8, 2022, https://www.aspistrategist.org.au/a-blockade-of-taiwan-would-cripple-chinas-economy/.
[142] Ian Easton, "Why a Taiwan Invasion Would Look Nothing Like D-Day," *The Diplomat*, May 26, 2021, https://thediplomat.com/2021/05/why-a-taiwan-invasion-would-look-nothing-like-d-day/.

Logic Model for Response Selection

Our Framework

Economic statecraft is an art, not a science. While an empirical mapping of U.S.-China economic interdependence highlights areas of asymmetric vulnerability that present logical pressure points in an economic war, it does not produce a roadmap for U.S. and Chinese first responses. To complete the picture, the next step in "gaming" an economic conflict is to understand the political and material constraints governing response selection.

Our framework attempts to systematize this analysis. It first assesses the specific *intent* of U.S. sanctions under each scenario: **deter** the counterparty from undertaking a certain action, **coerce** it into modifying or reversing that action, **degrade** its ability to carry out a certain policy over the medium term, and/or **stigmatize** the counterparty by imposing an economic penalty. It then evaluates potential sanctions by measures of economic **effectiveness** and political **feasibility.** Critically, our assumptions about the political economy of response selection varies across the three scenarios. For example, in Scenario 3 (amphibious invasion), we assess that U.S. partners in the region would have a higher pain tolerance than in Scenarios 1 (cyberattack) and 2 (blockade) and a greater willingness to endure collateral damage from sanctions, which widens the aperture for possible U.S. responses. In Scenario 1 (cyberattack), the U.S. might assign relatively less importance to the speed of sanctions implementation, due to problems of attribution and a desire to avoid needless escalation. What ultimately emerges from the framework is a proposal for a specific set of coercive economic measures that pass the political and operational smell test. Below, we discuss each variable in greater detail.

Intent ƒ(scenario)	Effectiveness (Econ)	Feasibility (Pol)	→	Action
Deter Coerce/Compel Degrade Signal Punish	Asymmetric impact P (China) : Pain (U.S., allies) Speed of implementation Immediacy of impact Reversibility (if i = coerce) Scalability	Domestic politics Alliance politics Unilateral/multilateral Enforcement costs Escalation risks		Financial sanctions Export restrictions Travel bans Asset freezes Investment restrictions
Example: **Partial Blockade** | U.S. DELIBERATION				
Compel China to lift the blockade	Asymmetric pain Immediacy of impact Reversibility	Moderate alliance pain tolerance Multilateral sanctions Maintain off-ramps for de-escalation	→	**X** energy embargo ✓Expand EX restrictions on semiconductors ✓Partial freeze of PBOC FX reserves

Economic Effectiveness

Asymmetric impact: Economic warfare is inherently value-destroying and pareto-inefficient. Financial sanctions, export restrictions, tariffs, and blockades disrupt the normal exchange of goods and capital across borders, often inflicting "losses" on both sanctioned and sanctioning economies (even if specific sectors of the domestic economy benefit, for example, in the case of tariffs). The basic logic of sanctions, therefore, is to capture relative gains from asymmetric losses, or in other words to choose measures that inflict more pain onto your adversary than onto yourself. If you take Action A and your opponent goes down 5 units while you go down 2 units, you emerge relatively 3 points better off. Any sanction, no matter the scenario, must meet this basic criterion of asymmetric impact.

Immediacy of impact: Sanctions can "slam the hammer" or "turn the screw". The former imposes high, early costs designed to shock the target, usually with the intent of unwinding or modifying a policy (coercion). Western financial sanctions against Russia in 2022 fit this category: Russia was unprepared to see its foreign reserves frozen and for its largest banks to be removed from SWIFT, and the Moscow-based MOEX exchange rapidly lost value as investors fled the market. The goal was to create a sense of crisis within Russia by shocking markets. This category of sanction has higher coercive potential but inflicts more collateral damage, since non-target markets also have less time to adjust. Conversely, sanctions which "turn the screw" build costs over time. Their goal is less to induce a crisis than to sustain political pressure by strangling key sectors of a target economy, often by restricting financing or strategic technology transfers. This category of sanction typically inflicts less collateral damage, but it also leaves target economies with more time to adjust, diluting its coercive potential. A classic example is Western "sectoral" sanctions applied against Russia in 2014, which avoided an outright ban on transactions with Russian oil and gas companies but restricted specific kinds of transactions, such as long-term lending or the provision of Arctic/off-shore oil exploration technologies.

Speed of implementation: If the intent of sanctions is to impose pain immediately, then an additional consideration is how quickly the sanctions can be implemented and whether they require a high degree of coordination among partners. To illustrate the point: a hypothetical U.S. decision to interdict Chinese oil imports would deal immediate pain to China's economy, but would take time to negotiate among partners. Would Saudi Arabia comply with the U.S. embargo, or would the U.S. navy have to interdict oil tankers, and at what rate? How would the U.S. ensure energy imports still make their way to coalition partners in range of Chinese missiles? Resolving these questions would slow the U.S. response. By contrast, it only takes hours for the U.S. to apply devastating financial sanctions, which rely on banks for enforcement, and whose final "form" is a PDF document posted to the Treasury website. It bears noting that China is advantaged in this category due to its centralized decision making and the fact that it has fewer partners with whom to negotiate sanctions.

Reversibility: Coercive sanctions must be reversible. If a target economy perceives economic pain as a "sunk cost," it has little incentive to modify its behavior. But the promise of removal must be credible in order for sanctions to be coercive. One way to enhance the credibility of sanctions is to design them to automatically expire, or to require their review at regular intervals. By contrast, sanctions which are codified into law, such as the Countering American Adversary Through Sanctions Act (CAATSA), are harder to remove and serve more to degrade or signal than to coerce behavior change.

Scalability: Sanctions can be designed as an on/off switch or a dial. For example, sanctioning parties could issue full blocking sanctions against key companies in the target economy, or restrict only certain kinds of financial transactions, such as long-term debt financing. Similarly, a sanctioning party could implement a 5 percent tariff or a 50 percent one, or threaten to progressively scale up the tariff in order to build in time incentives for behavior change.

Political Feasibility

Domestic politics: The immense scale of economic activity at risk of disruption in a U.S.-China economic conflict means that interest groups in both countries face incentives to influence policy in ways that minimize pain. This is particularly true for America, a pluralistic society with a decentralized government and established lobbying culture. China is the U.S.'s largest import market. Estimates suggest that decoupling would cost the American aviation industry up to $875 billion by 2038; the semiconductor industry up to $159 billion and 100,000 jobs; the medical services industry more than $479 billion over the next decade. When the U.S. sanctioned Rusal in 2017, lobbying from American companies such as Boeing contributed to a U.S. decision to reverse that action. At the same time, governments might be relatively immune to corporate lobbying if clearly defined strategic interests are at stake.

Alliance politics: The spillover effects of coercive economic tools tend to be regionally concentrated: just as the economies of Poland and the Baltic states hurt the most from a disruption of trade with Russia, so too would South Korea, Japan, Germany, and Australia face potentially significant pain from a geoeconomic war with China. At the same time, as the case of Poland and the Baltics show, the pain tolerance of neighboring countries can be strong if the target's action is egregious. We assess that the pain tolerance of key U.S. partners is low in Scenario 1, moderate in Scenario 2, and high in Scenario 3. Alliance politics narrows or widens the aperture for U.S. actions. It is comparatively less of a concern for China, who tends to act more unilaterally and whose partners are less able to exert pain on the U.S. economy.

Enforcement costs: Certain measures, even if coordinated with allies, carry high enforcement costs. For example, while we believe U.S. companies would willingly comply with export controls, the case of Russia reveals how sanctioned products such as microchips continue to make their way to target countries through third parties. U.S. secondary sanctions are one mechanism of enforcement, but they require *time* for monitoring and intelligence gathering, while their imposition can carry political costs (i.e. angering Turkiye, a NATO ally). China, too, would face enforcement costs in making restricted exports are not simply rerouted through third countries.

Gaming Economic War

Our Method

Next, we apply our understanding of U.S.-China economic vulnerabilities and our framework for response to selection to simulate how Washington would respond to China under each of the scenarios as well as what measures Beijing would take in turn.

This exercise bears an important disclaimer: In gaming U.S.-China economic war, we are neither prescribing nor forecasting which actions the U.S. and China should or might take in the event of a conflict. *We adopt an empirical approach that generates "moves" based on our best understanding of mutual vulnerabilities, intent, and the logistical, operational, and political constraints governing economic response selection*.

What follows is a description of the deliberation and decision making that took place in a mock strategic game in April 2023 at Columbia SIPA. We begin by analyzing the strategic intent of coercive economic tools under our scenario. We then consider which economic and political variables the U.S. and China would prioritize in selecting response measures. We then propose specific "Actions" that fulfill *intent* and

GAME 1: CYBERATTACK

U.S. INTENT

In Scenario 1, we assess that the main intent of U.S. sanctions is to **deter** future cyberattacks. China has already conducted the attack and Taiwan has suffered the consequences; while the U.S. is not capable of undoing China's action, it nevertheless wants to impose an economic penalty on China that makes Beijing reconsider a replication or escalation of the attack in the future.

U.S. DELIBERATION

We identify several variables within our framework that animate the U.S. response:

- *Speed of implementation:* In order to signal resolve, the U.S. wants to respond quickly. But it does not necessarily reach for measures designed to create immediate, widespread impact on the Chinese economy. Speed of implementation is of greater importance than immediacy of impact.
- *Scalability:* To strengthen the deterrent effect of sanctions, initial U.S. sanctions are modest but designed to be scaled up under existing legal authorities in the event of an escalation.
- *Alliance politics:* We judge the economic "pain tolerance" of U.S. partners in the region to be relatively low in the event of a cyberattack. Understanding this, the U.S. opts for measures that

do not disrupt trade between China and U.S. partners in the region. Washington prioritizes alliance unity over pain imposition.

U.S. MOVES

- An intelligence assessment from the U.S. intelligence community (IC) attributes the cyberattack to PLA Unit 61398, which has been implicated in past cyberattacks targeting U.S. and European companies. The U.S. chooses an action that is economically inconsequential but creates a mechanism for accountability (cyberattack → attribution → penalty).

  Action: The U.S Department Treasury updates the Specially Designated Nationals (SDN) list to apply travel bans and full blocking sanctions on all known members of PLA Unit 61398 as well as key commanders in the Strategic Support Forces (the arm of the PLA tasked with cyber and information operations).

- Additionally, the U.S. takes aim at elements of the Chinese technology sector, reasoning that China's cyber "aggression" against Taiwan should carry costs for China's overall technological capacity. The U.S. also seeks to expose and counter PRC military-civil fusion, whereby the PLA gains access to advanced military technologies developed by nominally unaffiliated companies, universities, and research programs. However, mindful of escalation risks and not wishing to start a sanctions tit-for-tat that would adversely affect U.S. partners in the region, the U.S. opts for highly targeted sanctions dialed to avoid significant macroeconomic impact.

  Action: The Department of Treasury imposes financial sanctions prohibiting U.S. purchases of Chinese corporate bonds in the high end technology sector (AI, quantum computing, 5G, and advanced semiconductors, but exempting any climate-related technologies, such as novel EV battery technology).

  This restricts U.S. investment into low- or mid-sized Chinese technology with demonstrable dual-use military applications. It does not impose restrictions on U.S. investment into other technology sectors such as social media, food delivery, or e-commerce, where China's largest tech companies are concentrated.

  Action: The Commerce Department expands existing semiconductor export controls on cutting-edge chips, now requiring export licenses for a narrow range of select lower-end chip technologies.

  Though considerably less impactful than the October 2022 ban on advanced semiconductor exports, this action signals U.S. intent to immediately take aim at China's most vulnerable sector, albeit at a low level initially. The implicit message is that the U.S. will broaden its export ban should China replicate its cyberattack against Taiwan.

CHINA'S INTENT

Reputation matters in a strategic game. In Scenario 1, China's intent is primarily to **signal** that it will respond forcibly to U.S. measures in order to avoid appearing weak. At the same time, China is cautious to avoid countermeasures that could ignite a cycle of escalation. Having sent a strong message to Taiwan, Beijing wants to "freeze" the game in order to minimize economic damage.

CHINA'S DELIBERATION

China's response is animated by three variables:

- *Speed of implementation:* Like the U.S., China emphasizes a rapid response more than an economically damaging one. China must avoid a perception that it does not have levers to pull in an geoeconomic game with the U.S.
- *Scalability*: China also opts for countermeasures that can be scaled up in the event of an escalation.
- *Alliance politics:* In responding, Beijing chooses measures that magnify existing cleavages between the U.S. and its regional partners, with the ultimate goal of undermining support for U.S. sanctions. America's network of allies and partners is a vulnerability as well as an opportunity for China.
- *Domestic politics:* China's more opaque business environment and the strong hand of the state in directing private actors opens opportunities for "informal" responses.

CHINA'S MOVES

- Unlike the U.S., China opts *not* to sanction military officials. Mindful of international skepticism towards America's growing reliance on sanctions, Beijing aims to draw a distinction between itself and Washington and to project a more mature and even-handed approach.

- Under the same logic, China does not formalize its countermeasures within a legal framework. It does not countersanction. Instead, Beijing reaches for informal measures that have an immediate impact on U.S. and partner companies but which create little macroeconomic disruption.

  Action: Beijing creates an unexplained regulatory delay in shipments of REEs to the U.S. Under (private) political pressure, a major Chinese investor unexpectedly backs out of a new LG megafactory in Korea. Chinese regulatory, security, and legal organs increase pressure on U.S. companies operating in China.

  This signals to the U.S. that China, too, is willing to immediately take aim at America's most glaring vulnerability–its dependence on imported critical minerals–even if at a low level. Second, by making a key U.S. partner, South Korea, the target of countermeasures, Beijing hopes to undermine support for U.S. policy. Finally, Beijing hopes that by pressuring U.S. companies operating in China it sends a message to the U.S. business community that they should oppose further U.S. escalation.

GAME 2: PARTIAL BLOCKADE

U.S. INTENT

In Scenario 2, we assess that the primary intent of U.S. sanctions is to **compel** China to lift the blockade. We have moved beyond deterrence to coercion aimed at policy modification.

U.S. DELIBERATION

In Scenario 2, U.S. planners emphasize a different set of variables.

- *Immediacy of impact:* The main consideration of U.S. planners is to employ measures that have an immediate, asymmetric impact on the Chinese economy. (It follows that speed of implementation is also important). Washington's goal is to induce a crisis in Chinese markets with strong initial measures and the promise of additional, compounding sanctions to follow.
- *Reversibility:* At the same time, the U.S. opts for tools that can be quickly turned "off" should China lifts the blockade. If China perceives that the economic damage is done, it has less incentive to lift its blockade. The U.S. might even consider automating the removal of sanctions should China lift its blockade. This would increase their coercive power.
- *Alliance politics:* Once again, the response of partners factors centrally in U.S. deliberations. This time, however, Washington is more confident that key regional allies will at least partially support U.S. measures, even if at a lower level of severity.

U.S. MOVES

- The imperative to impose immediate costs orients the U.S. towards financial sanctions. But this time Washington expands its target beyond individual Chinese citizens and companies to entire sectors of China's economy. The U.S. also goes after the People's Bank of China.

  Action: The U.S. levies full blocking sanctions on China's largest defense companies as well as its five largest technology companies: Huawei, JD.com, China Mobile, Alibaba, and Tencent. This sends the Shanghai Stock Exchange into a tailspin and roils global exchanges.

  Action: The U.S. imposes a partial (50%) freeze of PBOC dollar reserves. The EU and Japan match the U.S. action by freezing China's euro and yen reserves at the same levels. This amounts to a 30-40% of PBOC foreign reserves.

- The U.S. dramatically scales up existing export restrictions on semiconductors.

  Action: The U.S. widens its existing semiconductor export bans to include a wider subset of microchip technologies. Export restrictions now cover roughly 70% of total U.S.

semiconductor exports to China. With strong encouragement from Washington, Japan and South Korea, accounting for 21% and 12% of Chinese semiconductor imports respectively, also implement export restrictions, albeit at a lower level.

- Washington contemplates measures to choke China's access to energy by using the U.S. Navy to interdict oil imports. This is among the most escalatory measures available to U.S. planners. Initial consultations with regional allies generate strong pushback to the idea.

  Action: The U.S. decides to forgo an energy embargo for now but moves two additional aircraft carriers

CHINA'S INTENT

China's intent is also coercive. Beijing aims to weaken the resolve of the U.S. and its partners to sustain an economic pressure campaign by imposing countermeasures that target alliance cohesion.

CHINA'S DELIBERATION

In Scenario 2, Beijing is already suffering immense economic pain. It is less constrained by escalation concerns and more interested in imposing severe–though reversible–economic pain on the U.S. and its partners.

- *Immediacy of impact*: This time, China wants to impose immediate and painful economic costs on the U.S. and its partners.
- *Reversibility*: China also wants its measures to be reversible in order to reserve off-ramps and the ability to steer the U.S. and its allies towards de-escalation.

CHINA'S MOVES

- China moves from informal "delays" of U.S.-bound critical mineral shipments to formal export controls of rare earth elements and other critical minerals.

  Action: China restricts U.S.- and Japan- bound exports of processed cobalt and lithium, promising to expand the export ban to other critical minerals.

  Action: China also expands its partial blockade of Taiwan to choke some exports of advanced Taiwanese semiconductors (at roughly the 30% level).

GAME 3: AMPHIBIOUS INVASION

U.S. INTENT

In Scenario 3, we assess that the primary intent of U.S. sanctions is to **degrade** China's ability to sustain conflict against Taiwan.

U.S. DELIBERATION

In an invasion scenario, U.S. planners are less concerned with escalation risks or reversibility.

- *Immediacy of impact*: The U.S. once again reaches for immediate, high-impact measures that inflict catastrophic pain on the Chinese economy. (It again follows that speed of implementation is also important).
- *Alliance politics*: The scale of human death shocks the international community and raises the economic pain tolerance of U.S. partners. This in turn widens the scope for hard-hitting U.S. sanctions.

U.S. MOVES

- The U.S. immediately uses its most powerful geoeconomic tool, financial sanctions, against China's largest banks.

  Action: The U.S. levies full blocking sanctions against the PBOC and China's five largest banks. This sends the Shanghai Stock Exchange into a tailspin and roils global exchanges.

  Action: The U.S. freezes remaining PBOC dollar reserves. The EU and Japan follow suit.

- The U.S. works with the Netherlands, Japan, and South Korea to crank up export controls on semiconductors to China.

  Action: The U.S. and its partners institute what amounts to a full ban on the export of semiconductors to China.

CHINA'S INTENT

China's intent is to compete in an economic war of attrition by inflicting devastating damage on the U.S. economy.

CHINA'S DELIBERATION

Having already suffered immense economic pain, China is less worried by escalation concerns and more interested in reciprocating, to the extent it can, the damage done to its own economy.

- *Immediacy of impact:* China wants to inflict immediate counter damage on the U.S. and its partners.
- *Alliance politics:* In an economic war of attrition, China continues to focus on undermining the cohesion of the sanctioning coalition by targeting U.S. partners.

CHINA'S MOVES

- China's moves to freeze the world's access to advanced semiconductors.

  Action: China implements a full naval embargo of TSMC semiconductor exports from Taiwan.

- China targets other inputs into U.S. defense capabilities.

  Action: China expands its critical minerals export restrictions to rare earth elements used in U.S. defense applications.

- For the first time, China pulls the agriculture lever.

  Action: China institutes an import ban on U.S. agricultural products such as soy or corn.

Key Takeaways

In S1 and S2, sanctions immediately target high-sensitivity vulnerabilities at a low scale. Both actors place a premium on calibration. Small, frequent adjustments undermine target economy adaptation while controlling escalation.

In S3, sanctions do not diminish China's warfighting capabilities along a meaningful timeline. Sanctions are a limited tool and not a replacement for a military and diplomatic strategy. Their primary power is deterrence.

The locus of financial power sits firmly in the West. ⅔ of China's $3.2 trillion in FX reserves are in Western government bonds. Less than ⅕ of China's trade is settled in RMB. The U.S. and EU control key nodes of interbank financial communication.