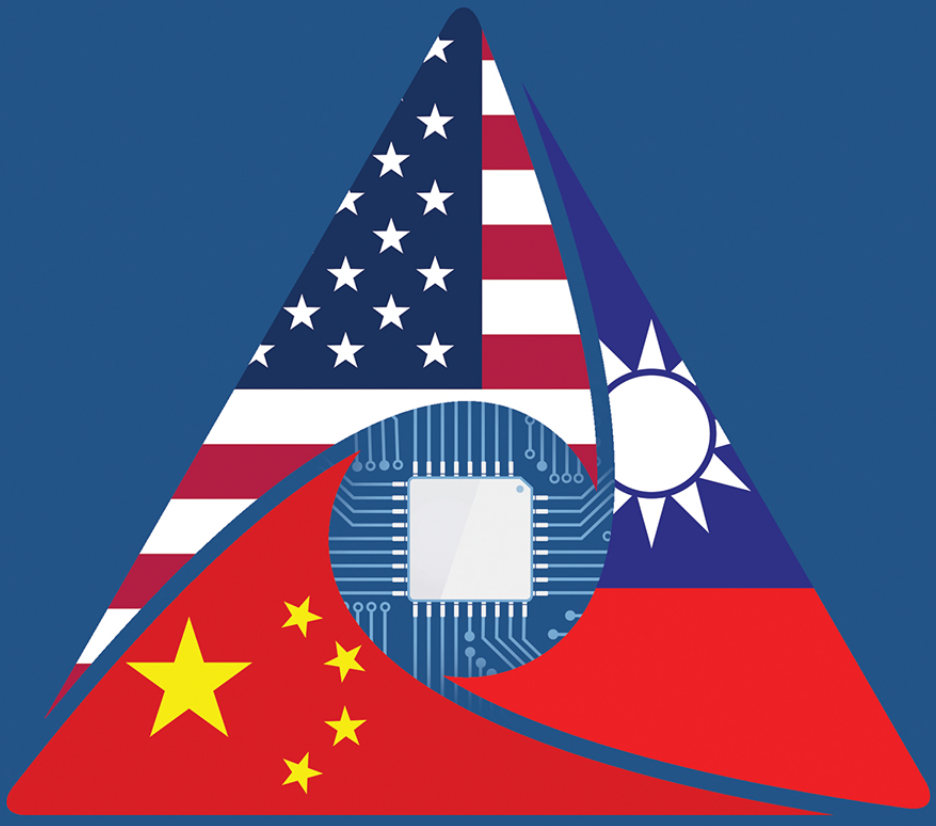

Silicon Triangle

The United States, Taiwan, China, and Global Semiconductor Security

Edited by Larry Diamond, James O. Ellis Jr., and Orville Schell

CHAPTER NINE

Mitigating the Impact of China's Nonmarket Behavior in Semiconductors

ROBERT DALY AND MATTHEW TURPIN

The United States and its partners should be on guard to mitigate nonmarket behavior by China's emerging semiconductor firms.

While starting from a weak position, China's leaders are aggressively pursuing their domestic semiconductor aims—first to reduce the country's dependence on imports and then to take global market share through chip supply chain exports. As witnessed in a raft of other industries, the variety of government targets and subsidies to this end imply a high likelihood that semiconductor firms in China operating under nonmarket incentives may undercut pricing of established US and partner semiconductor firms.

This nonmarket behavior by semiconductor firms in China could have negative near-term impacts on US or partner producers, for example in mature chip production. And over time, it could create new US or partner dependencies on China-based supply chains that do not exist today, impinging on US strategic autonomy.

The US government has a variety of tools to monitor and limit the impact of such export dumping. It should also be concerned with the risk of its partners developing new dependencies on chips from China.

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Semiconductors are ground-zero in this technological competition.
—SECRETARY GINA RAIMONDO[1]

Since China produced its first integrated circuit in 1965, its semiconductor policies have been shaped by its need for material and technological development, its drive for great-power status, its relations with the United States, and, especially since 2015, its quest for technological autonomy. As in other industries, China was willing to accept dependence on global semiconductor supply chains during an unavoidable period of tutelage and adaptation. As it mastered or obtained key technologies in the mid-2010s, however, China began a campaign intended to take it from dependence to dominance.

American export controls imposed in 2019 and then again in 2022 shocked China's planners and caused China's semiconductor industry to turn its focus from dominance to survival. Its current goals are, first, to master advanced-node design and manufacturing to shield itself from continued decoupling in high-tech sectors; and second, to protect its supply chains from the impact of possible future sanctions. Only if China succeeds in meeting its own demand for both mature and advanced semiconductors will its dreams of industry dominance return to the forefront of policy. In the interim, its goals are defensive, and the mood in China's semiconductor industry wavers between determination and desperation.

Warning Signs

Technology acquisition in the service of national development and military power has been China's primary goal in its relations with the United States since the Qing Dynasty sent students to the United States in 1872.[2] Their suspicions that the United States was denying China access to its leading technologies—and US suspicions regarding the ends and means of China's technological strategy—have been a mainstay of bilateral relations ever since.

Persistent US concerns—both economic and strategic—were heightened in 2006 when China announced its Indigenous Innovation agenda, which coincided with Beijing pressuring the European Union to lift its Tiananmen arms embargo.[3] Indigenous Innovation was not a secret program. When China's ministries announced detailed plans for the project

in 2009, it was hailed domestically as a comprehensive plan for industrial policy that would make the country "a technology powerhouse by 2020 and a global leader by 2050."[4] When foreign governments and corporations said the program was a threat to their interests and that China's methods violated global norms, Beijing seemed surprised and confused—China's leaders muted propaganda related to Indigenous Innovation but continued to implement the strategy at full force.

The pattern of declaration, blowback, and retrenchment was repeated in 2015 with the launch of Made in China 2025 (MiC 2025). MiC 2025 was a program of investment and research for China's corporations aimed at making the People's Republic of China (PRC) the world leader (defined as 70 percent of global market share) in ten industrial sectors: (1) information technology; (2) automated machine tools and robotics; (3) aerospace and aeronautical equipment; (4) maritime equipment and high-tech shipping; (5) modern rail transport equipment; (6) new-energy vehicles and equipment; (7) power equipment; (8) agricultural equipment; (9) new materials; and (10) biopharmaceuticals and advanced medical products. Though a source of pride for China, the program was viewed internationally as a brazen announcement that China would do whatever it took—relying on "discriminatory treatment of foreign investment, forced technology transfers, intellectual property (IP) theft, and cyber espionage"—to reduce China's dependence on the world and lock in the world's dependence on China.[5] Again, China seemed surprised by the criticism, as if its status as a strategically innocent developmental state was so firmly established that no one would question its motives. China's leaders spoke about the program less after 2018—but for foreign governments and corporations, the klaxon had already sounded.

Aptly named Military-Civil Fusion policies, which began in the 1990s, were another source of Western alarm. Instituted under the restrictions of the Tiananmen arms embargo, the program's goal was to achieve complete modernization of China's armed forces based on "informatization, intelligence, and mechanization" by 2027, the hundredth anniversary of the People's Liberation Army (PLA). Military-Civil Fusion required that any technology available to China's industry

or academia be provided to the PLA. It was not surprising that China would have such a policy. The Four Modernizations—first proclaimed by Zhou Enlai in 1963, later amplified by Deng Xiaoping as the core of China's development strategy—highlighted the essential integration of China's agriculture, industry, science and technology, and defense. China's whole-of-government (举国制度) approach was reflected in a series of National Intelligence Laws enacted under Xi Jinping that required all domestic entities, including universities, to give the state any information it requested.[6]

The strategic logic of these programs—Indigenous Innovation, MiC 2025, Military-Civil Fusion, and the National Intelligence Laws—was explained to the satisfaction of many US lawmakers, especially on the Republican side of the aisle, by Michael Pillsbury's *The Hundred-Year Marathon*.[7] Published in 2015, the book claimed that China has long had a plan to eclipse the United States and dominate a new global order. The same point was made (perhaps to a more Democratic readership) in Rush Doshi's *The Long Game: China's Grand Strategy to Displace American Order*.[8] Business communities in the United States and Europe both took notice, as evidenced by the publication of reports by the US and European chambers of commerce in early 2017 pointing out the harm PRC policies would do to their members.[9]

US bipartisan focus on the looming technology race and great-power competition was heightened by milestones reached and investments made under Xi Jinping during his first two terms as Party general secretary. Not only was China the most populous nation and largest exporter on Earth—it quickly became the world's largest producer and consumer of electric vehicles and batteries, as well as the global leader in mobile payments, wind and solar power generation, patents awarded, research cited in peer-reviewed journals, and training of college STEM (science, technology, engineering, and mathematics) students. It is the world's fastest-growing manufacturer of the legacy semiconductors used in most electronic devices and automobiles.[10] And China has invested heavily in the hardware that will drive the next generation of discovery (including supercomputers), the world's largest radio telescope (arguably underused), and one of the world's most advanced wind tunnels,

which Beijing uses to develop hypersonic weapons. In 2016, working with European partners, China launched the world's first quantum satellite, which completed a handshake with a quantum ground station.[11]

These advances all took place while China remained sanctioned under a comprehensive arms embargo by nearly all developed economies, as well as the target of multilateral dual-use export control regimes. As chapter 7 in this report notes, in the wake of the Cold War, the United States and its allies dismantled the Coordinating Committee for Multilateral Export Controls (COCOM) and replaced it with the Wassenaar Arrangement, which included states of the former Soviet Union and its Eastern Bloc satellites. Due to the Tiananmen arms embargo imposed on China in 1989, Beijing was not invited to join Wassenaar, and it still remains outside this multilateral regime.

Semiconductors—and the artificial intelligence (AI) and high-performance computing they enable—are essential to the PRC's commercial and military projects, as described in Indigenous Innovation, Made in China 2025, Military-Civil Fusion, and the National Intelligence Laws. China cannot achieve its MiC 2025 or military modernization goals, or master quantum computing, nanotechnology, or other emerging technologies, without a secure supply of advanced chips and without the designs, software, manufacturing equipment, and components needed to make them. Now that the era of US-China engagement is over, the problem for China is that no semiconductor supply chain can be secure unless it is within China, but most components of the advanced-semiconductor supply chain are in foreign—and especially US—hands.

Geopolitics/Geoeconomics

Semiconductors have once again become the key terrain of superpower rivalry, just as early semiconductors were in the rivalry with the Soviet Union.[12] This battleground, however, is a subset of a global contest between the superpowers, which has the hallmarks of a cold war. Long-term, comprehensive, "extreme" geopolitical competition between China and the United States will condition the strategies both sides

employ to win the semiconductor battle.[13] Put another way, the logic of security—not technological progress or economic efficiency—will drive the contest, even if tech and finance are its principal battlegrounds.

Beijing perceives an existential threat from a United States that wants to contain it or even bring down the Chinese Communist Party (CCP).[14] It, therefore, sees an urgent need to become more secure, not only in its high-tech industries but in its food supply,[15] culture,[16] biopharmaceutical sector, and media. Moreover, the West's rapid response to Russia's February 2022 invasion of Ukraine spurred China to sanctions-proof its economy. China's inclination toward decoupling did not begin with the semiconductor war or even the trade war that President Trump launched in 2018. Rather, self-sufficiency has been a keystone of CCP thinking since 1921, and many of China's modern industries have never coupled to the West in the first place. Until recently, however, China seemed confident that it could decouple selectively and at its own pace. That is no longer its plan, although it is unclear whether Beijing has fully considered the costs of this decision to rapidly decouple across a variety of sectors, or calculated its likelihood of success.

Washington's view now is that an expansion of China's economic and technological power is not in the interests of the United States or the rules-based international order. The United States, therefore, will no longer sell China the rope it needs to hang the United States in the global marketplace or on the battlefield. In the parlance of this report's strategic scenario work, Washington accepts a world moving to the "western" quadrants—and if that means hampering China's continued educational, scientific, medical, and economic progress by denying advanced chips and artificial intelligence to China's military, so be it. If it means greater scarcity and higher prices for US consumers, lower profits for US corporations, and the decoupling of global supply chains, so be it.

Popularized by President Trump and largely unquestioned by President Biden, antiglobalist narratives—as opposed to increasing market access among partners with common values—have prepared the ground for costly decoupling. These narratives appear to reflect a broader geopolitical trend. When the founder of Taiwan

Semiconductor Manufacturing Corporation (TSMC), Morris Chang, spoke at the Phoenix, Arizona, site of a new TSMC fabrication facility ("fab") in December 2022, he said, "Twenty-seven years have passed and [the semiconductor industry] witnessed a big change in the world, a big geopolitical situation change in the world. Globalization is almost dead and free trade is almost dead. A lot of people still wish they would come back, but I don't think they will be back."[17]

Even so, barring a direct military conflict between the United States and China, it is far more likely that the complexion of what we call "globalization" will simply shift over time, becoming characterized by a greater distribution of economic activity across more countries and regions. In many ways, we have mislabeled the last quarter century as a period of "globalization"—it was really a period of hyperconcentration in one country: China.[18]

Given that many of the unique geopolitical circumstances that led to this hyperconcentration of economic activity in China have ended, companies and countries will likely diversify their supply chains and manufacturing to places other than China. As this process unfolds, there will be relative gains and also significant costs, both of which will produce winners and losers. And as some have started to point out, China will likely lose more from this process.[19]

China's Ends, America's Means

Before 2019, Beijing's semiconductor policy focused on increasing China's global market share in every phase of production—from design to packaging—and producing more-advanced nodes. This agenda was pursued aggressively, but it was premised on gradually weaning Chinese producers off from foreign suppliers and then surpassing them. In other words, China was realistic about its dependence on the global supply chain—it was not looking so much to decouple immediately from US and third-country technologies as it was looking to reduce its dependence on them over time. The unstated assumptions of this approach were that foreign companies would remain as involved in the domestic market as China permitted them to be and that China could

be as integrated or as self-sufficient as its own capacities warranted. The attractiveness of China's vast market to tech multinationals would keep China in the driver's seat as long as the logic of technological progress and economic efficiency drove the semiconductor industry. That is to say, China assumed it would control the pace of decoupling to its advantage and that the rest of the world would be too dependent on China to prevent its success.

The placement of ZTE (in 2016) and Huawei (in 2019) on the Commerce Department's Entity List—subjecting them to US export controls—was a strong signal that Beijing's assumptions were wrong. Others could control the pace of decoupling, and China was not, in fact, the sole author of its technological future. This point was further underscored by the August 2022 passage of the CHIPS and Science Act. Also in August, Commerce banned the sale of electronic design automation software to China and informed chip designer Nvidia that, effective immediately, the company would need new licenses for the export to China of its A100 and H100 integrated circuits—both of which are essential to AI research and have a 95 percent market share in China.[20] Nvidia's DGX enterprise AI infrastructure systems (which incorporate A100 or H100) as well as "any future Nvidia integrated circuit achieving both peak performance and chip-to-chip I/O performance equal to or greater than . . . the A100, as well as any system that includes those circuits," were also covered by the order.[21] This move banned not only the sale of Nvidia's advanced graphics processing units (GPUs), but also any product of Advanced Micro Devices (AMD) or other American fabless chip design companies whose technology met the criteria detailed in the order. It ripped away the foundation on which China's AI and data analysis strategies had been built years before China was ready to stand on its own.

While the export controls of August 2022 were, as Gregory Allen of the Center for Strategic and International Studies (CSIS) wrote, aimed at "strangling large segments of the Chinese technology industry . . . with an intent to kill,"[22] from the US perspective they were actually restrained, as they left additional steps in the escalation ladder available to the United States. Rather than seeking a complete technological

decoupling from China, the Biden administration's policy has sought to limit its controls to chips that train AI models with advanced military applications. That delicacy may not have been noticed by China, however, as it has no "immediate substitute for the Nvidia GPUs that train AI models for autonomous driving, semantic analysis, image recognition, weather variables, and big data analysis," and every buyer in China will be affected by the new rules.[23]

One of the difficulties for Nvidia and other US suppliers is that they have no immediate substitute for the China market. In the third quarter of 2022, Nvidia "had booked $400 million in sales of the affected chips . . . to China that could be lost if [Chinese] firms decide not to buy alternative Nvidia products."[24] That said, the impacts on these companies should not be viewed in isolation; China's loss of its pathway to technological superiority in advanced chips would generate national security and economic competitiveness costs that would dwarf the affected sales of companies like Nvidia.

If the Nvidia announcement destabilized the train of China's semiconductor strategy, changes in export controls announced by the Department of Commerce's Bureau of Industry and Security (BIS) on October 7, 2022, knocked it off the rails. The BIS rules on advanced computing and semiconductor manufacturing added new license requirements for any US products sent to China's fabs that support the domestic building of logic chips of 14nm or below, DRAM memory chips of 18nm half-pitch or less, or NAND Flash memory chips with 128 layers or more. As Gregory Allen explained, Biden was attempting to

> (1) strangle the Chinese AI industry by choking off access to high-end AI chips; (2) block China from designing AI chips domestically by choking off China's access to US-made chip design software; (3) block China from manufacturing advanced chips by choking off access to US-built semiconductor manufacturing equipment; and (4) block China from domestically producing semiconductor manufacturing equipment by choking off access to US-built components.[25]

The rules also restricted the ability of unlicensed US citizens or green card holders to support the design or production of advanced chips in China's fabrication facilities.[26] This class of restrictions meant that hundreds of Americans employed by the industry in China (no exact number is yet available), including forty-three senior executives, had to quit working immediately. Many of these executives were naturalized American citizens of Chinese origin with advanced degrees from the United States and long experience in Silicon Valley.[27]

China's Response

After the October 2022 export controls were released, China's strategy of steadily progressing toward industry dominance on its own timeline, with an assumption of ready access to foreign technology and talent along the way, had to be scrapped. Because the CCP's 20th National Congress closely followed the announcement—and itself was followed by a series of economic and social crises related to Xi Jinping's "dynamic zero"-COVID policy—it was not clear by year's end that Beijing had fully absorbed the impacts of the new export controls.

When Beijing felt attacked by US actions during the Trump administration, its response was to mirror US actions immediately. It made such shows of strength throughout the trade war, for example, when the United States required Chinese media outlets to register as foreign missions and when the PRC consulate in Houston was suddenly shut down in 2020. Given this tendency to counterpunch, some commentators expected China to hit back against the new US rules by banning the sale to the United States of products such as rare earths, medicine and medical precursors, or legacy chips. On a number of occasions involving science and technology over the last five to ten years, however, China lacked the leverage or capability to successfully respond. For example, a little more than a year after Huawei's Entity Listing, the National People's Congress passed and adopted the Export Control Law of China (ECL) in an effort to mirror US capabilities and deny China's advanced technologies to the United States.[28] Like the US Export Administration Regulations (EAR), which provide the legal basis for Commerce's and the State

Department's export controls, China's 2020 ECL establishes extraterritorial reach, directs the creation of control lists and blacklists, and defines controls for dual-use items and military products. Unfortunately for Beijing, this legislation remains an empty regulatory shell, as China lacks control over advanced technologies that surpass what is available to its rivals. One could imagine a future where Beijing responds in this domain with true reciprocity, but that time has not arrived.

To date, rather than hitting back against American export controls, China has adopted five broad, long-term strategies aimed at limiting their impact and, if possible, advancing its drive for technological security and dominance:

1. *Increasing investment* in China's semiconductor companies, large and small; in training personnel; and in building design and manufacturing hubs
2. *Encouraging workarounds* to existing technologies
3. *Discouraging third countries* from working with the United States
4. *Playing for time* in the hope that the costs of decoupling, the interest of US corporations, and pressure from US partners result in the watering down of export controls
5. *Controlling the international narrative* on technological decoupling

Strategy One: Increased Investment

China's commitment to achieving dominance in the semiconductor industry, based on the size of its domestic market and investment in its companies and universities, coincided with American policy makers' understanding of the challenge Beijing was posing.[29] As outlined in chapter 8 of this report, the current drive to fund the industry was launched in 2014.[30] In that year, China published its Guideline for the Promotion of the Development of the National Integrated Circuit Industry, "with the goal of establishing a world-leading semiconductor industry in all areas of the integrated circuit supply chain by 2030."[31] It also established the National Integrated Circuit Industry Investment

Fund (or "Big Fund") to provide an estimated $150 billion in state funds to support research. By 2020, China was home to more than ten thousand semiconductor companies,[32] a figure that more than doubled over the course of that same year.[33] Many of these enterprises were overnight operations that existed primarily to chase government subsidies. Some, like Tsinghua Unigroup, a company founded at Xi Jinping's alma mater that even bid to buy Micron in 2015 for $23 billion, were spectacular failures that spotlighted the waste that remains endemic in China's government investment programs.[34] Tsinghua Unigroup had received tens of billions of dollars in government support but still defaulted on its bonds in 2020. Others, like Wuhan's Yangtze Memory Technologies Co. (YMTC), which was founded in 2016 and is now China's leading memory chip maker, were spectacular successes.[35] TechInsights, a Canadian semiconductor and microelectronics analytics company, recently declared that "at their current rate of innovation, YMTC is poised to be the uncontested global NAND flash technology leader before 2030."[36] China's latest Five-Year Plan, unveiled in July 2021, committed to raising public and private R&D spending by 7 percent annually—a rate greater than the increase in its military spending—with semiconductors as a top priority.[37]

It is too soon to predict the scale at which Beijing will further increase its investments in the industry, but the speed with which major Chinese municipalities responded to the October 2022 export controls indicates that a major reinvestment is under way. In late October 2022, the Lingang Special Area (a free-trade zone), Shanghai University, and the city's Integrated Circuit Industry Association—all shocked by the BIS ban on US persons in China's semiconductor companies and buoyed by grants from the municipal government—set up a new campus to foster talent for the semiconductor industry.[38] Such training efforts garnered government support despite China's overall success in developing STEM talent broadly.

According to Georgetown University's Center for Security and Emerging Technology (CSET), "by 2025 Chinese universities will produce more than 77,000 STEM PhD graduates per year compared to approximately 40,000 in the United States. If international students

are excluded from the US count, Chinese STEM PhD graduates would outnumber their US counterparts more than three-to-one."[39] Even so, that advantage may not be of much help in the semiconductor industry. The China Semiconductor Industry Association anticipates that China already has a shortage of two hundred thousand semiconductor engineers for the years 2022 and 2023, while one of China's leading educational talent organizations reports that most STEM students prefer work in AI and big data over the lower-paying semiconductor industry (ironically mirroring a trend observed among US STEM graduates, as outlined earlier in this report).[40]

In Shenzhen, the municipal government announced plans to reinvest in its semiconductor industry architecture on October 8, 2022, one day after BIS's bombshell. The city's Development and Reform Commission announced that it would cover 20 percent, or up to US$1.4 million annually, to subsidize the R&D expenses of companies chasing breakthroughs in the design and development of logic chips, including CPUs (central processing units) and GPUs.[41] Huawei, which is based in Shenzhen, is leveraging the established networks and talent in that city to invest in firms throughout China, including NAURA Technology Group (China's leading chipmaking equipment manufacturer), to build itself a complete China-only supply chain. The Fujian Jinhua Integrated Circuit Corporation (JHICC)—after being driven into bankruptcy in early 2019 after the Trump administration placed it on the Entity List in 2018 for stealing intellectual property from Micron Technology—has been resurrected to play a major role in this network.[42] Huawei engineers are reported to be working stealthily in JHICC's Quanzhou plant to help the telecom giant recover from its own placement on the Entity List in 2019[43]—albeit neither Huawei's nor JHICC's engineers have access to the most-advanced software, tools, or components that would help them to achieve these objectives.

Strategy Two: Work-Arounds

Writing in *American Affairs*, Geoffrey Cain claims that China's failure thus far to meet its MiC 2025 goals for chip development stems from

its deeply entrenched "diplomatic isolation . . . oppressive top-down mandate(s) of selecting national champions . . . the weak position of starting generations behind industry leaders in America, Taiwan, South Korea, and Japan," and corruption.[44] Within China, most domestic commentators are similarly pessimistic about China's prospects for building an indigenous cutting-edge semiconductor supply chain using existing technologies. China is therefore searching for new technologies that can match the performance of systems developed and controlled by Western-oriented competitors.

For example, the Beijing Open Source Chip Research Institute—a group of research centers and companies that includes the Chinese Academy of Sciences, Tencent, and Alibaba[45]—is developing domestic semiconductor-related intellectual property using the RISC-V open-source chip design architecture created by the University of California, Berkeley. If it succeeds, the group's Xiangshan RISC-V architecture could free China from IP constraints imposed by ARM, the Cambridge-based company whose technology underlies most cell phones, including Apple products.[46] China may also hope to offset the need for US-designed advanced nodes by developing photonic chips (which use photons instead of electrons in integrated circuits[47]) and experimenting with nonsilicon substrates, such as cubic boron arsenide, graphene,[48] and silicon carbide.[49] As described in chapter 2 of this report, however, marketable breakthroughs in any of these areas are likely decades off, and China's pace of advancement even here may face acute threats after its stockpiles of banned chips, components, and manufacturing tools run out or require repairs in the next year or two.

Strategy Three: Outreach to US Allies

The ubiquity of essential US semiconductor designs, software, manufacturing tools, and components in the global supply chain makes it possible for the Department of Commerce to use its Entity List and Foreign-Direct Product Rule to compel allies and partners to support its ban on cooperation with China's semiconductor industry.[50] The Netherlands, Taiwan, South Korea, Japan, and most other suppliers

share US concerns about China's threats to security, intellectual property, and global order—but they value their trade relations with China highly. China will be alert to any opportunities that such conflict provides to sow division within US partnerships and gain the chips and chip manufacturing equipment it needs to develop its industries and military.

China accounts for over 25 percent of the annual global demand for semiconductor equipment. It would doubtless buy as many of Advanced Semiconductor Materials Lithography's (ASML) $100 million extreme ultraviolet (EUV) lithography machines as the Dutch company could sell it, but the Netherlands agreed in 2016 that none of ASML's high-end machines would be sold to China. Bloomberg reported on December 7, 2022, that Amsterdam had agreed to enforce Washington's October 2022 export controls as well.[51] ASML will continue to sell its mature-node manufacturing equipment to China, however, and the knowledge that China is its greatest potential profit center will continue to nag at ASML's leadership, despite the firm's claim that under current market conditions, it can sell as many machines as it can produce to other customers.[52]

America's Asian partners in the "Chip 4" alliance will likely fall in line as well—but doing so will be costly for them, and China will exert as much pressure on them as it can to seek carve-outs and workarounds to US requirements. As outlined in chapter 6, US partners have their own substantial semiconductor supply chain strengths and ambitions, with sales to or production in China as part of them. In 2021, Taiwan's chip sales to China, worth $155 billion, constituted 62 percent of its exports to the mainland. The latest data, however, shows that Taiwan's export of chips to China and Hong Kong fell for a fourth month in a row in February 2023—a 31 percent drop in exports from a year earlier.[53] Semiconductor manufacturing machines and materials are Japan's second-largest export, and one-third of them are purchased by China—a trade worth $9.5 billion to Japan in 2021.[54] China buys 43 percent of South Korea's exported chips—58 percent including exports to Hong Kong—a trade worth over $49 billion ($66 billion including Hong Kong) to South Korea in 2022.[55] The US Commerce Department recently granted Samsung and SK hynix exceptions to its

export controls, allowing them to provide otherwise banned capabilities to their facilities in China for one more year—but it is not likely that those exceptions will be granted again.

Taipei, Tokyo, and Seoul are all likely to be courted, hectored, coerced, and threatened by Beijing as they move toward full compliance with BIS rules. They may also compensate for cooperating with the United States on semiconductors by reassuring Beijing in other aspects of their political and trade relations, and Beijing will be attentive to such opportunities to weaken the will of, and widen the divisions between, America's Asian partners.

Assiduous attention to alliance management, therefore, will be essential to the success of US policy. Here again, we run across a ubiquitous theme of this report: the sustainability of US security-oriented efforts toward China will rely on the commercial attractiveness that the United States can offer its partners. Making the subsidies through the CHIPS and Science Act attractive to allied partners—and not saddled by non-security-related short-term US social or protectionist politics—is the first step.[56] Beyond those five years, like-minded partners need confidence that the United States will continue to offer market access and bidirectional investment.

Strategy Four: Play for Time

China domestic companies' most effective responses to US pressure may be to stockpile chips and equipment while they are still available (Nvidia, for example, will continue to ship AI chips from its Hong Kong logistics center through September 2023[57]); manage their capital reserves to weather the current slowdown in global chip demand; and hope that the current storm passes. At the moment, the United States' position seems certain, but its adamancy may not last. A change in administration in 2024 could also bring a change in priorities. Or the United States might blanch as the ban's full costs to US companies become clear. AMD, Intel, Nvidia, and Qualcomm all have enormous stakes in sales to China, as do US semiconductor manufacturing equipment companies such as Applied Materials, KLA, and Lam Research.[58]

Even though most US multinationals no longer lobby for expanded trade with China (as they did in the run-up to the PRC's ascension to the World Trade Organization [WTO] in 2001), executives and their shareholders are bound to ask Washington to take some of the roughest edges off its export controls.

Only two months after October 7, 2022, China already saw signs of a thaw in the American position and an opportunity to import advanced chips despite the export controls. Under the new BIS rules, thirty-one companies in China, including YMTC and NAURA Technology, were placed on an "unverified list" and given sixty days to prove that no controlled items they imported from the United States could be used in weapons manufacture or transferred to China's military. "Verification" involves on-site inspection of companies in China by US officials who conduct "end-use checks." Historically, the CCP has viewed these procedures as insults to its sovereignty and has refused the necessary access to Americans. During a December 6 event at the Center for Strategic and International Studies, however, Alan Estevez, the under secretary of commerce for industry and security, said that China's Ministry of Commerce had been cooperating on end-use checks since November, raising the possibility that firms currently on the unverified list might be verified as good actors and would therefore be eligible to import advanced US chips and equipment.

The United States has assumed, reasonably, that China's Military-Civil Fusion program and National Intelligence Laws were proof—if proof were needed at all—that any technology available anywhere in China that had a military application was certain to be put to that use. As the US-China rivalry expands and as military conflict becomes more imaginable, that assumption might seem to imply that US enforcement of export controls on China should be absolute and unwavering. Estevez's comments suggest, however, that China may now see a glimmer of light: cooperating with Commerce's end-use checks to get firms off the unverified list and stalling may be its best short-term strategy to keep open a channel for technology imports.

Despite this potential for near-term churn, over the long term, time may arguably be on the side of the United States and its allies in

this realm. If—as characterized in the strategic scenario planning of chapter 1—trends toward supply chain diversification continue and companies like Apple reduce their dependency on China's manufacturing base and market, then the leverage Beijing now applies to get access to technology from foreign companies could dissipate.[59] As the world shifts from hyperconcentration to a more dispersed distribution of high-tech manufacturing with fewer dependencies on the PRC, then companies will have less incentive to place advanced capabilities in China. The current commercial logic for providing advanced-chip capabilities to China is that much of the world's electronics manufacturing takes place in China. As that condition changes, so too will the commercial rationale for providing the advanced chips. South and Southeast Asian nations likely stand to be the true beneficiaries of these trends. Manufacturing jobs and the attendant flows of infrastructure funding, science and technology know-how, and economic development will flow to them just as those same benefits flowed to the PRC over the past quarter century. Rather than being the grass trampled between two competing superpowers, the nearly 2.2 billion people of South and Southeast Asia could experience a dramatic increase in economic growth and prosperity.

Strategy Five: Frame Narratives

Building "discourse power" (话语权) is an essential component of China's "comprehensive national power" (国家综合势力). On September 1, 2022, after the announcement of restrictions on the sale of Nvidia GPUs to China, Foreign Ministry spokesman Wang Wenbin said:

> The US has been stretching the concept of national security and abusing state power. The US seeks to use its technological prowess as an advantage to hobble and suppress the development of emerging markets and developing countries. This violates the rules of the market economy, undermines international economic and trade order, and disrupts the stability of global industrial and supply chains.[60]

On October 8, Foreign Ministry spokesperson Mao Ning argued:

> In order to maintain its sci-tech hegemony, the US has been abusing export control measures to wantonly block and hobble Chinese enterprises. Such practice runs counter to the principle of fair competition and international trade rules. It will not only harm Chinese companies' legitimate rights and interests, but also hurt the interests of US companies. It will hinder international sci-tech exchange and trade cooperation, and deal a blow to global industrial and supply chains and world economic recovery.[61]

Such statements do not aim to convince Washington to change its policies. They are intended, first, to persuade the Chinese people that China is an innocent and righteous victim of a malign United States; and, second, to persuade third countries—the Global South and nondemocratic partners of China in particular—that the United States is a bully to developing nations and a threat to global order. These messages are conveyed around the world by the state-run broadcaster China Global Television Network (CGTN), which is a leading provider of news in Africa and the Pacific Islands.[62] China's critique of the United States has also gained traction in the Middle East, Latin America, and many countries that participate in the Belt and Road Initiative.

China has prepared domestic and foreign audiences to be receptive to these messages about the technology war by promulgating a master narrative over the past ten years—a narrative that forms the backbone of its rebuttals to the United States: *The United States has fundamentally misperceived China's intentions and policies because it fears that China's peaceful, globally beneficial rise and the success of its governance model threaten its own hegemony.* Global public opinion polling indicates, however, that China's well-resourced, carefully planned global public diplomacy campaign has had mixed results at best.[63] In developed democracies, it has failed entirely, but it has adherents in the Global South, where it is largely unchallenged by US messages.

Cowed but Unbowed

In addition to these five observable responses to the imposition of export controls, it would be wise to assume that China's established technology-acquisition methods have accelerated since 2022. These include IP theft, hacking campaigns, digital and traditional espionage, talent recruitment programs such as the Thousand Talents Plan, recruitment of third-country technology experts, and global influence operations designed to spread PRC narratives among foreign publics, including diaspora Chinese.

The PRC government was angered, but not surprised, by the United States' determined prosecution of a tech war in 2022. The Ministry of Commerce's cooperation with US end-use checks indicates that BIS now has Beijing's full attention, and many of China's semiconductor companies are desperate. Many will go under. It is too soon to predict the course of these developments, but it is already clear that China is adjusting in an attempt to limit damage; it is not reconsidering its national goals, however, and it has not used all of the weapons at its disposal.

Beijing is unlikely to abandon its dual objectives to assume a leadership position in the development of cutting-edge semiconductors and to become self-sufficient in the production of semiconductors for broader use. As outlined in this chapter, the first objective has become more difficult to achieve, given the actions taken by the United States and the likelihood that the United States can persuade others to squeeze the semiconductor choke points. China will seek to find work-arounds to these restrictions, but it appears that the United States is paying close attention to China's actions and has sufficient regulatory escalation space to continue to stymie Beijing. In pursuit of the second objective, however, state subsidies and other forms of encouragement now give China a path to build an increasingly dominant position in the manufacture of legacy chips. While economic on the surface, this pursuit will nonetheless also have important national security implications that the United States and its partners must consider.

The Next Challenge

Going forward, the United States and its partners must design policies to deal with two interrelated challenges caused by China's semiconductor industrial policies.

The first is *military*. The United States cannot afford to lose the unequal technological advantages it has long enjoyed. In an era in which a US-China conflict is becoming more likely, the United States will derive qualitative military advantages by denying the most-advanced semiconductors and AI applications to China.

The second is *economic*. Even if US export controls are enforced and expanded, China may be able to generate an overcapacity of legacy chips and dominate the global market for semiconductors that go into household appliances, automobiles, and the internet-of-things. Such dominance will create political and economic leverage for China, as its near monopoly on rare earth extraction and refining already do. As China floods global markets with low-cost, good-enough mature chips, the ability of the United States and other countries to manufacture them will be degraded, along with the profit margins that fuel further commercial R&D for the next generation of products. China's profits from legacy chips will be used to offset the impact of US export controls through greater investment in the education and research needed to design and manufacture advanced nodes.

The Biden administration's formally stated rationale for the ban on the sale of advanced chips, design software, manufacturing equipment, and components to China is that these technologies are employed in weapons that target the United States and in surveillance systems used to monitor and persecute Chinese citizens. But the economic arguments for limiting Chinese dominance of mature- and advanced-node markets are almost equally strong. If China achieves the goals it has set for its semiconductor industry, the global risks of technological lock-in and innovation drag are high. The instructive example is China's dominance of solar panel production. Studies by the Information Technology and Innovation Foundation[64] argue that, once China pushed other manufacturers out of the solar panel market, innovation in this young

and vital technology sector all but ceased.[65] Chinese panel production, dominated by national champion companies controlled by the CCP, had neither the motivation nor the ability to develop the technology further. The same is possible if China dominates chip design and manufacture, particularly if done primarily through subsidized state-oriented enterprises.

China is, in fact, on track to become a major producer of legacy chips. If its behavior in other industry sectors is a model for its actions in legacy semiconductors, the world should expect massive overcapacity of these older chips, which would collapse the price for every other producer. Consumers who purchase commercial electronics will benefit from marginally lower prices, but Beijing's dumping of subsidized semiconductors will severely undermine companies that currently produce legacy chips in South Korea, Taiwan, Japan, the United States, Europe, and the Middle East. Those companies will lose the revenue needed to make capital improvements, as well as the revenue to conduct R&D for the next generation of semiconductors. This all could cause a consolidation of semiconductor manufacturers whereby foreign fabless chip design companies become increasingly dependent on mature-node PRC fabrication facilities. This dependency does not exist today.

Commercial consolidation and increased dependency on Chinese fabs for legacy semiconductors will have important national security implications. As outlined in chapter 2 of this report, advanced chips are crucial to military superiority—but the majority of semiconductors used in defense applications are legacy chips, drawn from both dedicated (for sensitive applications or chips with special attributes like radiation hardening) and off-the-shelf commercial chip suppliers. Losing access to a healthy global ecosystem of friendly commercial suppliers of mature chips could increase costs or drive the defense industrial base to rely on single-source producers, limiting innovation. While the defense industry may seem large, it is dwarfed by the commercial sector for legacy semiconductors. And even if countries can avoid dependencies on China for legacy chips in their defense industries, the wider economy will likely fall victim to overcapacity and dumping of legacy chips.

One potential mitigation against the worst harms of Beijing's semiconductor industrial policy would be to take preemptive action and impose antidumping/countervailing duties (AD/CVDs) on China-manufactured chips immediately. Traditionally, countries like the United States impose AD/CVDs only after the harm of dumping has taken place—that is, once companies go bankrupt and employees are laid off. Given the track record of China's industrial policies, however, the United States and other countries should act proactively by imposing those duties now, which would prevent Beijing's semiconductor policy from harming domestic chip manufacturers. Should those duties be insufficient, countries could also block the importation of China-manufactured legacy semiconductors. This move could force electronics manufacturers to require non-PRC legacy chips or further shift the manufacture of electronics outside the PRC.

While such actions would likely lead Beijing to bring suit at the WTO, China would be making these arguments in bad faith, given China's failure to fulfill its own obligations to other members of the WTO and the harm done to the global trade system in the process.[66] The United States and other countries should not shy away from confronting Beijing on this issue—to repeat a phrase that Chinese Foreign Ministry spokesman Zhao Lijian often deploys (albeit against Western nations), China's protest to the WTO would be like "a thief crying 'stop the thief' (贼喊捉贼)."[67]

While this threat may seem further off than the one posed by the acquisition and production of advanced chips, failure to take actions like these in the short term could endanger US abilities to constrain PRC efforts to develop cutting-edge semiconductors in the medium term. The semiconductor industry is first and foremost a commercial industry that is shaped by market forces, and it is hard to predict just how damaging Beijing's dumping of legacy chips would be to the health of the broader industry—particularly to those companies that spend massive amounts of money on building new fabs, buying new and more advanced tools, and investing in R&D. While it is possible that the effects of legacy chip dumping could be isolated to only a small number

of semiconductor companies, it is also possible that there would be a contagion effect that would weaken even the most advanced manufacturers. Given these uncertainties, the United States and its allies should err on the side of strenuous and well-coordinated actions against Beijing's plans. It is understandable that companies and governments would want to take the least costly action—but again, given the complex commercial, geopolitical, and technological dynamics, it is nearly impossible to predict with accuracy what the perfect balance will be. In this critical and fast-moving sector, we should pursue an "all of the above" approach that seeks to deny China the capability to achieve its objectives. Under these conditions, we advocate being more exclusionary rather than less.

Would pursuing this approach encourage Beijing to double down on its objectives? If so, should we instead moderate our response to reassure Beijing and persuade them not to pursue their goals? To date, the United States and its allies have had a poor track record in reassuring the PRC and persuading it to abandon goals that undermine our interests. It would be naïve to place our faith in our powers of persuasion yet again. Rather than trying to reassure China, we should focus on a strategy of denial. That is the strategy that the October 2022 rules announced. Having crossed that Rubicon and knowing that China is now gearing up to compete with the United States on those terms, the time for cautious gradualism has passed.

In short, meeting the two challenges—military and economic—posed by China's semiconductor policies will require different tools, different groups of partners, and different strategies. The complexity of pursuing and coordinating these strategies, and the scale of investment and intensity of diplomacy required to succeed, will require government direction. It can't be left to the market, as the primary measure of success will not be profit. The United States' task is to hamper China's development of advanced AI that could help it win wars by restricting China's access to the world's most powerful chips—*without incentivizing its dominance of legacy semiconductor markets worldwide by doing so*.

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