FEATURE

Clash or Consensus?

The Conflicting Economic and Security Imperatives of Semiconductor Supply-Chain Collaboration in the Indo-Pacific

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Abstract

As a crucial node in technology supply chains, semiconductors are a vital part of the global economy and especially important for the Indo-Pacific region, which is host to the most important chip producers and production networks. The nature of the industry is highly distributed and concentrated. No country is vertically integrated, and, therefore, all rely on supply and cooperation across the region. Recent supply-chain disruptions demonstrate the fragility of the ecosystem. Each government and its private sector must balance the competing imperatives of innovation, cooperation, and resilience and find ways to deal with the Chinese government's efforts to distort the market and steal intellectual property. Beijing's industrial policies aim at acquiring more advanced chip production capabilities, which could enable Beijing to occupy supply-chain chokepoints and utilize this leverage to force trade partners to make political concessions. This article examines these challenges and contends that, despite its complexity and drawbacks, multilateral cooperation involving the private and public sectors of the United States, South Korea, Japan, Taiwan, and the European Union is ultimately the only feasible long-term solution to ensure a robust supply chain, maintain the technological advantage, reduce economic blowback, and limit China's ability to coerce partner countries and distort the global marketplace.

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In the beginning of 2021, a global shortage in semiconductors caused supply-chain disruptions for a wide array of products across the world, highlighting the importance and difficulty of maintaining robust supply lines. The global semiconductor industry is projected to reach USD 573 billion in sales in 2022.[1] Chips are the fourth-highest traded product across the world and are not only at

the heart of the modern economy but also central to several frontier technologies, including artificial intelligence (AI), quantum computing, and electric vehicles.[2] The nature of the industry, and the geopolitics that surround it, creates complexities in the effort to shore up the supply chain and maintain continued innovation.

An underestimation of demand was the principal cause of this supply crunch, though the pandemic, natural disasters, shifting trade deals, and slowing economic growth also played roles. Although macroeconomic factors caused the current chip shortage, it is conceivable that an adversary could deliberately restrict access to chokepoints in the chain to exact political concessions. In particular, if China can develop and scale production capabilities to develop monopolies over irreplaceable components, Beijing could intentionally disrupt the civilian and military supply chains of the United States, South Korea, Japan, Taiwan, and other nations. A National Security Commission on AI report to the Congress said, "If a potential adversary bests the United States in semiconductors over the long term or suddenly cuts off U.S. access to cutting-edge chips entirely, it could gain the upper hand in every domain of warfare."[3] China engages in industrial policies that distort the market and create unfair advantages for its domestic firms and also routinely conducts corporate espionage to steal intellectual property. Despite this, China remains a crucially important player in the industry, meaning that a technological decoupling would have disastrous economic consequences for the United States, South Korea, and the entire Indo-Pacific. To forecast potential solutions, it is important to examine the nature of the industry and then review what has been done thus far.

Supply-chain vulnerability is inherent to the semiconductor industry because of its distributed, interdependent, and concentrated nature. No country is vertically integrated, and, therefore, all rely on supply and cooperation across the region. This global value chain boosts price efficiency and leads to performance improvements. The capital intensity of chip design and production has spurred specialization.[4] While there are a handful of integrated device manufacturers (such as Intel) that both design and produce chips, many firms specialize in either research and development (R&D) (called *fabless firms*) or manufacturing (called *foundries*). There are more than 50 points in the supply chain where a single region has in excess of 65 percent of market share.[5] The highly concentrated nature of the industry makes supply chains extremely vulnerable to natural disasters and geopolitical risk.

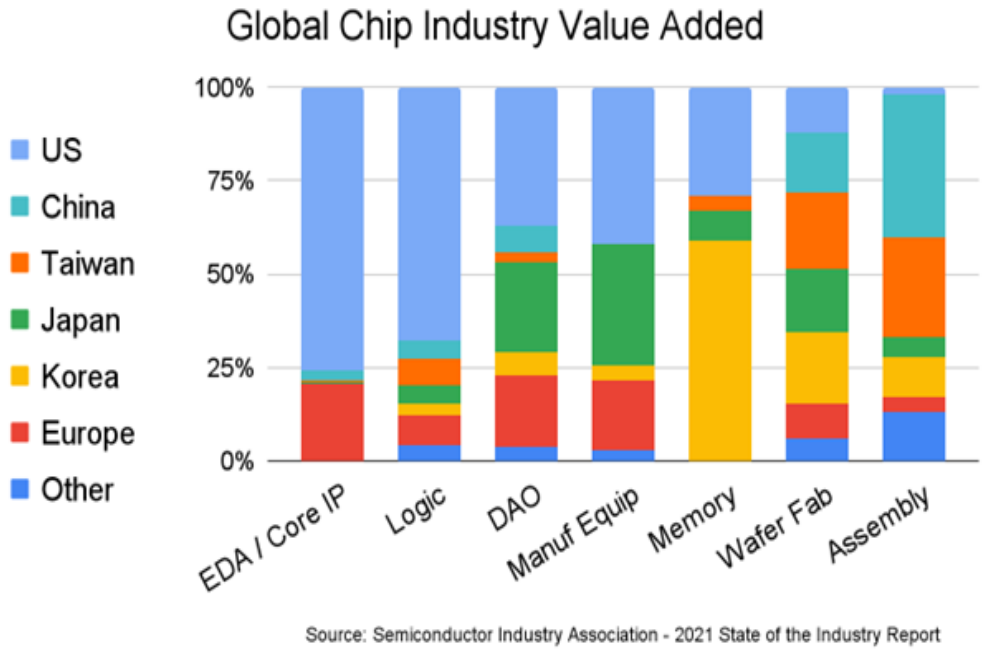
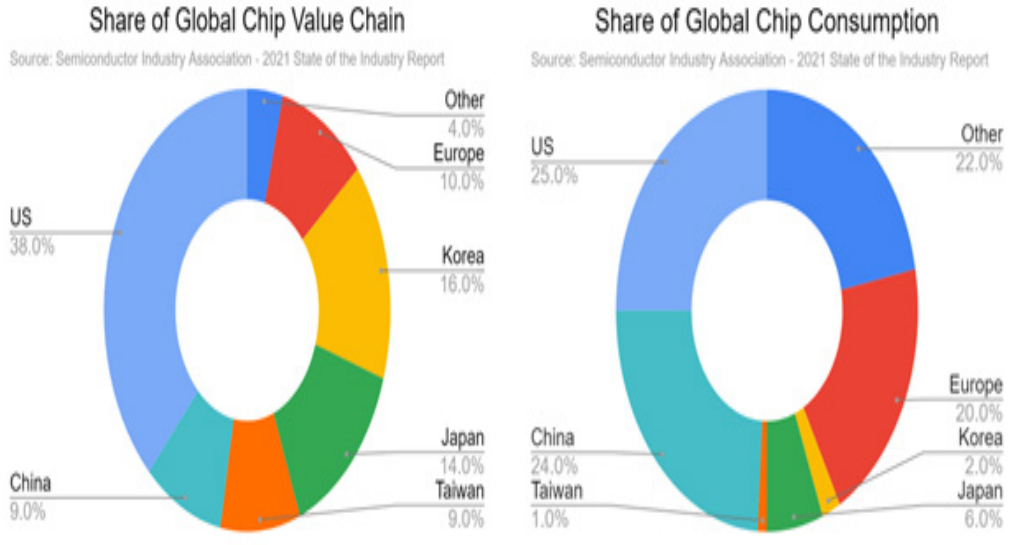


Figure 1. Global chip industry value added

Three-fourths of chips are now made in China and East Asia. In particular, all production of cutting-edge logic chips below 10 nanometers is done in Asia (Taiwan produced 92 percent of those below the 10-nanometer level in 2019). South Korea leads in memory chips, and China leads in assembly, packaging, and testing. The United States leads in processes that are more R&D intensive, including electronic design automation (EDA) and reusable architectural building blocks (Core IP); logic semiconductors; and discrete, analog, and other (DAO) semiconductors, which receive and transmit information like temperature and voltage. The world's three largest chip companies (Taiwan Semiconductor Manufacturing Co., Samsung Electronics Co., and Intel Corp.) account for more than 40 percent of all chip-making equipment.[6] Together, the United States, Japan, and the Netherlands control about 90 percent of production capacity of advanced chip-making equipment.[7]



Figures 2 and 3. Shares of global chip value chain and consumption

America's share of global semiconductor manufacturing has slipped from 37 percent in 1990 to just 12 percent today.[8] Nonetheless, America remains the global leader in market share, with 47 percent in 2020, compared to South Korea (20 percent), Japan (10 percent), Europe (10 percent), Taiwan (seven percent), and China (five percent). America's high market share depends on access to a global marketplace. This in turn enables the United States to enter a virtuous innovation cycle in which the revenues secured through the large market share and global access are used to fund the highly capital-intensive R&D process required to ensure technological enhancements to retain a strong position.[9] Because of China's critical role in late-stage assembly, Beijing purchases about half the global total of chip sales, to the tune of just less than USD 300 billion.[10] China produces more than half the world's circuit boards and the majority of raw materials needed for chip production (such as tungsten and silicon).[11]

The United States and its Indo-Pacific partners have become increasingly concerned about vulnerabilities in the supply chain and have initiated efforts to address them, although these plans remain largely in the incubation stage and questions linger about the degree of cooperation possible. The United States and its partners—South Korea, Japan, Taiwan, and the EU—each have a different risk assessment of China and varying degrees of willingness to confront and pressure Beijing to play by the rules. Another aspect of the industry that adds to the complexity of cooperation is the competing needs of innovation, resilience, and coop-

eration. Striking a balance between these competing elements will be essential in the effort to answer national security threats while minimizing economic impact.

State of Play

Supply-chain disruptions prompted governments around the world to enact policies to add rigidity to the supply chain and increase self-sufficiency. A shortage of semiconductor manufacturing equipment has prompted the Taiwan Semiconductor Manufacturing Company (TSMC) to warn customers that it may be unable to increase production of advanced chips until after 2024.[12] Demonstrating the gap between demand and supply, global chip companies project more than USD 180 billion in capital expenditure this year, but chip-making equipment manufacturers predict only USD 107 billion worth of sales. This will impact the production of next generation (two- and three-nm) chips, with International Business Strategies Inc. Chief Executive Handel Jones saying that there will be a 10–20-percent supply shortage for these most advanced chips in the next few years. National security concerns have increasingly risen to the fore, adding a new dynamic and extra complexity to the global industry.

In May 2019, the US Bureau of Industry and Security added the Chinese company Huawei to the Entity List of the Export Administration Regulations for engaging in activities "determined to be contrary to the national security or foreign policy interests of the United States."[13] Unable to source component parts for its smartphones from US suppliers, Huawei then turned to Japan, Taiwan, and the Netherlands. In August 2020, the United States added additional affiliates to the list, limiting Huawei from accessing chips containing US parts or technology.[14] In April 2022, US Secretary of Commerce Gina Raimondo called the chief executive officers of three US chip producers (Applied Materials, Lam Research Corp., and KLA Corp.) to discuss accusations that Chinese customers were being favored. Over the past two years, all three firms ramped up China sales growth more rapidly than total growth, according to data from Bloomberg. "If at any point we found evidence of preferencing Chinese companies, then we would take action to address it immediately," Raimondo said.[15] After the meeting, it was determined that only market forces were responsible.

Indeed, in recent years, US-based private investors have ramped up investment in Chinese chip companies, doubling the number of deals from 2013–2016 to 2017–2020 to 58 deals.[16] The high-intensity dealmaking has continued since 2020, with US investors inking 67 deals to fund Chinese chip firms. National Security Advisor Jake Sullivan said the United States is "looking at the impact of outbound U.S. investment flows that could circumvent the spirit of export controls or otherwise enhance the technological capacity of our competitors in ways

that harm our national security." US Senators Bob Casey (D-PA) and John Cornyn (R-TX) introduced new legislation that would introduce measures to address this. That bill is lauded by the bipartisan, independent U.S.-China Economic and Security Review Commission but criticized by the US Chamber of Commerce and the US-China Business Council.[17]

Citing national security concerns, the United States and its partners have moved to restrict China's access to the most sophisticated chip-making technology. US officials believe that the capacity would benefit China's military modernization. One example is that China's People's Liberation Army seeks to develop and harness AI, and this effort will depend on access to chips utilizing US technology.[18] Export controls have not yet affected the lower rungs of the production ladder. China's annual purchases of foreign semiconductor-producing machinery increased 58 percent in 2021, making it the world's largest buyer for two years running.[19] One explanation for the buying spree is that Chinese firms anticipate that more stringent export controls will prevent future purchases, so they are buying now to meet present and future needs. And 40 percent of these purchases were by multinational firms in China.

The effort to restrict access to the most advanced technology involves the Dutch firm ASML, which makes an extreme ultraviolet (EUV) lithography tool. This tool enables the creation of the world's smallest, fastest, and most powerful semiconductors. The EUV machines contain US technology. ASML has a monopoly over the advanced lithography machines, which are thought to be too complex to be reverse engineered and replicated.[20] Each EUV tool requires "5,000 suppliers [providing] 100,000 parts, 3,000 cables, 40,000 bolts and 2 kilometers of hosing." It "ships in 40 freight containers, spread over 20 trucks and 3 cargo planes."[21] China is the Netherlands' third-largest trading partner, and nearly 15 percent of ASML's revenue came from the Chinese market last year. The Dutch government has not renewed ASML's license to export the machines to China. Nonetheless, even with the restriction, ASML's sales to China tripled in the past five years.[22] In early summer 2022, the United States began lobbying the Dutch government to expand the existing restrictions to include older lithography machines, which are a step behind the bleeding edge but still "the most common method in making certain less-advanced chips required by cars, phones, computers and even robots."[23] Despite the ban, China's Semiconductor Manufacturing International Corporation (SMIC) is reportedly selling bitcoin-mining technology using 7-nanometer semiconductors. The US ban was meant to prevent China from developing below the 10-nanometer threshold.

Continuing this export restriction will become increasingly fraught. Partner countries have fabrication plants in China, and without the EUV tools, these

firms fear that they will fall behind. For example, in November 2021, Korean chip maker SK Hynix halted plans to install EUV technology in its Wuxi, China-based production plant because of US concerns about China acquiring the tech.[24] The single SK Hynix plant in Wuxi produces more than 40 percent of the company's dynamic random-access memory (DRAM) chips and seven percent of the world's total supply. It is believed that SK Hynix seeks to use EUV tech to improve production efficiency and better compete with rivals Micron and Samsung, which are increasingly turning to EUV machines. The United States is reportedly always lobbying the Japanese government to also restrict sales of the older lithography machines to China. Being deprived of access to the older lithography machines would stifle China's plans to develop its domestic chip-making industry.

All the major Indo-Pacific players are taking steps to shield their domestic industry from supply shocks and national security threats. A quick review of recent developments provides context for the difficulty of balancing the needs of cooperation, resilience, and innovation.

The United States

Facing supply-chain disruptions and increasing competition, the United States is pushing forward on initiatives to improve the resilience of its semiconductor supply chain and the innovative capacity of onshore producers.[25] To do so, the executive and legislative branches are moving ahead on parallel tracks. In February 2022, the White House unveiled its Plan to Revitalize American Manufacturing and Secure Critical Supply Chains in 2022, which resulted in chips being designated a critical export sector that is eligible for financing from the Export-Import Bank (EXIM) Domestic Manufacturing Initiative.[26] After languishing in Congress, the CHIPS and Science Act of 2022 was signed into law in August 2022, providing USD 52.7 billion in incentives for American semiconductor manufacturing, R&D, workforce development, and collaboration with partners on chip supply chains.[27] Foreign recipients of the funds are barred from building advanced chip facilities in China and other countries of concern. This has also been complemented by onshoring efforts that have resulted in the construction of a new USD 12 billion TSMC plant in Arizona that specializes in five-nm chips[28] and a new USD 17 billion Samsung plant in Texas.[29] The US-based Intel moved forward with a USD 20 billion plant in Arizona and a USD 20 billion plant in Ohio, reaching more than USD 100 billion "in investment pledges over the past year."[30]

Importantly, some foreign investments were said to be contingent upon the provision of US government incentives. For example, TSMC CEO Mark Liu said the company would only go ahead with its USD 12 billion Arizona plant if

the United States can "make up TSMC's running costs difference between the United States and Taiwan."[31] Similarly, Taiwanese firm GlobalWafers announced plans to build a USD 5 billion wafer fab in Texas, but its CEO told Commerce Secretary Gina Raimondo that the investment "is contingent upon Congress passing the CHIPS Act." However, it should be noted that Samsung's USD 17 billion plant in Texas moved forward even before the CHIPS Act, in part because the firm was able to secure incentives at the state and local level.

On the diplomatic front, the United States proposed "Chips 4," a multilateral group involving Korea, Taiwan, and Japan, for the purpose of coordinating semiconductor supply chains.[32] Beijing pressured Seoul through the media and in diplomatic communications to abstain from the group, but Korea's Foreign Minister Park Jin asserted Korea's right to attend the initial meeting of the group at the end of summer 2022, insisting that the intention is not to "exclude" China.[33] The group is still in an initial phase, and it is still unclear if Chips 4 will be an information-sharing consultative body, an investment-coordination vehicle, a supplier–diversification scheme, a venue to coordinate export controls, or some combination of the aforementioned activities.

People's Republic of China

China is the world's largest consumer of chips, taking in more than half of all supply. It currently depends on imports for more than 80 percent of its needs, a statistic that Beijing is hoping to reduce within the next decade.[34] As part of China's 2014 *National Integrated Circuit Industry Development Guidelines*, Beijing set a goal to lead all segments of the industry by 2030.[35] To do so, China is pouring massive amounts of state-directed aid, lowering barriers to entry for foreign firms, providing breaks on import taxes for raw materials and parts, and acquiring foreign firms and foreign talent. The country also engages in less scrupulous and illegal means. For instance, Chinese firms collude to reduce the value of a takeover target and then purchase it at a reduced rate.[36] Additionally, espionage operations target US firms Micron, Avago, and Skyworks; Taiwanese-based firms TSMC and Nanya Technology;[37] and South Korean firms as well.

In 2015, Beijing announced its *Made in China 2025* initiative, which hoped to raise the proportion of indigenous components in chips to 40 percent by 2020.[38] Reflecting the challenges posed by this ambitious plan, the country had only achieved a rate of 16 percent by 2021. In an analysis, Boston Consulting Group estimates that Beijing will be able to increase China's self-sufficiency to 40 percent by 2025.[39] This would cause the US global market share to slip by 2–5 percent, US revenues to drop 3–9 percent, and US R&D spending to decline 2–10 percent.

In response to export controls that limit the flow of US and other technology to China, Beijing is pouring government capital into tech firms to ramp up domestic production capacity.[40] China's Ministry of Industry and Information Technology lists nearly 5,000 "Little Giant" firms in critical tech sectors like chips that receive support from the government in the form of subsidies, loans, tax cuts, and talent placement.[41] The subsidy-to-sales ratio of Chinese firms is much higher than that of other countries. The ratios for the Chinese firms Semiconductor Manufacturing International Corporation (SMIC) and for Huahong Group are 6.6 percent and 5 percent, respectively. This compares with 0.8 percent for South Korean firm Samsung Electronics and 0.5 percent for SK Hynix.[42] US-based Micron Technology, Qualcomm, and Intel had a ratio of 3.8 percent, 3 percent, and 2 percent, respectively. Taiwan's TSMC was 3 percent. Beijing's aggressive support policy has a mixed record thus far. On the one hand, it is yielding some dividends. Thanks to sanctions and supply-chain snarls, Chinese firms that were once dependent on chips from abroad are now able to buy them at home from an assortment of Chinese chip companies that are growing more quickly than anywhere else in the world.[43] China's Dual Circulation Strategy aims to increase the country's economic self-sufficiency. To do this, it needs to both grow the middle class to boost domestic consumption and progress indigenous technologies up the value chain. Analysts at the China Power project believe this will be difficult to meaningfully accomplish in the short term.[44] Furthermore, Beijing's industrial policies that guarantee state financing to chip startups could bake-in inefficiencies and stymie innovation. An analyst from the research firm Rhodium Group assesses, "China's semiconductor industry is an industrial-policy-driven bubble," noting the creation of 22,000 new chip companies in 2020, an annual increase of 200 percent.[45]

South Korea

South Korea's market share in the global chip sector (20 percent) lags only the United States. Chips are extremely important to Korea's economy and represent its largest export. In 2021, Seoul announced that companies would invest USD 450 billion in the chip sector within the next decade and the government would expand tax benefits.[46] The dilemma for Seoul is that China is the country's largest trade partner, while the United States is its most essential security ally. China accounts for about half of South Korea's chip imports and exports. Both Samsung and SK Hynix are moving forward with expanded production in China.[47] However, from 2018–2021, South Korean chip exports to China increased by just 6.5 percent, much less than those of Taiwan (57 percent) and Japan (34 percent).[48] The Federation of Korean Industries attributes this decline to increasing Chinese

self-sufficiency, falling prices, and US export controls, which restricted South Korean sales to Chinese firms Huawei and the SMIC.

During the first summit meeting between presidents Joe Biden and Yoon Suk-yeol, the United States and South Korea pledged to "enhance public and private cooperation to protect and promote critical and emerging technologies, including leading-edge semiconductors [and] establish a regular ministerial-level Supply Chain and Commercial Dialogue to discuss promotion of resilient supply chains of key products, including semiconductors."[49] In a sign of the issue's prioritization, Biden and Yoon also visited a Samsung semiconductor plant, hailing chips as "the key to propelling us into the next era of humanity's technological development."[50]

Taiwan

Taiwan's TSMC is a crucially important player in the global chip chain, producing 92 percent of the world's most advanced chips, which are used in both civilian technology and military equipment.[51] TSMC announced that it plans to begin production of the next generation two-nm chips by 2025. Semiconductors alone accounted for almost half of Taiwan's trade with China. Geopolitical risk is created by the fact that the country's fabrication plants are all located on Taiwan's west coast near the "red beaches" that would be the landing zones in the case of a Chinese invasion. China routinely talent poaches Taiwanese chip experts, for instance luring 10 percent of the country's 30,000 R&D engineers to the mainland in 2019. Taipei has taken measures to "reshore" operations by securing over USD 20 billion in "investment pledges from 156 Taiwanese companies returning from the mainland."[52] TSMC has resisted participating in export controls against firms blacklisted by the United States such as Huawei, arguing that it does not need a US export license because its products and processes are composed of less than 25 percent of US technology.[53]

Japan

Like the United States, Japan is engaging in efforts to recover lost manufacturing capabilities. It previously produced over 50 percent of the world's semiconductors but now makes around 10 percent.. To brace against geopolitical risk, Tokyo has adopted a "China+1" strategy, "which has Japan staying in the Chinese market while actively developing other markets as well."[54] Tokyo's Ministry of Economy, Trade, and Industry has plans to reinvigorate the Japanese chip industry, and the Kishida administration approved a USD 6.8 billion domestic chip investment in November 2021.[55] In a May 2022 summit between President Biden

and Prime Minister Fumio Kishida, the two countries "concurred on establishing a joint task force to explore the development of next generation semiconductors."[56] Thereafter, the partners launched plans to build a joint manufacturing base to produce next-generation, two-nm semiconductors by 2025.[57] This cooperation will see both governments providing support for a collaboration between Japanese and US firms. However, there are lingering doubts whether Japan's efforts have "the funding, the diplomacy and the zeal necessary for success."[58]

The Argument for Balanced Dynamism

This section examines different approaches that the United States, South Korea, Japan, Taiwan, and the EU can adopt to address the challenges facing the industry. The first critical factor will be the extent to which the partners can harmonize an approach to the competing imperatives of innovation, resilience, and cooperation. The second critical factor will be the extent to which the partners will develop consensus about the threats posed by Chinese market distortion, espionage, and geopolitical risk. The threat perception will also need to then be balanced against the economic benefits gained from maintaining an open, global ecosystem.

These critical factors are mutually reinforcing. The degree of harmony achieved in one domain will positively impact the ability of the partners to generate consensus in the other domain. Likewise, failure to come to terms in one domain will impair coordination on the other front. Deciding not to adapt, of course, is also an option though for obvious reasons this would cause considerable economic setbacks and add significant risk exposure. This path is not worth serious discussion besides to point out that failing to act would be a tremendous mistake for any of the countries under observation. The global surge in political capital and private investment directed to the semiconductor industry is testament to the near-universal recognition that action is needed.

However, just because the need to act is quite apparent does not mean the path forward is clear. The Global Semiconductor Strategy Map, below, illustrates the first critical factor, demonstrating how the three competing needs of resilience, innovation, and cooperation can be balanced—but at a cost. For instance, the chart shows how a resilience-first approach would use export controls and subsidies to achieve added autonomy and some shock resistance. However, the resilience-first approach will also impair growth and innovation and elevate costs because of the lack of access to the global value chain, which supercharges innovation and boosts efficiency.

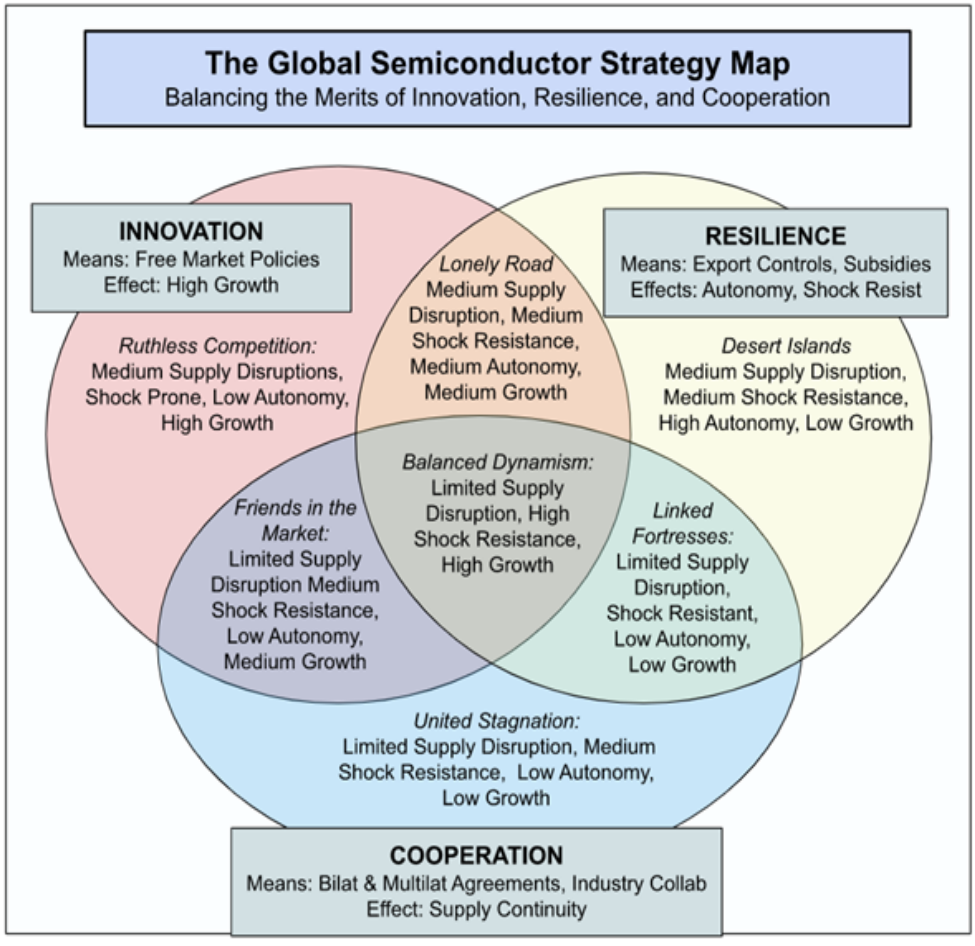


Figure 3. Global semiconductor strategy map

Importantly, no approach is perfect, and the most important factor is harmony. If the United States chooses to prioritize cooperation but its most important partners instead prioritize resilience, the plan will fail. Similarly, if the United States prioritizes innovation but other countries enact high barriers to trade, subsidies, and export controls, US firms will struggle to derive the benefits of the approach. Herein lies the prisoner's dilemma aspect of the problem. The United States and its partners stand to benefit from cooperation, but none can be sure that their partners are dependable. For example, TSMC founder Morris Chang criticized US efforts to improve chip autonomy, saying "it will be impossible for the U.S. to rebuild a full chip supply chain in the country."[59] And S. Paul Choi, founder of Seoul-based political risk advisory StratWays Group, said, "The U.S. is worried about technology being transferred to China, but many Koreans are

equally worried about their technology being transferred to the U.S." He added that, "Koreans don't want to be strong-armed by the Chinese but they don't want to be strong-armed by the Americans either."[60]

For this reason, it is essential that the United States develop and lead cooperation based on high standards, fair practices, reciprocity, common values, and market principles balanced with mutually agreeable security measures. This would require negotiating (and continually adjusting) agreements on export controls, subsidy ceilings, and working together on joint ventures, talent development, and R&D. Critically, this effort would need to engage and involve the private sector, including each country's respective semiconductor industry association. Consultative working groups and task forces should advise on policies and adjustments to answer to critical national security threats without compromising the conditions needed for continued innovation and cross-border cooperation. There are several existing multilateral groups that can serve as vehicles for different aspects of this approach.

The current approach is mostly defensive. Supply-chain resilience cooperation will be orchestrated through the Indo-Pacific Economic Framework for Prosperity (IPEF) and perhaps also through the Quadrilateral Security Dialogue (Quad). Export controls are orchestrated through the Wassenar Agreement, a 42-country agreement designed to slow the spread of technologies with potential military applications. "Under Wassenaar, Washington and its allies have harmonized controls over the flow of chip technology to China."[61] However, the overall plans remain incipient, reactive, and unbalanced. Demonstrating the need for further progress, in March 2022, the United States reportedly suggested a semiconductor alliance with South Korea, Japan, and Taiwan.[62] Seoul reportedly rejected the idea as "not fully acceptable" given the retaliation vulnerability presented by the large presence of South Korean firms in China and South Korean chip sales to China. To address this, the United States must present a vision for cooperation that registers and accommodates for the different levels of exposure and vulnerability of each partner country.

Going forward, there is room in the debate about the degree to which each lever can be pulled in terms of responding to the China threat and balancing innovation, resilience, and cooperation. Figure 4 portrays an array of responses, ranging from the most drastic and disruptive on the left side (in red) and the least disruptive and most cooperative on the right (in green). Decoupling and onshoring are the only surefire ways to insulate the domestic supply chain completely from supply shocks and geopolitics, but there is reason to believe this strategy is infeasible and would cause more harm than good. The best way forward is to harness the productivity of the global supply chain and simultaneously take steps to

shield against supply shocks and geopolitics through an approach called *balanced dynamism*. This approach combines public–private cooperation, friendshoring, ally coordination, and selective restrictions.

Figure 4. The China chip threat response spectrum

The Boston Consulting Group investigated two different scenarios.[63] In one scenario, which may be referred to as *technological decoupling*, all US semiconductor firms would be blocked from making sales to Chinese customers. Technological decoupling would result in a 100-percent decline in US revenues from Chinese customers. Global US revenue would drop 37 percent compared to 2018, and global US market share would drop 18 percentage points to 30 percent Declining revenues would cause a reduction in R&D spending of 30–60 percent. The resulting decline in innovation would hurt the competitiveness of US firms, causing gradual reductions in market share and revenue. In the near term, these drawbacks would open the door for South Korea to become the market leader, followed in the long term by China.

The Boston Consulting Group also analyzed the economic impact of selective restrictions, describing a scenario wherein existing US restrictions on Chinese access to US technology remain in place and become the status quo. Within a few years, this scenario would cause US companies to lose 55 percent of their revenues from Chinese customers compared to 2018. Global US revenue would drop 16 percent compared to 2018, and global US market share would drop eight percentage points to 40 percent. Declining revenues would cause a reduction in R&D

spending of 13–25 percent. Despite these drawbacks, the United States would remain the market leader.

It is not necessary to rely only on forecasts to predict how decoupling will affect US chip firms. Downstream complications from the US–China trade war have already constrained the revenue growth of US semiconductor firms.[64] The annual growth rate of the top 25 US chip companies declined from 10 percent prior to the imposition of tariffs in July 2018 to 1 percent thereafter. Subsequent restrictions on US technology sales to Huawei had a similar effect. However, the cost of decoupling would not just be prohibitive for the United States. The rest of the world would also have to deal with the fallout. In case of severe decoupling, Bao Yungang, a computing technology expert at the Chinese Academy of Sciences, said, "China is fully capable of advancing the evolution of [its indigenous chip architecture] independently and building an ecosystem together with Belt and Road countries."[65] However, there are reasons to think that China would realistically struggle to catch up, especially with regard to producing chips below the 10-nm level. Despite self-sufficiency goals, domestic firms remain at least a generation behind in production capacity and rely on foreign firms for crucial inputs, particularly manufacturing equipment.[66] For example, heeding the call from President Xi Jinping to onshore chip supply chains, Chinese automakers have developed advanced chips, such as Geely's 7-nm DragonHawk 1, but foundries are still unable to manufacture any chips below the 10-nm mark due to US restrictions. Geely turned to Taiwan's TSMC to make the DragonHawk chip.[67] Furthermore, Belt and Road countries are currently not active players in the global chip supply chain and lack the talent, materials, and IP to quickly scale up.

The fallout of technological decoupling for the rest of the world would depend on the degree of unity among US partners. As argued by a Boston Consulting Group report, if South Korea sits on the sidelines of a decoupling scenario, Korean firms would grow market share and revenue. The same could be true for Taiwan. However, given the degree of US technology in Korean and Taiwanese chips (not to mention the high level of supply-chain integration), it is difficult to imagine how either country could practically sit out a decoupling without choosing sides. Instead, it is more likely that two separate ecosystems with two separate technological standards would emerge, resulting in a suboptimal supply chain: "higher costs and innovation loss for all semiconductor end-users globally."[68]

A complement to decoupling is onshoring. Harvard professor Graham Allison and former Google CEO Eric Schmidt recommend that the United States "use its political leverage" (along with tax incentives and subsidies) to convince Taiwan and South Korea to "form partnerships with U.S. chip designers and manufacture advanced semiconductors in America."[69] This is a mistake. First, a 100-percent

onshoring approach would be expensive and counterproductive, according to a joint report by the Semiconductor Industry Association (SIA) and Boston Consulting Group.[70] An initial investment of USD 1 trillion would be required to make domestic chip supply chains fully self-sufficient and would cause chip prices to increase by 35–65 percent. Second, too much pressure toward a one-sided agenda will ultimately be counterproductive. If the United States tries to duel with China in a competition of industrial policies, Washington will not have a strong a hand to play. China is a bigger market. It buys more chips and, therefore, has more leverage in that regard. However, the United States can offer something China cannot—a vision for a set of fair standards that ensures reciprocal benefits across the long term. The United States' strength over China is not the size of the market and the exercise of its leverage, but America's ability to inspire, cooperate, and lead based on shared interests and shared values.

The alternate to decoupling and onshoring is selective restrictions and friendshoring. US Treasury Secretary Janet Yellen described *friendshoring* as deepening "ties with those partners and to work together to make sure that we can supply our needs of critical materials."[71] This will enable the United States to "get the benefits of continued efficiencies in production by having a group of partners who work to shore up supply chains and make them more resilient." With regards to the possibility of decoupling, Yellen said, "I would like to see us preserve the benefits of deep economic integration with China, not going to a bipolar world, but clearly that's a danger that we need to address." For an example of this approach in action, we can again turn to President Biden's trip to a Samsung plant in South Korea, where he cautioned against a supply chain that relies too much on countries that "don't share our values."[72] The "critical component" of this approach is to work with and exchange investments in partners that do share values, such as South Korea, Biden added. Korean President Yoon said, "Korea-U.S. relations will be reborn as an economic and security alliance based on high-tech and supply chain cooperation."[73] This approach needs to strike a delicate balance.

Secretary Yellen said that many US allies are reluctant to cut business ties with China and that technological decoupling could cause the United States to lose out on the benefits of access to the global supply chain, "where advances in one country benefit countries worldwide."[74] As explained by Georgetown University's Center for Security and Emerging Technology, a full chip embargo against China "would alienate regional partners and jeopardize the long-term viability of the U.S. semiconductor industry."[75] An official with South Korea's Chamber of Commerce and Industry explained, "China's pursuit is a life-or-death concern not just for the U.S. but for us too, and it will necessitate a proactive joint response."[76] A joint response means allowing partners to help shape the agenda. A South Korean

think tank researcher said that it is in Seoul's interest "to get on board with the U.S.-led supply chains, but officially taking part in a cartel to shut China out is an entirely different issue."[77]

Conclusion

Balanced dynamism is the only approach that balances the competing imperatives of innovation, cooperation, and resilience and affords the best possible protection against market distortion and coercion. Boston Consulting Group advocates for a balanced dynamism approach, arguing that the "dual objectives [of addressing national security concerns and preserving global market access for US firms] are fundamental to maintaining the proven innovation model that will allow the industry to continue to deliver technology breakthroughs that are crucial for U.S. economic competitiveness and national security."[78] The United States should pursue such an approach aggressively and in close coordination with South Korea, Taiwan, Japan, and the EU, setting forth a values-based vision of fair and reciprocal standards. Working multilaterally and cooperatively with representatives from the private sector will ensure that this set of practices represents balanced and future-oriented priorities, protecting against national security threats but not allowing said provisions to obstruct the market and inhibit innovation. ✪

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