FOREIGN AFFAIRS

The Illusion of Controls

Unilateral Attempts to Contain China's Technology Ambitions Will Fail

BY SARAH BAUERLE DANZMAN AND EMILY KILCREASE
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SARAH BAUERLE DANZMAN is Associate Professor of International Studies at the Hamilton Lugar School of Global and International Studies at Indiana University, Bloomington, and a Nonresident Senior Fellow at the Atlantic Council. She was previously a Council on Foreign Relations International Affairs Fellow in the Office of Investment Affairs at the State Department.

EMILY KILCREASE is Senior Fellow and Director of the Energy, Economics, and Security Program at the Center for a New American Security. She previously served in economics and security roles at the Office of the U.S. Trade Representative, the National Security Council, and the Department of Commerce.

In October, the Biden administration announced a series of new, unilaterally imposed export controls designed to freeze China's advanced chip production and supercomputing capabilities. The strengthened rules came less than a month after National Security Adviser Jake Sullivan announced a major change in U.S. technology competition strategy. Previously, the United States sought to deny the export of chips or other technologies to China if such items were designed or likely to be used for military purposes, or if the transfer would impair the U.S. ability to maintain an advantage over

competitors in cutting-edge commercial technologies that might also have military applications. Now, Sullivan said, "we must maintain as large of a lead as possible" in certain technology areas as a whole, for all intents and purposes erasing the line between civilian and military applications in the advanced chip production and supercomputing sectors.

A narrative quickly took hold that these export controls, and especially the "foreign direct product rule" provisions that allow the United States to apply its controls extraterritorially under certain circumstances—such as preventing companies outside the United States from selling semiconductors to China if they were produced using U.S. equipment—were a sign that the U.S. was "weaponizing" its influential position in the semiconductor supply chain. The United States, this argument went, enjoys market dominance in certain kinds of software and equipment used to design and manufacture semiconductors, as well as certain advanced chips critical for artificial intelligence, and it can use this privileged position to stymie China's attempts to develop its own microelectronic and supercomputing capabilities. In a similar way, the United States has used the centrality of the U.S. dollar to freeze individuals and governments out of the global financial system.

But the U.S. role in the semiconductor supply chain cannot be compared with the primacy of its currency in global finance. Technology supply chains can be adapted and reorganized more easily than the dollar-based financial system. Worse, this argument is dangerous because it lulls policymakers into a false sense of security about the effectiveness of unilateral approaches, leading them to discount the importance of building multilateral alliances to ensure the effectiveness of export controls. It may also undermine the critical signaling of Western unity in confronting the systemic challenges presented by China. Although U.S. officials are committed to convincing key allies and

partners to jointly impose similar controls, the U.S. actions were announced alone and the prospect of a deal with other allies and partners remains uncertain.

Understanding how export controls or other instruments of geoeconomic statecraft can be applied to greatest effect requires a finer appreciation of the U.S. position within globalized supply chains, as well as the underlying structure and adaptive nature of these networks. Unlike U.S. dollar dominance in global finance, the U.S. position in advanced technology supply chains is more contingent and more vulnerable to shocks. Coordinating geoeconomic strategy and policies with key partners and allies can shore up the U.S. position and prevent power within these networks from shifting away from the United States over time.

A FAULTY ANALOGY

For states to deploy weaponized interdependence effectively over time, they must enjoy a dominant position within a hierarchical network structure. The centrality of the U.S. dollar in the global financial infrastructure is the classic example of a hierarchical network in which the United States enjoys unambiguous dominance and can exploit its position to achieve its geopolitical objectives. U.S. sanctions strategy is based on this premise. It is exceedingly difficult to reorient the global financial system around an alternative to the dollar because of the so-called network effects of the currency's ubiquity—just like social media platforms, a currency becomes more useful the more widely it is used. The U.S. dollar has the resilience to remain the dominant currency even in the face of extreme shocks, such as the 2008 financial crisis.

Policy planners should not overlearn the lessons of the United States' experience with financial sanctions, nor should they make the mistake of

imagining that the supremacy of the dollar offers an analogy for the country's position in the global semiconductor supply chain. This supply chain is actually far more difficult to effectively weaponize than the global financial system because its complexity allows for those involved to adapt to shifts over time. It consists of multiple networks of different inputs that generate chokepoints in several different countries. The United States is arguably the most influential node of these networks, accounting for 46 percent of the $528 billion global semiconductor market in 2021. It is globally dominant in the making of electronic design automation software that is integral to designing complex circuitry for the most advanced chips. Along with the Netherlands and Japan, it controls the supply of equipment necessary to manufacture semiconductors, a sector known as "tooling."

But the United States is entirely reliant on Taiwan and South Korea for the fabrication of the most advanced semiconductors. Moreover, the United States manufactures only 11 percent of chips made globally. The raw materials necessary for microchip fabrication are similarly concentrated in just a few countries, including China. Foreign suppliers dominate the functions of testing, packaging, and assembly that take place at the back end of the chip production process. The intricate and often overlapping networks of production create numerous, complex dependencies among different places—notably China, Japan, South Korea, Taiwan, the United States, and European states—at different stages of the supply chain. Several countries have greater control over specific parts of the supply chain than do others, but no single country dominates the entire network.

Because of high production costs, economic activity within each layer of the network tends toward concentration, with one or two different firms holding a dominant share of the global market for each particular part of the semiconductor production process. This tendency creates discrete technology

chokepoints that the United States and others can leverage in the short term. It costs between $10 billion and $20 billion to create a plant that makes wafers (key components in semiconductors). Designing and developing new equipment has high R & D costs and long lead times that encourage industry consolidation. For instance, the Dutch chip maker ASML uses an extreme ultraviolet light lithography machine that took three decades to develop, requiring multiple corporate acquisitions, thousands of highly skilled workers, and close collaboration with technology suppliers. The industry's high fixed costs, technical complexity, and demands for talent encourage specialization and the segmentation of markets such that just a few suppliers control many critical parts of the supply chain. To maintain those positions of control within the supply chain, firms must invest in continuous innovation and R & D. To keep up, firms and countries must continuously and fiercely compete, and they remain vulnerable to being replaced if they fall behind.

CUTTING THE CHAIN

Whether the United States, or any other state, can weaponize its position in the semiconductor supply chain is contingent upon how easily isolated countries can reconfigure critical pieces of the supply chain network. Replacing a key node in the chain is a complicated task, requiring a significant amount of patient investment and a high level of technical sophistication. But it does not require a complete reconfiguration of the semiconductor network as a whole, just one or two dedicated actors that have the technical capacity, deep R & D budgets, and economic motivation to replicate the functions of another country. The semiconductor space is cutthroat, and technology develops quickly. Engineers can make new breakthroughs both by developing more advanced chips and by finding more efficient and reliable production methods. Technological leaders can see their

fortunes rise, fall, and revive—sometimes thanks to ample government assistance. Although finding alternatives to the United States would not be an easy feat, close competitors may be able to pull it off, particularly if they retain access to other sources of technology and expertise.

The dynamism of the industry is well illustrated through tooling, one of the chokepoint technologies that the new U.S. export controls seek to deny China. A handful of U.S. companies—namely, Applied Materials, KLA, and Lam Research—control important tooling technologies today. But foreign-based companies such as ASML and the Japanese firm Tokyo Electron are market leaders in related parts of the supply chain and are well positioned to develop substitutes to U.S. technologies in the medium term. These foreign companies may want to do just that, as the forced exit of U.S. tooling companies from China creates a natural market opening. The foreign tooling companies also have a strong incentive to design out U.S. technologies in their own supply chains as a way of evading the threat of further U.S. controls.

The recent unprecedented expansion of extraterritorial rules in U.S. export controls turbocharges these concerns, heightening the risk that other countries or firms will ice out U.S. suppliers as a matter of protecting their autonomy and preserving their ability to sell globally—including in China. Critically, U.S. tooling companies may face declining sales outside the Chinese market as foreign chip firms look to create production lines free of U.S. tools in order to avoid the long reach of the new export control policy. In 2019, the United States made aggressive use of extraterritorial controls to deny the Chinese telecommunications firm Huawei access to the global chip supply, which subsequently throttled Huawei's expansion. But these measures were limited to one company as opposed to entire segments of China's advanced technology ecosystem. The new U.S. willingness to use far-

reaching authorities that are both unilateral and extraterritorial should be expected to create a greater shock to the supply chain than the U.S. actions that targeted Huawei. It is therefore likely that foreign firms and governments will increasingly view reliance on U.S. technology as a vulnerability they have to mitigate.

U.S. tooling companies may see their own prospects decline as a cycle of shrinking market opportunities leaves them with less revenue to invest in innovation. This same dynamic played out in the commercial space sector in the early years of the twenty-first century, after the United States unilaterally imposed stricter controls on satellite exports to China. U.S. market share and capabilities declined as European firms started offering products that excluded U.S. components, including to the China market. The new controls will have an undeniable effect in the short term by denying China access to tooling, but this chokepoint may prove undefendable over time as the supply chain shifts to include alternative suppliers.

THE WEAPONIZATION FALLACY

The case of semiconductors illustrates how countries cannot easily weaponize interdependence, especially when it comes to supply chains characterized by complex and overlapping dependencies. Certain companies may be able to maintain specific technology chokepoints in the semiconductor supply chain, but they can only keep those positions through continuous competition. This generates a supply chain structure that is far more amenable to change over time and harder for any single player to control. Global leadership in other advanced technology areas—such as artificial intelligence and quantum computing—is highly contested and will present similar complications. Smart and effective policies to strengthen U.S. technological leadership in all these areas must recognize such constraints.

In this context, the United States must act quickly to build a consensus among advanced economies on a shared approach to the technology competition with China, one that reaches a deeper understanding of the appropriate role for export controls. The United States may not dominate the entire semiconductor supply chain, but it has the strong advantage of deep alliances and partnerships with the majority of places that represent other critical nodes. A better coordinated strategy will dramatically decrease the risk that other actors will simply fill the vacuum left by the United States. Multilateralism will help preserve the U.S. role within these networks and ultimately make any controls imposed on China more devastating. For example, U.S. tooling could be replaced over time by Dutch and Japanese capabilities, but it will be much more difficult for China to replicate the capabilities of all three countries on its own. To that end, recent press reports of progress in negotiations among these countries are promising, but it remains too early to assess whether the talks will result in a deal that creates a genuine, multilaterally controlled chokepoint.

The United States will face challenges in seeking such a consensus, including on the question of whether it is wise to freeze China's commercial capabilities, as well as more technical questions of whether other countries have the legal authority and enforcement capacity to implement the desired policies. U.S. officials must have difficult conversations with allies about how wide the yard and how tall the fence should be with respect to so-called dual-use technologies, those that have both military and commercial uses. Although key partners are aligned with the U.S. assessment of China as a strategic threat, there remain fundamental disagreements about the effectiveness of the U.S. approach and the tradeoffs inherent in the intensifying use of export controls. A multilateral deal built on the threat of further U.S. extraterritorial controls may deliver short-term policy objectives,

but it will only deepen the concerns of allies and their semiconductor industries about the costs of depending on U.S. technology and encourage such actors to develop alternatives. Threats of new controls are not enough. U.S. officials must work with partners to develop a shared understanding of how to best respond to Chinese technological advancement.

Building a shared strategy to responsibly manage the technology competition with China has never been more urgent. Beyond export controls, the Biden administration and Congress are considering a range of new tools to address the perceived dangers of economic entanglement with China, including unprecedented regulations of U.S. investment in China. The ultimate objective may be to stem the flow of critical U.S. technology, capital, and expertise into China's advanced technology sectors. But just as the United States cannot effectively weaponize its nondominant position in chip supply chains, it equally will not succeed in slowing China's indigenous technology advances more broadly if it simply acts alone.
