Bureau of Industry and Security 2022 Agenda

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Recommendation #3:

Strengthen Semiconductor Manufacturing Equipment Restrictions to Prevent China's Self-Sufficiency

FEBRUARY 2022

The Department of Commerce's Bureau of Industry and Security (BIS) is probably the most important U.S. government agency most people have never heard of. Charged with ensuring export control, treaty compliance, and strategic technology leadership, BIS plays a critical role in U.S.-China policy. Without its due diligence, sensitive and strategic American-made technologies could end up in the hands of the Chinese military and threaten America's national security.

Several months ago, President Biden nominated Alan Estevez for Under Secretary of BIS. He brings unparalleled national security experience to BIS at one of the most critical junctures in the agency's history. Given the agency's importance, the Senate must end its delay and give him a vote.

This series of policy recommendations will provide ideas for BIS and its leadership to pursue an aggressive agenda and use the agency's full range of tools to protect America's security and prosperity.

Semiconductors are used to power virtually all forms of modern technology, from everyday devices, like tablets and smartphones, to sophisticated defense systems. U.S. chip exports exceeded $66 billion last year, a nearly 11 percent increase year-over-year.[1] However, in the wrong hands or in the wrong applications, American-made semiconductors and semiconductor manufacturing equipment (SME) present a national security risk.

As such, the U.S., like other developed nations, regulates the export of semiconductors, which often have dual-use commercial and military applications. Controls are not always successful. For example, the *Washington Post* reported last April that chips made with U.S. software were employed by the Chinese Aerodynamics Research and Development Center to develop a hypersonic missile which may be capable of evading U.S. defense systems.[2]

"Semiconductors are part of China's national strategy," Nazak Nikakhtar, former Assistant Secretary for Industry and Analysis at the U.S. Department of Commerce's International Trade Administration said last month.[3] "The transfer of semiconductor technology from the United States to China is what enabled China to race ahead in hypersonics—two years ahead of us… What we did several years ago for the benefit of one or two companies now has put the entire world in incredible jeopardy… At what point are we willing to scale back to protect the national security interests of not only this country, but the entire world?"

Semiconductor manufacturing and design is one of a few technological fields in which the United States maintains a competitive advantage over China. Yet, the People's Republic of China (PRC) has committed significant investment to bolster the country's indigenous chipmaking capabilities. Xi Jinping, General Secretary of the Chinese Communist Party (CCP), has pledged $1.4 trillion to develop China's capabilities in key technology sectors, including semiconductor manufacturing.[4]

The success of these efforts will depend largely on Chinese companies' continued access to American-made chips and SME. China imported $432 billion worth of semiconductors last year, up nearly a quarter from the previous year.[5] These chips may be reverse engineered to provide dual-use technology to the Chinese military, or directly employed against U.S. interests. More alarming, China's acquisition of SME could provide the tools to surpass the United States in chip design and manufacturing capabilities.

Semiconductors are one of the few but important chokepoints that the U.S. can exercise against the PRC to maintain security and a technological advantage. Export controls are one of the few defenses to prevent the PRC from acquiring and weaponizing U.S. semiconductor technology. As the agency responsible for developing and enforcing export controls, BIS will play a critical role in this power struggle and could very well determine the outcome.

CHINA'S SEMICONDUCTOR AMBITIONS: A CLEAR AND PRESENT DANGER

There is growing awareness among policymakers and experts that the PRC's objective to dominate the semiconductor industry is part of a broader national strategy to achieve "the great rejuvenation of the Chinese nation."[6] The Office of the Director of National Intelligence's latest Annual Threat Assessment[7] identified China's "push for global power" at the top of its threat list. In November, the Department of Defense's report to Congress stated: "the PRC is the only competitor capable of combining its economic, diplomatic, military, and technological power to mount a sustained challenge to a stable and open international system."[8]

Under President Biden, BIS has continued to add Chinese companies to the U.S. Entity List, though not necessarily in the semiconductor space, which is arguably most important. Last June, the Biden White House initiated a 100-day supply chain review, with semiconductors among the four key focus categories.[9]

Yet, these escalations have not disrupted China's growth. The country's semiconductor production grew 33 percent last year, more than double the rate in 2020.[10] The Semiconductor Industry Association (SIA) reported in January that Chinese companies' global chip sales are on the rise, "due largely to… a whole-of-nation effort to advance China's chip sector, including government subsidies, procurement preferences, and other preferential policies."[11]

Just five years ago, China accounted for less than four percent of global chip sales. By 2020, the Chinese semiconductor industry registered an unprecedented annual growth rate of 30.6 percent to reach $39.8 billion in total annual sales, according to SIA's analysis. If that growth is sustained, China would capture more than 17 percent of global market share by 2024. Moreover, China is projected to add 40 percent of the world's new semiconductor manufacturing capacity over the course of this decade.[12]

By comparison, U.S. semiconductor production has fallen 70 percent over the past three decades. In 1990, the U.S. provided about 40 percent of global supply. As of last year, that market share had dwindled to about 12 percent.[13]

CHINESE NATIONAL CHAMPIONS YMTC, SMIC, AND CXMT REPRESENT A DIRECT THREAT TO U.S. SECURITY

U.S. export controls are designed to prevent adversaries like the PRC from acquiring chips that could be weaponized or otherwise exploited against U.S. national security and economic interests. However, Chinese chipmakers like Yangtze Memory Technologies Company (YMTC)—which lawmakers have called a "PRC state-owned national champion"[14]—have sought to circumvent these restrictions.

YMTC recently launched a "massive" multi-year review of the company's supply chains that involved 800 full-time workers to reduce reliance on U.S. semiconductor makers. "YMTC is seeking to learn as much as it can about the origin of everything that goes into its products… The audit extends not only to YMTC's own production lines, but also to suppliers, [and] suppliers' suppliers," the *Nikkei Asia article notes.*[15] The White House's 100-day supply chain review report notes that YMTC has received $24 billion of subsidies from the Chinese government and "is focused on rapid expansion," which may represent a "low-cost threat to U.S.-based memory companies."[16]

LETTER TO SEC. RAIMONDO

"...the national security community needs your leadership on this urgent matter to prevent YMTC from obtaining the technology it needs to continue engaging in activities contrary to our national security."

—Sen. Bill Hagerty and Rep. Michael McCaul

In July, U.S. Representative Michael McCaul (R-TX10) and U.S. Senator Bill Hagerty (R-TN) called on U.S. Commerce Secretary Gina Raimondo to add YMTC to the U.S. Entity List. "The CCP is implementing an unprecedented industrial plan to vertically control each segment of the semiconductor supply chain," the letter notes. "Based on these specific facts that link YMTC to the CCP military, the Party-state, and a national semiconductor plan designed to deplete the U.S. defense industrial base, the national security community needs your leadership on this urgent matter to prevent YMTC from obtaining the technology it needs to continue engaging in activities contrary to our national security."[17]

The National Security Council met in December to discuss tighter restrictions on China's largest chipmaker, Semiconductor Manufacturing International Corporation (SMIC)—another "national champion" that has been added to the U.S. Entity List.[18] So connected is SMIC to China's government, that direct state subsidies accounted for over 40 percent of the company's revenues from 2014 to 2018.[19] Only weeks later *Nikkei Asia* reported that at the direction of CCP General Chairman Xi Jinping, government-backed funds plan to invest significantly in new SMIC facilities, materials, and equipment, which may be bolstered by a newly announced "Cross-Border Semiconductor Work Committee" that will work to attract foreign chipmakers and even potentially acquire major U.S. companies.[20] (Discussed further below)

Like YMTC and SMIC, ChangXin Memory Technologies (CXMT) also maintains known ties to the Chinese military.[21] CXMT was founded as a "pilot demonstration" of the Made in China 2025 initiative and enjoys significant support from the Chinese government.[22] Multiple company officers serve in the Chinese Communist Party (CCP). Through these advantages, CXMT has emerged as China's first and only DRAM memory chip maker.[23]

Brian Matas, Vice President of Market Research at IC Insights, told *EE Times* that CXMT faces the challenges of "lack of IP" and "the inability to quickly invest in and transition to new equipment for next-gen process technologies."[24] These obstacles suggest the company will need to steal IP and purchase manufacturing equipment to sustain its growth. Even so, China's Topology Research Institute reported in 2019 that CXMT "is expected to support about half of the global DRAM demand"—which would mark an incredible leap given the company's relatively short existence.[25]

Last year Emily de la Bruyère, a Senior Fellow with the Foundation for Defense of Democracies, said that the U.S. export controls should be extended to CXMT, which she explained is "equally propped up and potentially equally connected" to the Chinese government and military. "This goes back to… the idea that our piecemeal efforts risk allowing China to find workarounds."[26]

Much policy discussion has focused on the need to support U.S. semiconductor manufacturers through government subsidies and tax incentives. The CHIPS Act (introduced by Senator John Cornyn (R-TX)) was passed in 2020 as part of the National Defense Authorization Act. The U.S. Innovation and Competition Act (introduced by Senate Majority Leader Chuck Schumer (D-NY)), which would allocate funding for the CHIPS Act, was passed in the Senate last June before faltering the House. These bills seek up to $52 billion of federal investments for semiconductor research, design, and manufacturing.

While such investments are critical to the growth of the U.S. domestic semiconductor industry, without an adequate export control regime to stop the PRC's theft of American-made technology, these efforts amount to damming half the river. It is critical that BIS strengthen the U.S. export control framework to prevent China from gaining the upper hand in the semiconductor sector.

SEMICONDUCTOR MANUFACTURING EQUIPMENT: A CHOKEPOINT TO DISRUPT CHINA'S AMBITIONS

Semiconductor manufacturing equipment (SME) remains one of the few areas where the United States continues to enjoy a competitive advantage over China. This equipment is critical to build sophisticated chips, and therefore creates an edge for the United States to maintain its leadership in semiconductor design and manufacturing. The National Security Commission on Artificial Intelligence advised last year that SME "is a critical choke point and an attractive target for export controls" to ensure U.S. chipmakers remain at least two generations ahead of China.[27]

JUNE 2021

"The Administration should target and implement export controls on critical semiconductor equipment… such controls will protect U.S. national security interests... "

—White House Supply Chain Report

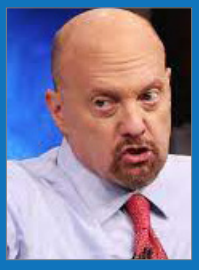
The White House's 100-day supply chain review made a similar recommendation: "The Administration should target and implement export controls on critical semiconductor equipment… such controls will protect U.S. national security interests by limiting advanced semiconductor capabilities in countries of concern while enabling continued leadership of the U.S. semiconductor sector."[28]

A *Nikkei Asia* exposé last year notes that 80 percent of sophisticated chipmaking and design processes, including etching, ion implantation, electrochemical deposition, wafer inspection and design software, "is in the hands of U.S. companies."[29] Further, as Will Hunt, a Research Analyst with Georgetown University's Center for Strategic and Emerging Technology (CSET), explained last year, some tools are only made by U.S. companies.[30] For example, there's an etch tool made by Lam Research that is relied on by YMTC.

U.S. policymakers have an imperative to protect our country's strategic advantage in the semiconductor market by preventing Chinese competitors from acquiring the tools to surpass the United States' design and manufacturing capabilities. That will require putting national security interests ahead of businesses' short-term profits. Eric Hirschhorn, Under Secretary of BIS under President Clinton, cautioned last year: "You don't balance national security with sales—you can't."[31]

AMERICAN SME MAKERS PROFIT WHILE EQUIPPING THE PRC

American SME makers have generated significant revenues from sales to China. These companies' justification seems to be, as Lam Research's Chief Financial Officer stated during an earnings call in 2020, that Chinese demand "has to be satisfied by somebody."[32] Why miss out on the near-term profit?



ADVICE TO INVESTORS ON KLA, LAM RESEARCH, AND APPLIED MATERIALS

"Business is going to be very good… The China opportunity could be enormous"

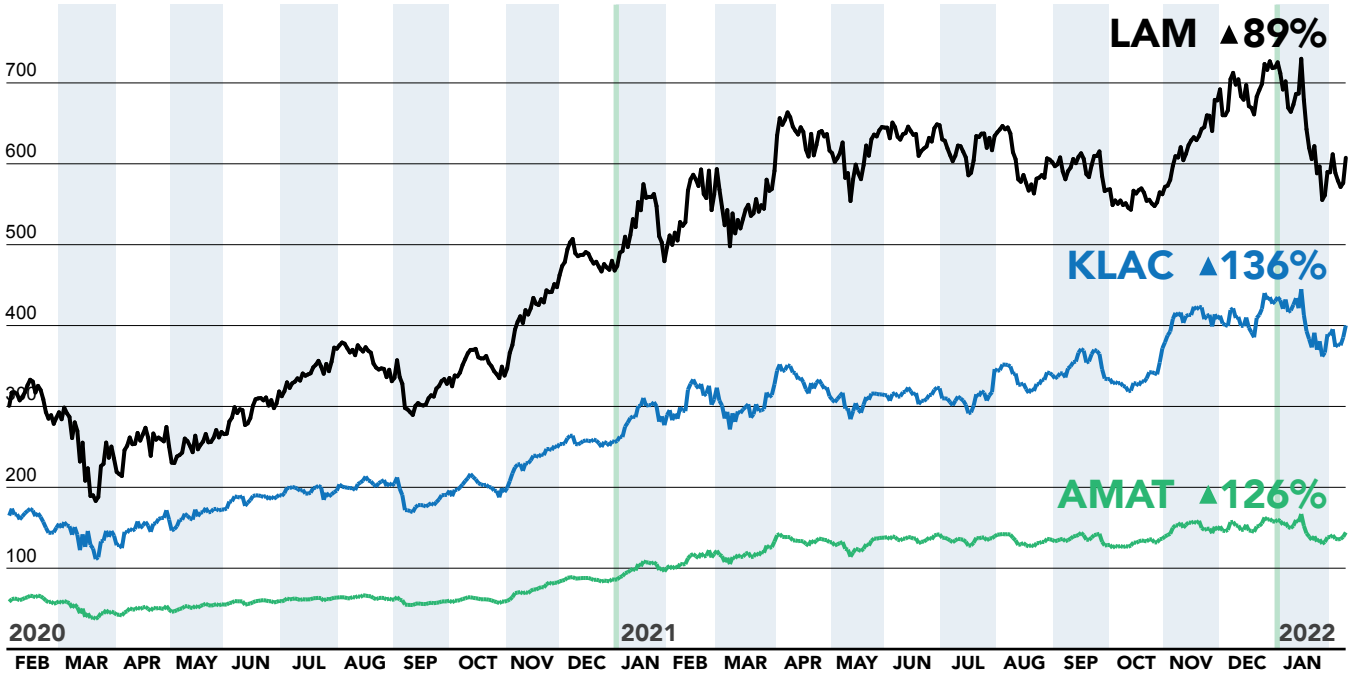
—CNBC's Jim Cramer

In November 2020, CNBC financial analyst and stock-picker Jim Cramer predicted a Biden Administration softening on China trade policy would further accelerate U.S. SME makers' profits. Mr. Cramer described semiconductor toolmakers Lam Research, Applied Materials, and KLA Corporation as the "jewel of what we have in our country" and said: "Business is going to be very good… The China opportunity could be enormous" (referring to continued access to Chinese companies).[33]

An accompanying article adds that Lam Research's, Applied Materials' and KLA Corporation's "exposure to China will serve well under a Biden administration."[34] Coincidentally, a China Tech Threat analysis the same day noted that Chinese spending on U.S. SME increased 50 percent in 2019 and cautioned that continued access could make implementation of export controls "increasingly difficult as China has no plans to slow its military development."[35]

Looking back, Mr. Cramer's prediction has been a windfall to stockholders. Comparing stock prices for U.S. SME today compared to two years ago, investors evidently believe these companies are well-positioned to capitalize on substantial growth opportunities, which points back to Chinese-owned companies. So even while the S&P 500 has increased 33 percent in the past two years, U.S. SMEs have far out-paced this growth with KLA increasing 136 percent, Applied Materials 126 percent, and Lam Research 89 percent.[36]

Stock Prices Jump for Lam Research, Applied Materials, and KLA Corporation



During an earnings call in January, Lam Research's Chief Financial Officer characterized 2021 as "a growth year" and predicted the company's sales to China will "grow again this year." Acknowledging the entrance of "new [Chinese] fabs and new players" he added, "Lam participates well in that market."[37]

These growth trends indicate that U.S. export controls on SME remain largely insufficient to prevent the flow of sensitive technology to Chinese-controlled companies. Last November, Representative McCaul cautioned: "Selling the PRC the tools and technology it needs to increase its coercive leverage over its trading partners damages America's strategic interests… [U.S. SME makers'] short-term corporate profits are sacrificing long-term American strategic interests. The Administration must use export controls to stop the PRC from further building out its semiconductor supply chain."[38]

Citing trade restrictions against SMIC as an example, Representative McCaul said U.S. licensing policy is "utterly ineffective" and "appears designed to give the company access to nearly all the semiconductor manufacturing equipment, technologies, and other goods it needs to make semiconductors."[39]

The United States cannot afford to cede its leadership in the semiconductor market by allowing Chinese companies unfettered access to American-made SME, especially since national intelligence laws and the PRC's Military-Civil Fusion strategy can compel Chinese businesses to support the government's goals to expand its control in this space. And there is urgency to act.

The Chinese government is not idly awaiting the United States' response; it is actively working to further secure access to U.S. technologies. *Nikkei Asia* reported this month that China plans to launch a "Cross-Border Semiconductor Work Committee"—a collaboration among the Chinese Ministry of Industry and Information Technology, the Ministry of Commerce and Tsinghua University—in the first half of this year. The organization's mission will be to strengthen cooperation with foreign chipmakers, with the end goal of building a self-sufficient supply chain.[40]

The article notes that the agency "appears to be designed as a way to acquire advanced semiconductor technologies from the U.S., Japan and Europe," including SME, and the Committee may provide funding to Chinese companies that seek to acquire foreign chipmakers. Documents obtained by *Nikkei* show U.S. companies Intel and Advanced Micro Devices are among the companies expected to be targeted by the organization.[41]

Policymakers must strengthen the U.S. export control regime to better prevent U.S. SME from being sold to and exploited by the Chinese government and Chinese-operated entities. Doing so may hurt American companies' profits in the short run. However, coupled with financial incentives to support the U.S. chip industry, these controls will reduce long-term financial damages, create a sustainable path for the U.S. semiconductor and SME sectors, and position the U.S. to remain a global leader in semiconductor design and manufacturing.

POLICY RECOMMENDATIONS

1. Add YMTC and CXMT to Entity List

Over the past six years, the U.S. Department of Commerce has significantly ramped up its application of the Entity List against Chinese companies with known ties to the PLA. Under the Trump Administration, BIS added over 330 Chinese companies, including SMIC in December 2020.[42] The Biden Administration has since added more than 50 Chinese companies to the Entity List.[43]

These blacklist designations are a powerful tool to prevent Chinese state-owned entities from acquiring and sharing sensitive U.S. technology, and, as demonstrated by the example of Huawei—which has faced significant challenges related to being added to the Entity List—they can be effective. Yet, inconsistent application has allowed major Chinese semiconductor manufacturers, like YMTC and CXMT, to operate freely, while restricting others, like SMIC and Tsinghua.

Not only does U.S. export control law compel BIS to restrict SME to military end users, putting YMTC and CXMT on the Entity List represents an effective exercise to choke China's military ambitions and protect Americans.

This should include collaboration with stakeholders (i.e. Congress and intelligence agencies) to develop a clear metric for determining compliance with the PRC and PLA, which is applied uniformly across all Chinese enterprises, particularly in the semiconductor sector. Inconsistent application of the Entity List and other trade restrictions have created a regime that targets certain bad actors while allowing others to operate freely. These holes allow the PRC and PLA to maintain access to sensitive American technology and equipment, creating a continual game of catch-up, rather than a reliable framework to close the door on Chinese state-owned entities.

2. Target "Organizing Forces" with Trade Restrictions:

Unlike the United States, where there exists a clear distinction between the public and private sectors, the PRC has developed a whole-of-nation approach to advance its economic and military interests. This reality is exemplified by China's Military-Civil Fusion Strategy and its 2017 national intelligence law[44] that compel virtually all Chinese companies and individuals to comply with the government's information-gathering efforts. As a result, organizing forces—the vast network of pseudo-government organizations that often operate at the CCP's behest—are able to efficiently redirect resources to other state-owned companies when an existing shell company is impacted by U.S. trade controls.

Martijn Rasser, a Senior Fellow and Director of the Technology and National Security Program at the Center for a New American Security, noted last year: "The Chinese have been very good at creating cutout companies and intermediaries [to circumvent U.S. export controls]," which creates a "game of whack-a-mole" that expends U.S. resources. "Fundamentally, we need to focus on where we have leverage—what are the chokepoint technologies."[45]

Some experts have suggested that U.S. policymakers should restructure export control policy to assume that all Chinese companies are acting in compliance with the PRC and require a burden of proof to be exempted from the Entity List or other restrictions. While that may be unrealistic (both administratively and legally), BIS should target organizing forces with export controls, which will reach "behind the curtain" to stop the Chinese government and military from stealing U.S.-made technologies.

Given the importance of the sector, leading trade expert Derek Scissors recommends that semiconductors as a whole should be decoupled from China. He explains the key reason is to protect high-paying U.S. jobs, though he describes other benefits including ending the regulatory arbitrage practiced by U.S. companies and China to exploit loopholes in U.S. laws and strengthening U.S. security. Notably trade with China in non-sensitive domains would continue.

3. Prioritize Unilateral Controls on U.S.-Made Semiconductor Manufacturing Equipment:

While policymakers have emphasized the need for multilateral controls to prevent China from acquiring sensitive U.S.-made semiconductor technology, BIS leaders should pursue unilateral restrictions, when appropriate, to stop the PRC from building up its design and manufacturing capabilities.

As Ms. Nikakhtar explained, "Multilateral sounds good. But in practice, it's not actually effective because of our allies' different levels of risk tolerance… So, we should be mindful and respectful of that, and then move forward with what we believe we need to control."

This is doubly true for SME. Making this equipment is a highly complex, patented, and expensive process and requires significant human capital and expertise. Even more than other chip technologies, producers can exert monopoly control, preventing other countries from "backfilling" demand.

Unlike semiconductor products, SME provides the PRC and its proxies with the capabilities to design and create cutting-edge chips. In other words, it provides the tools to cut China's dependence on the United States, thereby creating a direct avenue to surpass the U.S. in military technology, flood the market with cheap products, and ultimately drive competitors out of business. These outcomes would jeopardize our national security and economic interests and would further diminish the United States' market share of the semiconductor market.

While multilateral cooperation is necessary, U.S. policymakers must prioritize a "control-now-cooperate-later" approach with respect to SME. This should not be an "either-or" decision, but instead a "both-and" approach.

CONCLUSION

Semiconductors and semiconductor manufacturing equipment are critical to the PRC's ambitions to exert its economic, military, and political control on the global stage. CCP leaders are not waiting and watching for U.S. policy to be written. The PRC is actively working to advance the country's indigenous capabilities, with the clear goal of disrupting the United States' leadership in these key sectors.

Accordingly, BIS leaders should be laser focused on protecting the United States' competitive advantage. That must start by prioritizing semiconductors and SME with trade restrictions, strengthening the export control regime and eliminating holes in the framework, and implementing unilateral controls in tandem with broader multilateral efforts.

The outcome of the United States' competition with China in the semiconductor arena may very well be decided over the coming months, not years. It is critical that BIS, as the key authority over export policy, leverage every resource to prevent the PRC's exploitation of American technology, and businesses. The United States' national security and economic interests may very well hang in the balance.

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