

# Controlling For X: Advanced Semiconductor Export Controls and Emerging Global Technology Competition

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<https://doi.org/10.38126/JSPG220306>

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Keywords: export controls; technology competition; emerging technology; artificial intelligence

**Executive Summary:** The prevailing view in Washington is that the United States and China are in a fierce competition for control of critical technologies of the future. The Biden Administration's October 2022 semiconductor export control rules target China's ability to make or obtain the most advanced semiconductors – the foundational components of advanced technologies. It is best to understand the United States semiconductor export controls as a tool being wielded by the US government in a fight for global technological dominance, particularly in the realm of AI. This strategy represents a substantial assertion of extraterritorial power by the United States, increases the risk of catastrophic conflict between the United States and China, and has the potential to backfire by accelerating China's domestic semiconductor industry development. The United States should consider easing elements of the semiconductor export controls in exchange for diplomatic concessions, such as greater bilateral military communication, and focus more attention on increasing domestic production of advanced semiconductor technologies by fast tracking expert visas and permitting for new semiconductor fabrication facilities.

## I. Introduction

With so much excitement and anxiety surrounding new large language models (LLMs) such as ChatGPT 4 and other technologies termed artificial intelligence (AI), there has been comparatively less discussion about the United States' use of export controls as a tool in a global competition for control over emerging technologies. The Biden Administration has adopted a novel theory of export controls, using them as a tool for pursuing the United States' technological leadership and advantage in artificial intelligence (and other fields of) research. This approach carries considerable risks to the United States' global leadership status, position in the advanced semiconductor market, and to the relationship between the United States and China.

The unilateral export controls announced by the Biden Administration in October 2022 (Office of Commerce and Public Affairs 2022) restrict the

export of certain types of advanced semiconductors and the equipment and knowledge required to make them from the United States to China. Similar restrictions apply to third-party countries who work with the United States anywhere along the supply chain, including Taiwan, who produces the vast majority of advanced semiconductor products in the world today. The controls seek to curtail China's ability to "obtain, develop, or maintain" certain advanced computing chips with the stated aim of protecting United States national security and foreign policy interests (Office of Commerce and Public Affairs 2022). This move was made in the context of rising tensions between the two countries and ongoing military modernization efforts in China which are viewed with suspicion from Washington.

The new semiconductor controls intentionally target the sophisticated logic chips that are at the

heart of modern AI research and applications, which depend on the immense computational power enabled by these chips. Advanced semiconductors are critical for applications ranging from AI research to economic and weather simulations, as well as for advanced weapons and targeting systems.

After months of lobbying by the United States, Denmark and Japan agreed to their own versions of advanced semiconductor export restrictions (Allen and Benson 2022), joining Taiwan who agreed to implement similar controls shortly after the United States' October announcement. This March, Bloomberg reported that the Biden Administration is tightening the October controls and increasing the number of technologies that require export licenses (Leonard and King 2023). Reports suggest the Administration is considering similar export control rules for nascent quantum information technologies (Klyman 2023) and biotechnologies (Swanson 2022). In August, President Biden issued an executive order banning certain investments in Chinese companies working in three key technology areas: semiconductors, quantum information systems, and artificial intelligence (Freifeld et al, 2023).

These measures are part of a “small yard, high fence” strategy the United States has adopted towards certain critical “force multiplier” technologies as outlined by national security advisor Jake Sullivan (Sullivan 2022). This strategy says the United States should seek to produce strategically critical technologies domestically (small yard) and place strong protections on access to them (high fence). The Biden Administration has identified advanced computing technologies including quantum and artificial intelligence, biotechnologies and clean energy technologies as the three families of strategically critical emerging technologies.

## II. A paradigm shift

Export of advanced semiconductors and logic chips (and the equipment to manufacture them) to China was severely restricted by the Biden Administration's export control rules. Advanced logic chips and the high-performance computing (HPC) they enable have a hand in nearly all scientific progress today. Further, computations as

disparate as weather simulations and financial models all rely on advanced HPCs. Semiconductors are an inextricable part of the modern world, as fundamental as electricity or oil. This makes the United States's attempt to restrict the most advanced semiconductor technologies (both the finished products and the equipment and knowledge necessary to manufacture them) to China a radical move. Commerce Secretary Gina Raimondo has indicated the threshold and definition of “advanced” node semiconductor technology will remain fixed, so that as newer generations of semiconductors are released the number of controlled technologies will continue to grow.

C.J. Muse, a senior semiconductor analyst at Evercore ISI is quoted in a New York Times Magazine article about the controls as saying, “If you'd told me about these rules five years ago, I would've told you that's an act of war – we'd have to be at war.” (Palmer 2023). In the same article, Gregory C. Allen, director of the Wadhvani Center for A.I. and Advanced Technologies at the Center for Strategic and International Studies emphasizes, “The new policy embodied in Oct. 7 is: Not only are we not going to allow China to progress any further technologically, we are going to actively reverse their current state of the art.” (Palmer 2023).

The United States currently maintains a near monopoly (98 percent of global market) in electronic design automation, the software programs that design the most advanced semiconductor chips (Supply Chain Explorer 2022). This is the advantage being leveraged against China, which currently leads the United States in publishing artificial intelligence research (Li, Tong, and Xiao 2021) while lagging behind in semiconductor production, currently sourcing 90 percent of all semiconductors from outside of China (Platzer, Sargent Jr., and Sutter 2020). At present the United States and China are the only two major players in artificial intelligence research worldwide (Li, Tong, and Xiao 2021).

The prospect of China's progress in artificial intelligence clearly played a role in the decision to levy the controls. In the rules' announcement, the Bureau of Industry and Security explicitly cites

China's ambitions to be a leader in artificial intelligence technology:

“The PRC has poured resources into developing supercomputing capabilities and seeks to become a world leader in artificial intelligence by 2030. It is using these capabilities to monitor, track, and surveil their own citizens, and fuel its military modernization...Our actions will protect US national security and foreign policy interests while also sending a clear message that US technological leadership is about values as well as innovation.” (Office of Commerce and Public Affairs 2022)

In the past, export controls have been used defensively, to protect United States national security and economic interests. The above remarks point to a new theory of offensive export controls which are used to forcefully promote the United States' political values and preserve American technological leadership. Export control expert Kevin Wolf explains that this indicates a shift from the previous control paradigm, where there was a direct relationship between a specific controlled item and a military application. The new controls go back “several layers before [military use] in the food chain” (Schneider and Zhang 2022) and “[s]ubjected all semiconductors on the planet to American law, because every foundry on the planet uses US tools at least in part” (Palmer 2023).

There is a strong case to be made for the necessity of the October 2022 export controls. Advanced semiconductors are the basis of all modern technologies, so the leader in chips will lead the modern world. The Biden Administration notes correctly that any efforts at military modernization depend upon advanced node semiconductor technology. There is justified fear and uncertainty surrounding how artificial intelligence and other autonomous technologies will change warfare. Further, leading edge chips are used in the most advanced weapons systems, those with differentiated capabilities which can be decisive in conflict.

These arguments, while persuasive, seem to implicitly place the United States and China on a collision course, and act assuming this is the case. However, the restrictions will rightly be perceived by China as antagonistic, effectively amount to a declaration of economic war, and therefore increase the likelihood of conflict between the two countries.

The argument that military modernization efforts present a great enough national security risk to the United States to restrict China's access to all advanced semiconductors is not fully persuasive. The theoretical increase in national security does not seem worth the costs of this escalation. The chief concern addressed by the restrictions seems not to be any present national security threat, but rather the desire to prevent China from making advances in new technologies like AI before the United States. In summary, the new controls risk “militarizing” the technological competition more than it already is, adding fuel to a potential “AI arms race”.

With the controls, the United States has adopted a containment policy towards China, explicitly attempting to restrict their technological advancement. This guarantees rising hostility between the countries with the two largest global economies and increases the chances of future conflict.

As President Biden frequently says “we're in a competition with China and other countries to win the twenty-first century” (Fang 2021). The indirect nature of the threat posed by selling advanced logic chips to China combined with their relative advantage in AI research suggests that the October controls are best understood as a tool to slow our competitor's technological progress in order to try to “win” the race to develop transformative new technologies, particularly artificial intelligence. The Administration is right to be concerned about the disruptive potential of artificial intelligence and other new technologies. However, attempting to control China's access to advanced node semiconductors is an indirect strategy to address this concern, with foreseeable negative consequences and uncertain returns.

### III. Will the controls work?

Because of the importance of high-performance computing in scientific, economic, and artificial-intelligence research, limiting China's access to advanced semiconductors will slow the country's scientific and artificial intelligence research, in addition to economically harming global semiconductor companies that do business in China. The controls also contribute to the deterioration of diplomatic relations between the two countries. It is important then to consider the goals of the semiconductor export controls, and the likelihood of their success.

Do the new rules help advance the goal of security and prosperity for the United States? In the short term, they have the effect of slowing China's native semiconductor industry and making access to advanced semiconductors in China more difficult. As a result, they will likely slow Chinese progress in artificial intelligence research. But there are weak points in the export control strategy.

As pointed out by Paul Scharre, the Vice President of the Center for a New American Security, restricting the sale of advanced American chip technology reduces United States' leverage and provides a strong incentive for China to develop the capability to produce these chips domestically as soon as possible (Scharre 2023). A counterargument is that China was already aggressively seeking to develop an independent, domestic chip industry. However, no matter how many state incentives were in place previously, nothing spurs rapid innovation like a market vacuum. By removing the training wheels of foreign imports from the Chinese semiconductor industry, the United States may inadvertently accelerate its development.

Further, the controls incentivize countries and companies to diversify away from involving the United States in their semiconductor supply chains wherever possible to avoid the risk of being penalized for running afoul of current or future United States export control rules. Additionally the targeted, punitive nature of the controls gives the appearance of the United States unfairly putting its hand on the scales of global technological and economic innovation. This could undermine the goal of United States technological leadership as

well as weaken our position in the global semiconductor supply chain.

Finally, the task of enforcing the export controls is a herculean effort which the relatively small Bureau of Industry and Security will struggle with. BIS has three enforcement agents for all of China. Ensuring compliance with the sweeping controls will be a constant game of whack-a-mole, which could undermine their utility.

It is commonly understood that the effectiveness of export controls wanes over time, especially when they are not multilateral. Therefore, with the October controls the United States has bought some time to remain the global leader in advanced semiconductor design technology. The critical question is, what will we do with this time?

### VI. Recommendations

#### *i. Semiconductor controls*

The October 2022 semiconductor regulations have immediately had a negative impact on the United States-China relationship. To mitigate further damage to the countries' bilateral relationship, the Biden Administration should direct the Department of Commerce to conduct bi-annual reviews of the thresholds for controlled advanced semiconductor technologies, and change the threshold commensurate with technological progress. This will be seen as a sign of good will and evidence the United States is not attempting to force China into technological obscurity.

Critics of this suggestion will suggest that China will use these advanced chips to modernize its military. But China is pursuing military modernization either way, and by refusing even previous generations of advanced chips, the United States could inadvertently accelerate China's domestic development of advanced semiconductor manufacturing capabilities.

Next, the Biden Administration should direct the Department of State to use the prospect of easing controls on advanced chips (but not the equipment to make them) to incentivize greater bilateral military communication, a current goal of the United States. By offering some concessions, the US could ease tensions, and increase transparency to reduce the risk of catastrophic

miscalculation caused by lack of military communication.

Opponents of this suggestion may suggest that China should be making concessions, not the United States, as China has engaged in behaviors such as intellectual property theft and espionage which were part of the impetus for the sanctions (Bateman 2022). Nevertheless, diplomacy requires concessions, and the United States can only control its own actions. The risks of pursuing the current policy are too high to refuse any concessions, and lifting parts of the semiconductor controls may be a place to start.

#### *ii. Accelerate Domestic Production*

The federal government clearly views advanced semiconductor technology and the applications they enable (particularly AI) as determinative of a State's ability to maintain and exercise power in the twenty-first century. If maintaining the primacy of the United States in this area is so critical that it necessitates blocking a country with a fifth of the world's population from access to the newest technologies, then innovation and production of these technologies should be a top priority for the United States' national security. The CHIPS and Science Act of 2022 had this goal in mind. However, there are significant barriers to the success of this legislation. Onerous regulations and rules which are unrelated to the construction of semiconductor fabrication facilities will slow construction, increase costs, and consequently will lead to fewer new facilities being built.

To ease the construction of new, advanced semiconductor facilities in the United States, Congress should grant exemptions to permitting requirements and environmental reviews required by the National Environmental Protection Act (NEPA) which often delay new federal construction for years and add to the cost of the project. One way to handle this would be to allow semiconductor companies to essentially "copy and paste" their existing facility designs, accepting the permitting standards of the other country as adequate for the American facility.

One may suspect this move could reduce the safety of the facilities. However, the machines required to

run a fabrication facility are incredibly expensive, and so the companies themselves have a significant financial incentive to create a safe workplace on their own, and accidents in existing fabrication facilities are exceedingly rare.

Another problem is the lack of domestic expertise required to operate an advanced node semiconductor facility. To address this problem Congress should issue fast-track visas to engineers and other workers with specific knowledge of the semiconductor industry to enable them to work in the new United States' fabrication facilities.

One rebuttal to this is that the CHIPS funding is meant to create American jobs. However, without the necessary expertise, the facilities will not be successful. By fast-tracking the visas of specialized foreign workers, we will bring the specialized knowledge required to the new facilities, thus increasing the likelihood that the subsidies provided in the CHIPS act will succeed in making the United States a leader in advanced semiconductor manufacturing in the future.

#### **V. Conclusion**

Export controls are a blunt instrument for attempting to shape the global technological landscape. The Biden Administration's semiconductor controls' effectiveness should be regularly evaluated, the thresholds regularly updated with technological advances, and control relief used to incentivize greater military to military communication between the United States and China. Meanwhile, the federal government should use the United States' existing lead in semiconductor technology to feel comfortable fast tracking visas and permitting around construction of new advanced semiconductor manufacturing facilities, in order to accelerate domestic production of and innovation around critical emerging technologies. The stakes are incredibly high. The United States government has the power to shape the environment of global technological competition. Punitive export controls push competition in the direction of greater militarization. It doesn't need to go that way.

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