

The Art of Balancing Economic and National Security: *Policy Review of Semiconductor Manufacturing Equipment Export Control*

By Roslyn Layton, PhD

October 2020



1. Executive Summary

1. The key policy perspectives and stakeholders on the US-China semiconductor export control debate can be organized into three categories: No Restrictions, Balanced Approach, and Technology Decoupling.
2. The spirit, if not the letter, of the Wassenaar Agreement updated in 2019 and the US Export Control Reform Act of 2018 demands that the US restrict the transfer of certain semiconductor manufacturing equipment from developing or enhancing military capability, but US policymakers differ significantly about whether, how, and when to implement these rules.
3. The US Department of Commerce Bureau of Industry and Security must make Entity List designations for Semiconductor Manufacturing International Corporation (SMIC), Yangtze Memory Technologies (YMTC), and ChangXin Memory Technologies (CXMT) among other firms with demonstrated ties to the People's Liberation Army in China.



ROSLYN LAYTON, PhD

Co-Founder, China Tech Threat

Roslyn Layton co-founded China Tech Threat to improve US policy to protect Americans from technological threats from the People's Republic of China (PRC). She is a Visiting Researcher at the Department of Electronic Systems at Aalborg University and Senior Vice President at Strand Consult (Denmark). She is a Senior Contributor to Forbes. She holds a Ph.D. in business economics from Aalborg University, an M.B.A. from the Rotterdam School of Management (Netherlands), and a B.A. in international service from American University. She can be contacted at roslyn@chinatechthreat.com.

The Art of Balancing Economic and National Security: *Policy Review of Semiconductor Manufacturing Equipment Export Control*

Contents

1. EXECUTIVE SUMMARY	1
2. INTRODUCTION	3
2.1. LAWS AND REGULATIONS TO PROTECT STRATEGIC TECHNOLOGIES	3
2.2. METHODOLOGY, ANALYSIS AND RECOMMENDATIONS.....	5
3. SEMICONDUCTORS STRATEGIC IMPORTANCE: THE “BUILDING BLOCKS” OF TECHNOLOGY	6
4. PRC’S MILITARY-CIVIL FUSION AIMS TO DOMINATE SEMICONDUCTOR MANUFACTURING.	7
5. THREE DANGEROUS PRC SEMICONDUCTOR MANUFACTURERS.....	9
5.1. SEMICONDUCTOR MANUFACTURING INTERNATIONAL CORPORATION.....	9
5.2. YANGTZE MEMORY TECHNOLOGIES COMPANY	9
5.3. CHANGXIN MEMORY TECHNOLOGIES	10
6. THE PRC’S AGGRESSION AND MANIPULATION ON SEMICONDUCTORS DEMANDS A RESPONSE	11
7. KEY SEMICONDUCTOR POLICY STRATEGIES	12
7.1. NO RESTRICTIONS.....	13
7.2. BALANCED APPROACH	14
7.3. TECHNOLOGY DECOUPLING.....	15
8. POLICY RECOMMENDATIONS.....	16
9. ADDENDUM: ANALYSIS OF PAPERS	17
9.1. AMERICAN ENTERPRISE INSTITUTE.....	17
9.2. CENTER FOR SECURITY AND EMERGING TECHNOLOGY	19
9.3. CENTER FOR STRATEGIC & INTERNATIONAL STUDIES	20
9.4. EURASIA GROUP	22
9.5. INFORMATION TECHNOLOGY & INNOVATION FOUNDATION.....	23
9.6. NATIONAL BUREAU OF ASIAN RESEARCH	24
9.7. PRESIDENT’S COUNCIL OF ADVISORS ON SCIENCE AND TECHNOLOGY (OBAMA)	25
9.8. SEMICONDUCTOR INDUSTRY ASSOCIATION	26
9.9. SEMI.....	27
9.10. UNITED STATES INTERNATIONAL TRADE COUNCIL	28
10. WORKS CITED	30

2. Introduction

Semiconductors are the building blocks of electronic technology and have strategic importance for the US economy and national security. They enable new industries, reinvent old ones, and contribute to all areas of science and technology. The US semiconductor industry supports 250,000 high paying jobs and another one million jobs indirectly. The US is part of a highly complex global semiconductor industry which includes the design, manufacture, and distribution of integrated circuits and associated products, processes, and patents. This report focuses a small but important part of the overall industry, semiconductor manufacturing equipment (SME).

The US has exported SME to the People’s Republic of China (PRC) for some time, and there is a long-running debate that this endangers US national security. Through its policy of Military Civil Fusion, the PRC is determined to dominate advanced manufacturing globally, ensure self-sufficiency, and eliminate foreign competition. Specifically, the PRC seeks self-sufficiency in semiconductor manufacturing so that it can control the means of production, supply its growing demand for semiconductors both in military and civilian use, and reduce US economic power and leverage. The People’s Liberation Army (PLA) is a key actor in the production and consumption of semiconductors. There are some 90 semiconductor fabrication plants (“fabs”) in the PRC, most owned by PRC entities. Semiconductor Manufacturing International Corporation (SMIC), Yangtze Memory Technologies (YMTC), and ChangXin Memory Technologies (CXMT), and others have demonstrated ties with the People’s Liberation Army (PLA), the military of the PRC.

2.1. Laws and Regulations to Protect Strategic Technologies

Global and national regimes to stop the proliferation of strategic technologies for military use have been in place for years, though countries differ in their implementation. The US is among the 42 nations which signed the Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies was signed in 1996 in which “Participating States seek, through their national policies, to ensure that transfers of these items do not contribute to the development or enhancement of military capabilities which undermine these goals, and are not diverted to support such capabilities.” The US played a key role to update the regulation of semiconductor manufacturing equipment under section 3.B.1 in December 2019 to which nations agreed unanimously.¹ The Export Control Reform Act of 2018 authorizes the President to “control the export, reexport, and transfer of commodities, software, and technology to protect the national security, and to promote the foreign policy, of the United States, and for other purposes”, mandates the identification and control of “emerging and foundational technologies,” and delegates authority to the Department of Commerce (DOC) to implement these rules.²

There is policy debate about the effectiveness of the DOC to implement export controls required for national security when the Department serves a set of industry stakeholders which oppose restraints on trade.

There is policy debate about the effectiveness of the DOC to implement export controls required for national security when the Department serves a set of industry stakeholders which may sometimes oppose restraints on trade.³ The stated mission of DOC is to promote jobs, economic growth, and fair and reciprocal trade, and innovation and to provide data to support commerce.⁴

While it is not inevitable, the mission to promote commerce could be at odds with national defense goals--the protection of the nation state, its citizens, economy, and institutions. In fact, DOC's Bureau of Industry and Security (BIS) was established in 2001 ostensibly to align these two missions and to "advance U.S. national security, foreign policy, and economic objectives by ensuring an effective export control and treaty compliance system and promoting continued U.S. strategic technology leadership."⁵ BIS maintains the Entity List which specifies license requirements for transacting with the named entity, person, or firm.⁶ In effect, once a firm is added to the Entity List, Americans cannot do business with that company unless they first obtain a license from BIS.

Some have criticized BIS implementation of export controls as inconsistent and incomplete.⁷ Trade expert Derek Scissors questions the timing of rulemaking by DOC's Bureau of Industry and Security (BIS) to implement the Export Control Reform Act of 2018 (ECRA). While rulemakings for the described Emerging Technologies were initiated in 2018, Foundational Technologies such as semiconductors were not taken up until 2020.⁸ On September 25, 2020, BIS designated the PRC's Semiconductor Manufacturing International Corporation (SMIC) as a Military End User (MEU), obliging US, but not necessarily foreign, firms using US technology to obtain a license to supply SMIC.⁹ While it would seem that MEU is an apt designation given conclusive evidence of SMIC's ties to the PLA,¹⁰ some interpret the MEU designation a symbolic face-saving effort to give SMIC "a way out" of export controls if it could prove that it is not tied to the military.¹¹

On the other hand, BIS has added hundreds of PRC firms and their affiliates to the Entity List, making them off-limits for commerce. Many of these have been added during the Trump administration. In 2018 BIS added semiconductor firm Fujian Jinhua Integrated Circuit Company, Ltd. (Jinhua) to the Entity List for national security reasons.¹² BIS noted Jinhua's "nearing completion of substantial production capacity for dynamic random access memory (DRAM) integrated circuits" and that Jinhua "threatens the long term economic viability of U.S. suppliers of these essential components of U.S. military systems." In addition to Huawei and dozens of its affiliates,¹³ BIS has restricted almost 40 companies on account of their human rights abuses in the PRC's campaign against Uighurs and other predominantly Muslim ethnic minorities in the Xinjiang Uighur Autonomous Region (XUAR).^{14,15} Recently BIS also added 24 PRC companies to the Entity List for their "role in helping the Chinese military construct and militarize the internationally condemned artificial islands in the South China Sea."¹⁶

Rather than falling short, it could be that BIS acts prudently and appropriately to limit the downside to enterprise while fulfilling the law and being mindful of inevitable legal challenge. Note that Entity List designations must follow due process, notice and procedure, and are applied to specific actors for specific illegal actions for defined periods of time and are subject to judicial review. Indeed, BIS's piecemeal approach could reflect the reality that many its actions are met instantly with injunction, lawsuit, and other legal response to deter implementation.¹⁷ As such, implementing restrictions on SMIC which just fall short of the Entity List threshold could be a pragmatic way to exact the needed policy without triggering litigation from opponents. However, the grades and shades of implementation can make the BIS appear less than transparent.

2.2. Methodology, Analysis and Recommendations

This report attempts to bring greater clarity to SME export controls by analyzing 10 policy papers on SME and US-PRC semiconductor relations. The policy responses can be organized into three competing views: No Restrictions, Balanced Approach, and Technology Decoupling. The No Restrictions policy seeks unrestricted access to the PRC to maximize revenue for the industry. It discounts the threat of the PRC and does not address security concerns. The Balanced Approach recognizes the PRC as a hostile power but attempts to optimize security and revenue. It advocates restricting semiconductor manufacturing equipment (SME) to PRC firms but potentially allowing it for US firms operating in the country. Technology Decoupling is the winding down of the economic relationship with PRC on strategic fronts and removing all semiconductor supply chains from the PRC.

The Balanced Approach is the prudent policy choice because it optimizes security and economic goals and fulfils the national and international law. Given PLA ties, SMIC, YMTC, CXMT and others must be added to the Entity List to ensure critical US technology is not weaponized against Americans. The US, Netherlands, and Japan already account for 90 percent advanced semiconductor manufacturing equipment, so the cost of coordinating SME export controls among the three critical allies and Wassenaar signers is small. Indeed, the Netherlands and its key global SME player, ASML, already have restrictions in place against SMIC, reportedly at the request of the US government.¹⁸ The US won't have credibility if it doesn't do what it asks of its allies. It is important for Congress to maintain the pressure on the Department of Commerce to fulfil its mandate on export control in a timely and sufficient fashion.

The Balanced Approach is the prudent policy choice because it optimizes security and economic goals and fulfils the national and international law.

3. Semiconductors Strategic Importance: The “Building Blocks” of Technology

Semiconductors, a top American export, are crucial inputs to every electronic and computing product. As a 2016 Congressional Research Service report described, semiconductors as the “enabling technology of the information age” because they enable new industries and reinvent old ones (like aviation and automobiles) and contribute to all areas of science and technology.¹⁹ Semiconductors are the essential building blocks for electronics (phones, computers, TVs, software, medical equipment, electric cars etc.). The semiconductor itself consists of a set of materials which conduct electrons (data/information) between complementary materials like metal (conductor) and glass (insulator). The integrated circuit of the semiconductor (or chip) was co-invented by Jack Kilby and Robert Noyce at Texas Instruments in 1958.²⁰ Moore’s Law (ascribed to Andy Moore, co-founder of Intel) refers to the observation that the number of transistors in a dense integrated circuit doubles about every two years.

Semiconductors play a crucial role in current and advanced technology like 5G, quantum computing, and artificial intelligence (AI). Notably demand for semiconductors is up, buoyed by laptops, tablets and electronics needed to work from home during the pandemic. Also, demand is expected to grow as people purchase 5G smartphones to use on new networks. The four key categories of semiconductor integrated circuits include logic chips for interchange of data in computers; memory chips which store information including dynamic random access memory (DRAM) and flash or solid-state storage drives (SSDs) which allows data to be retained without a power source; microprocessors which execute software instructions; and analog chips for signal processing in radios etc.

The semiconductor subsectors of 3D NAND and DRAM are imperative to national security given their presence in data centers, pcs, missiles, drones, satellites, cloud, AI, smartphones, and communications networks. These two technologies have emerged as policy flashpoints. Next generation flash or 3D NAND represents an improvement in chip design such that the circuits are organized in a vertical 3D fashion (like a skyscraper) rather than planar 2D. It’s similar to the space improvement one achieves but putting books on a shelf rather than laying them out on the table. Moore’s Law continues to be pushed as leading SME manufacturers innovate 3D NAND circuitry at 128 layers and even 176 or 192 layers--all within the space of a few nanometers or the width of a few atoms.²¹ A nanometer (nm) is one millionth of a millimeter; and its size compared to a human hair is like the length of an inch compared to a mile.

While some high end manufacturing capability remains in the US, the global market share for US manufacturing has been halved in the last decade, from 25% to just 12%, mostly due to the outsourcing of foundries to other countries for the sake of cost savings and economic conditions.²² Indeed the US is not an optimal country to set up manufacturing given taxation and labor deficiencies. Naturally, SME makers look to other markets, raising the spectre of vital manufacturing capability going to the PRC.

Congress has taken an interest in semiconductors for 70 years and indeed created the conditions for the industry through funding for research and development during World War II followed by a series of federal investments for aerospace, computing, defense, and civilian applications. In 2015 Congress established the Semiconductor Caucus the advance the needs of the industry.²³

4. PRC's Military-Civil Fusion Aims to Dominate Semiconductor Manufacturing

Concerns about the security of semiconductor supply have been building for some time.²⁴ Already in 2015, the US Department of Defense noted its reliance on non-US companies for most of its hardware and that only a fraction of its chips comes from secure suppliers.²⁵ The issue featured prominently in the techno-thriller *Ghost Fleet: A Novel of the Next World War* in which America's fighter jets are rendered ineffective because of reliance on compromised foreign chips from the PRC. Semiconductor security has become mainstream as COVID19 delayed and disrupted many supply chains, causing delays in critical electronics for home, school, and government use.

The most recent Department of Defense Report to Congress on Military and Security Developments in the PRC for 2019 describes as an existential threat to the US.²⁶ The PLA is on track to overtake the US military. Its navy is now the largest in world with 350 ships, compared to 293 from US. The PLA matches, if not exceeds the US capability in shipbuilding, nuclear missiles, and integrated air defense. The PRC plans new military installations in at least a dozen countries. Once considered unthinkable, the PRC took control of Hong Kong ahead of the agreed turnover in 2047, and the PRC is similarly threatening Taiwan.

The urgency of this issue has been compounded by the fact that the PLA accounts for much semiconductor production and consumption.²⁷ This creates a problem for US semiconductor industry in that transacting with the PRC, it may unwittingly support the armament of the military.²⁸ While US semiconductor technology fuels a growing demand for consumer electronics in the PRC, there is no reliable and systematic way to ensure that the same technology is not used in PRC weaponry, a proliferation that violates US and international law against so-called "dual use" technologies.

While Americans consider society and the military to be separate domains, the PRC does not. The American Constitution describes the role of the military to protect the people, property, and interests of the United States of America, with ultimate decisions in the hands of civilian political leaders, not military officers.²⁹ In contrast, the PLA is part of a military dictatorship in which the PRC is a fusion of the military and government into a single entity.³⁰ The PRC employs a strategy of Military-Civil Fusion (MCF),³¹ and there is no clear line between the PRC's civilian and military economies. The PRC integrates economic, social, and security policy; leverages civilian service and logistics capabilities for military purposes; and ensures that national defense mobilization system includes all relevant aspects of society for competition and war.

The PRC conducts commerce to strengthen its military. It enjoins Chinese firms, universities, and provincial governments to cooperate with the military to advance technology.

Moreover, the PRC conducts commerce to strengthen its military. It identifies and subsidizes artificial intelligence (AI), autonomous systems, advanced computing, quantum information sciences, biotechnology, and advanced materials and manufacturing as part of the Military Civil Fusion. The PRC enjoins Chinese firms, universities, and provincial governments to cooperate with the military to advance technology. It undermines foreign universities and enterprises to obtain research, resources, and intellectual property. Sensitive, dual-use technologies and military-grade

equipment are key targets for theft. The PRC “leverages foreign investments, commercial joint ventures, mergers and acquisitions, and state-sponsored industrial and technical espionage, and the manipulation of export controls for the illicit diversion of dual-use technologies to increase the level of technologies and expertise available to support military research, development, and acquisition,” notes the Pentagon report.

For perspective, consider that NATO prohibits contractors and subcontractors from communist countries China, Cuba, Laos, and North Korea.³² Similarly, extensive national security mitigation was required in 2014 when IBM prevailed over vehement Congressional opposition to sell its strategic assets to information technology company Lenovo, owned partly by the Chinese government.³³ IBM’s accounts with the US government were not allowed to be transferred in the acquisition, and its servers deployed in sensitive US military and weapons had to be removed, as they otherwise would be accessed and serviced by Lenovo. An IBM server powered the Air Force’s Global Positioning System (GPS), which too had to be ripped and replaced at a cost of \$378 million to taxpayers.³⁴ Such decisions designed to maximize profits for select corporations but which needlessly put Americans’ security at risk catalyzed subsequent reforms by Congress. Under today’s laws today, the Committee on Foreign Investment in the US (CFIUS) would not likely approve Lenovo’s acquisition of IBM assets.

In any event the BIS rulemaking process which asks for public comment on “a process to identify emerging and foundational technologies that are essential to the national security... including semiconductor manufacturing equipment... tied to indigenous military innovation efforts in China, Russia or Venezuela” is entirely appropriate.³⁵

5. Three Dangerous PRC Semiconductor Manufacturers

In 2014, PRC “General Secretary for Life” Xi Jinping laid out the Chinese Dream,³⁶ the vision of “comprehensive national power”³⁷ and global supremacy by 2049, 100 years from the founding of the modern Chinese state. Technology is central to realizing the dream and to implementing the strategy of *Unrestricted Warfare*,³⁸ the transcending of traditional methods of war to vanquish adversaries like the US through “asymmetrical” or multidimensional means, including economic, financial, political, biological, and cyber means. Made in China 2025 is one of the PRC’s official plan to dominate 10 strategic technological industries globally in the future.³⁹

The plan is a type of “techno-nationalism” and includes designation of a series of national champions which deliver the PRC’s plan goals in targeted industries like information technology, robotics, aerospace, green energy, medicine, semiconductors, and more.⁴⁰ The PRC’s national tech champions receive the spoils of state support, forced joint venture, strategic acquisition, tech transfer, theft, and cyber-espionage. Like Huawei in telecom equipment, Lenovo in laptops, Inspur in servers, and Baidu in search, Semiconductor Manufacturing International Corporation (SMIC) is the national champion for semiconductors.⁴¹

5.1. Semiconductor Manufacturing International Corporation

James Mulvenon is author of three books on the intersection of the PRC’s military, intelligence, and commerce. In a widely covered report provided to federal officials, Mulvenon and his SOSI colleagues determined that Semiconductor Manufacturing International Corporation – the largest and most sophisticated Chinese government-owned semiconductor maker – has multiple close ties the People’s Liberation Army (PLA). The United States Department of Commerce through its Bureau of Industry and Security took action on September 25th requiring US businesses to obtain licenses before exporting certain technology to SMIC. Specifically, PLA researchers use SMIC chips and processes, indicating it is tailored for their purposes. For example, radiation hardening – which is used military and space purposes – employ a SMIC process design kit. Furthermore, the Pentagon identifies SMIC’s key customer CETC Electronic Equipment Group as a “Communist Chinese military company.”⁴²

Like Huawei in telecom equipment, Lenovo in laptops, Inspur in servers, and Baidu, Tencent, and Alibaba, Semiconductor Manufacturing International Corporation (SMIC) is the national champion for semiconductors.




5.2. Yangtze Memory Technologies Company

YMTC is owned by Tsinghua Unigroup, which also controls Tsinghua University, one of China’s most esteemed and celebrated universities, and a long-time collaborator with the PLA and the Chinese Academy of Sciences. Tsinghua Unigroup tried to purchase semiconductor manufacturers but was blocked by CFIUS.^{43 44} (To learn more about CFIUS’ history and recent reform to combat technological threats see <https://chinatechthreat.com/cfius/>.) Tsinghua University has 9 defense laboratories.⁴⁵

YMTC produces a 3D NAND 64-layer device (recall that the bleeding edge is twice this amount), and now has set its sights on the ambitious goal of increasing its global supply of the NAND market from 0 to 8% in just two years.⁴⁶ Huawei was identified “among the first wave of buyers” for chips produced by YMTC.⁴⁷

5.3. ChangXin Memory Technologies

CXMT was created as a “pilot demonstration” of the Made in China 2025 initiative, enjoys tremendous support from a variety of Chinese government programs,⁴⁸ and features multiple business leaders also serving in important Communist Party roles. With these many advantages, CXMT has “emerged as China’s first and only DRAM maker”⁴⁹ with chips measuring 19nm and 17nm products in the pipeline. CXMT’s challenges, according to an industry researcher, are “potentially violating numerous patents... [and] the inability to invest in and transition to new equipment for next-gen process technologies...”⁵⁰ In other words, CXMT will likely need to steal IP and buy manufacturing equipment. Despite these problems, the company “is expected to support about half of the global [dynamic random-access memory] DRAM demand”⁵¹ – an incredible leap given its 4-year existence.

COMPANIES	CHARACTERISTICS
 Semiconductor Manufacturing International Corp.	<ul style="list-style-type: none"> • PLA researchers use SMIC chips and processes, indicating it is tailored for their purposes.⁵² • Radiation hardening (military and space purposes) employ a SMIC process design kit.⁵³ • Collaborates closely with a top PLA contractor.⁵⁴ <p>*As of 9/25/20, the DOC is requiring US businesses to obtain licenses before exporting certain technology to SMIC.</p>
 ChangXin Memory Technologies	<ul style="list-style-type: none"> • Made in China 2025 favor designation.⁵⁵ • Potentially violating IP rights.⁵⁶ • Unexplained extraordinary rise with ambition to create half the global DRAM demand.⁵⁷
 Yangtze Memory Technologies Company	<ul style="list-style-type: none"> • Owned by Tshingshua University/Unigroup, which was blocked by CFIUS from purchasing US semiconductor manufacturers.^{58,59} • Linked to Huawei, which is “among the first wave of buyers” for chips produced by YMTC.⁶⁰ • Expectation to increase from 0 to 8% global NAND market in just two years.⁶¹

The Trump Administration is right to constrain SMIC, though the Entity List is preferable. Indeed, the administration made the proper Entity List action with semiconductor company Fujian Jinhua. This report emphasizes that other PRC semiconductor manufacturers – namely Yangtze Memory Technologies Co., Ltd. (YMTC)⁶² and Changxin Memory Technologies (CXMT)⁶³ should be placed immediately to the Entity List because they operate with the PLA and threaten Americans’ security.

6. The PRC's Aggression and Manipulation on Semiconductors Demands a Response

The PRC's rise did not happen overnight. Indeed, over decades, many US policymakers supported the PRC's emergence, believing it would evolve into a "responsible stakeholder." That illusion has been put to rest with the PRC's increasing militarization, widespread human rights violations, and weaponized strategies to dominate the earth and space. Now the US must wrestle with the PRC as a global giant with economic, military, and technological capability.

US policy to protect and promote the semiconductor industry dates from World War II. Legislation to ensure the national security aspects of the technology has been enshrined for decades and is implemented by the Departments of Commerce (DOC) and State. The Trump Administration, recognizing the importance of semiconductors, has sought to update policy based upon the new security reality, building on concerns raised at the end of Obama Administration. President Obama's Council of Advisors on Science and Technology found that "Chinese policies are distorting [semiconductor] markets in ways that undermine innovation, subtract from U.S. market share, and put U.S. national security at risk."⁶⁴

It is the Constitutional responsibility for the US government to protect Americans' security, and many laws adopted by Congress compel the Executive Branch to take proactive policy steps to mitigate such threats. As recently as 2018, the Foreign Investment Risk Review Act (FIRRMA) and Export Reform Control Act (ECRA), passed on a broad bipartisan basis demand stricter assessment of inbound and outboard commerce with the PRC. While restrictions on PLA companies and other PRC state-owned enterprises have been in place for some time,⁶⁵ the Trump Administration placed Huawei on the Entity List in 2018 and tightened its restrictions in 2019, a policy which has succeeded to diminish significantly the proliferation of Huawei network equipment outside of the PRC and to win the support of many nations to the US view.⁶⁶

**"Most companies in the semiconductor production space are used to operating globally... They are agnostic [about the U.S.] — they don't care where demand is coming from. As long as the ducks are quacking, they are generally not concerned where the end market resides."
- Industry Analyst; July 28, 2020**

SME is an important choke point in the PLA's development. A military term, a choke point is a geographic or architectural feature (bridge, strait, or pass) of which can inhibit an armed force from reaching its objective or be a location of vulnerability to an opposing force. The PRC can't make circuits unless they import the necessary SME or develop the capability themselves, which has proven difficult.

While it would be welcome for the semiconductor equipment manufacturers to play a greater role in security, it is not necessarily their chief concern. As one industry analyst explained, "Most companies in the semiconductor production space are used to operating globally. They have Chinese customers, Korean customers, Japanese customers and EU customers, and they're used to deriving about 80 percent of their revenue outside of the U.S. They are agnostic [about the U.S.] — they don't care where demand is coming from. As long as the ducks are quacking, they are generally not concerned where the end market resides."⁶⁷

7. Key Semiconductor Policy Strategies

The goal of this paper is to uncover and compare the salient policy strategies for US semiconductor manufacturing equipment vis-à-vis the PRC. It identified 10 policy outlets representing government, industry, think tanks, and market intelligence from different parts of the political spectrum. Their authors are recognized policy experts and analysts, though their views expressed are not necessarily official positions for the organizations. The policies analyzed were published by the American Enterprise Institute (AEI), the Center for Security and Emerging Technology at Georgetown University (CSET), the Center for Strategic & International Studies (CSIS), Eurasia Group (EG), the Information Technology & Innovation Foundation (ITIF), National Bureau of Asian Research (NBR), The President’s Council of Advisors on Science and Technology (PCAST-Obama), the Semiconductor Industry Association (SIA), the trade association SEMI, and the United States Trade Council (USITC). Analysis of the papers follows in the final section of this document.

In general, the papers favor a strong US domestic semiconductor industry and generally support increased intellectual property protection and enforcement, some level of government investment in research and development, workforce development, and favorable tax policy. However, positions diverge on foreign policy and how to address the PRC and the security of semiconductor supply. The papers were categorized along the following types of policy preference: No Restrictions, Balanced Approach, and Technology Decoupling.

POLICY	GROUPS / EXPERTS	CONSEQUENCES
NO RESTRICTIONS	EG, ITIF, SIA, SEMI, USITC	Maximize short-term economic opportunity at the risk of long-term economic and security degradation
BALANCED APPROACH	CSET, CSIS, PCAST	Limited lost revenue, but better protects US strategic advantages
TECHNOLOGY DECOUPLING	AEI, NBR	Some economic disruption to ensure national security

7.1. No Restrictions

Five of the papers (EG, ITIF, SIA, SEMI, USITC) advocate that the US continue to sell chips and semiconductor equipment to the PRC. They appear to support only the limited historical restrictions on dual use technologies and oppose further expansion of these rules. Moreover, they argue that restricting trade harms American semiconductor firms. While these papers may recognize some problems like IP theft, they downplay, if not dismiss, security concerns with the PRC and its increasing militarization. Their objective is to maximize revenue for US semiconductor firms. The ITIF paper prefers coordination among allied nations over the unilateral action of the US and emphasize that export controls must be coordinated with allies.

These papers have the implicit perspective that the economy and national security are separate domains and that their policies can be compartmentalized. In general, they model the global semiconductor industry as one of perfect competition. This model has a set of assumptions related to many buyers and sellers, perfect information, relatively similar products, no government intervention, and that the parties are, if not fair dealers, neutral. That is, one is not using the premise of competition to build up their military with the goal to wage war against the other.

While these papers may recognize some problems like IP theft, they downplay, if not dismiss, security concerns with the PRC and its increasing militarization. Their objective is to maximize revenue for US semiconductor firms.

This model fails for important reasons. As the ITIF and AEI papers note, while there may be top level information about the semiconductor industry, there is a lack of transparency about the size of the PRC's semiconductor operations in revenue, imports, technology transfer, dependency, investment, and military partnerships. Semiconductors are hardly commodities; they are patented, highly complex, expensive to produce, and require significant human capital.⁶⁸ For that reasons, producers can exert monopoly power over their products. The market is characterized by state intervention in the form of subsidies, promotion, controls, and so on. Finally, one player in the market, the PRC, is increasingly belligerent.

This pro-business view of US-PRC relations may be considered the dominant prevailing policy, if only until recently. One observation of the policy process is the presence of collective action,⁶⁹ in that small, highly organized groups are more effective to achieve their policy goals than large, diffuse groups (e.g. the public) because of higher transactions costs for the latter. This might explain the ability of the semiconductor industry to secure its preferred policy for selling to the PRC for many decades. By contrast, a whopping 81 percent of Americans see the PRC's growing military power as a problem, and most Americans see the PRC as a threat to the US.⁷⁰ It should follow that public policy should reflect the general preferences of the people, but that is not necessarily the case with all SME.

7.2. Balanced Approach

The papers from CSET, CSIS, and PCAST offer a balanced approach which seeks to optimize both security and economic policy toward the PRC.

The CSET paper offers a deep dive on global SME strategy, describing it in the context of the critical technology which the US must control for future leadership in artificial intelligence (AI). They demonstrate that the policy question is a relatively simple matter of three SME producing nations (US, Netherlands, and Japan) agreeing not to supply the PRC with strategic SME. The Netherlands already restricts advanced SME to the PRC, and the CEO of Dutch ASML notes that the policy has no impact to its revenue.⁷¹

The PCAST paper published in January 2017 notes the importance to “Reshape the application of national security tools to deter and respond to PRC policies. U.S. export and investment controls should focus on national security concerns rather than economic goals.” CSIS and Lewis have supported by Democrat and Republican administrations, developing cybersecurity policy⁷² for the Obama Administration as well as principles for the Trump Administration’s Clean Path program for 5G.⁷³

The CSIS paper has the proper starting point in that the PRC is a hostile power. As such, attempting to address its actions through rule of law methods is ineffective; the PRC will only respond to realpolitik, or consequential action. Author James Lewis notes that US policies to date have worked to slow the PRC’s development of a home-grown semiconductor industry. However, he wants a policy that does not punish the American semiconductor industry for the strict measures which need to be imposed. As such, he suggests that that no SME be licensed to PRC firms. Only US firms operating in the PRC should be allowed to import SME. Indeed, this would be the important measure to ensure that firms continue to realize existing revenue, the industry’s key concern. Notably the measure would preclude new sales to PRC firms.

Lewis notes that careful restrictions on SME exports to PRC would slow PRC’s semiconductor growth. Though the PRC has lagged in semiconductors, it is competitive with some memory chips and is moving in the logic and specialized chip domains. The PRC buys most chips from US companies, many which have fabs in the PRC. As discussed YMTC has PLA ties. The US should restrict equipment to this company. Lewis observes,

“Restrictions on [semiconductor manufacturing equipment] exports to China, if used carefully, would slow China’s semiconductor growth. A straightforward approach would block export to Chinese companies while allowing sales to U.S. and Japanese firms, even if they are located in China.... If YMTC or other Chinese companies succeed in making commercially viable memory chips, a new source of supply will be introduced and shrink market share and revenue for the other producers. However, if YMTC no longer had access

To realize this policy, US law must be updated so that semiconductor manufacturing equipment does not proliferate to PRC firms. This can be done by naming SMIC, YMTC, and CXMT to the Entity List.

to Western SME or materials, this would slow the company’s competitiveness, growth, and its ability to produce more advanced chips.”⁷⁴

Lewis recognizes that YMTC needs to be added to the Entity list in addition to SMIC (*Note that the United States Department of Commerce through its Bureau of Industry and Security took action on September 25th, 2020, requiring US businesses to obtain licenses before exporting certain technology to SMIC*). This measure requires effective coordination with US allies and other semiconductor countries Japan, South Korea, Netherlands, and Taiwan to avoid workarounds and defections. However, there is evidence to suggest that the governments of these countries are already aligned with the Balanced Approach.

Lewis and CSIS partnered with the State Department to develop principles for the 5G Clean Path effort to which more than 30 major telecommunications providers from 20 nations representing more than half of the world’s economy have joined.⁷⁵ A similar Clean Path could be developed for the semiconductor supply chain by starting with the SME itself. Moreover, the US firms in the PRC should be encouraged to transition their operations to other countries to reduce the proximity and probability of PRC predation. Over time, US semiconductor firms will realize new revenue in safer, more sustainable environments.

To realize this policy, US law must be updated to so that SME does not proliferate to PRC firms. This can be done by naming SMIC, YMTC, CXMT, and other PLA linked fabs to the Entity List.

7.3. Technology Decoupling

The AEI and NBR papers advocate technology decoupling and disengagement with the PRC on the technological front. Scissors argues for complete disengagement with the PRC on semiconductors, which means no sales or licensing, and shifting supply chains to other countries. He argues that the PRC cannot and will not behave as a fair actor and that doing business with PRC puts Americans at risk, notably with disruption of supply chains as seen during COVID19. He notes that attempts to manage PRC through export restrictions is not working to reduce theft or cyberattack or to improve Americans safety. Moreover, the engagement with PRC creates the illusion of market opportunity. Economic returns to investing in the PRC are diminished by the country’s persistent predation.

Scissors believes partial decoupling to be superior because political incentives are removed for both US firms and the PRC to game the regulations, and that any US exposure in the PRC on semiconductors is problematic.

The NBR paper argues for “partial disengagement”, a strategy which is essentially partial decoupling. Its goal is to “**strengthen[s] defensive measures to reduce vulnerabilities to surveillance, sabotage, or disruption and to slow diffusion of critical technologies to China.**” This will require constricting the outward flows of some technology to China.” Note that this paper does not

discuss semiconductors specifically, but it is included because it was a solid strategy paper, which subsequently was peer-reviewed and published in leading academic journal.⁷⁶ Plus articles by one of the authors was published in leading foreign policy media⁷⁷⁸ calling for stricter limits on “the machinery and software required for manufacturing high-end semiconductors.”

The implicit conclusion is that technology disengagement and decoupling automatically supports stricter export controls. Scissors, however, believes technological decoupling to be superior because political incentives are removed for both US firms and the PRC to game the regulations, and that any US exposure in the PRC on semiconductors is problematic.

8. Policy Recommendations

The policy responses are No Restrictions, Balanced Approach, and Technology Decoupling. The No Restrictions policy does not address security concerns while the other two policies do. Technology Decoupling is a decision warranting additional consideration before recommendation. In the interim at least the Balanced approach needs to be taken.

The Balanced Approach seems the most practical and realistic, and indeed, affords the most flexibility to adapt strategy should facts change in the future. For example, Entity List designation for SMIC, YMTC, CXMT, and others can be applied for limited periods of time and extended as needed. On the other hand, if US technology becomes embedded across PRC semiconductor factories as allowed by the No Restrictions policy, it is essentially impossible to remove the SME in future.

Given increasingly militarization by the PRC, there is urgency to limit sales of SME to PRC companies today, notably SMIC, YMTC, and CXMT, among others. Acting quickly can also reduce economic harm to US firms. Indeed, the amount of US SME sold to the PRC is limited today, so an Entity List designation has limited impact on US balance sheets. The policy if delayed to the future could likely be more costly, both from a security perspective as well as reduced revenue. Simply put, it is more prudent to not sell the strategic SME to the PRC in the first place, than to allow the sales now and thus face a stronger, even more militant PRC in the future.

Given increasingly militarization by the PRC, there is urgency to limit sales of SME to PRC companies today, notably with YMTC and CXMT. Acting quickly can also reduce economic harm to US firms.

9. Addendum: Analysis of Papers

The following section summarizes a series of policy papers on the US semiconductor industry and the PRC.



9.1. American Enterprise Institute

Partial Decoupling: A Brief Guide

URL: <https://www.aei.org/wp-content/uploads/2020/07/Partial-decoupling-from-China.pdf>

Derek Scissors, July 2020, (16 pages)

POLICY CATEGORY: TECHNOLOGY DECOUPLING

This paper advocates a “partial decoupling” strategy between the US and PRC, economic disengagement for trade in industrial technologies, ending of all trade of semiconductors (license, components, equipment) between the two countries, and repositioning supply chains to other nations. This is preferable to the current set of restrictions and export controls which allow the PRC to switch between corporate instruments and continue to undermine the US. The paper claims that open trade is impossible with the PRC because it blocks foreign entry to its market, infringes intellectual property, and dishonors laws and agreements. The paper notes that semiconductors are the most important of all supply chains to remove from the PRC because of their importance to the US economy, security, and next generation telecommunication.

Scissors argues that the semiconductor producing nations are already US allies, and together, the group can offset losses from PRC. He notes that President Trump has not decoupled but has pursued deals meant to expand trade between the US and PRC. The US can’t prevent PRC’s theft, but it can reduce it by lessening the opportunity for engagement and reducing American companies’ incentive to endure theft. He notes that the PRC systematically transfers all applicable technologies to its military, a violation of US and international law. The PRC also takes American data out of the country and blatantly ignores rules for listing on US exchanges.

Scissors notes that in 2018 Congress overwhelmingly broadly passed bipartisan export control reform, but that the Department of Commerce has been exceedingly slow to implement these regulations. Tighter export controls would be the single most valuable method of stopping technology transfer and arguably the single most important element of partial decoupling, given the implications for both military and economic competition. Scissors suggests that if DOC continues to slow walk the regulations, that this authority should be transferred to another government agency. In contrast, it took the Department of the Treasury only 14 months to publish a full draft of implementing regulations to reform the Committee on Foreign Investment in the United States (CFIUS) based on 2018 **Foreign Investment Risk Review Modernization Act (FIRRMA)**. Scissors does not explain why DOC was delayed to implement the rules, but it could be observed that semiconductor industry actors attempted to weaken, lessen, and delay DOC policy on Huawei by having the Department of Defense intervene on its behalf.⁷⁹

Decoupling involves a range of tools and economic activities. Policymakers should document and respond to Chinese subsidies, implement already legislated export control reform, monitor/

regulate outbound investment, and move/avoid supply chains out of the PRC. It notes that costs of inaction are greater than partial decoupling. The PRC will continue to steal US property, disrupt US economy, and threaten US safety. While decoupling can increase prices and lower investment and sales in the short term, this pain is worth the alternative: loss of US technological leadership in many areas, which will probably never be recovered. The US must recognize that it can't change the PRC, and therefore must instead shrink and limit its economic relationship for an indefinite period because it is harmful. Scissors notes that decoupling must also be durable. It must be enshrined in Congressional legislation. The use of Executive Order can easily be undone from one President to the next.

Shortcomings

AEI's Scissors is critical of Trump Administration policy and notes that it has attempted to increase, not reduce, trade with the PRC. However recent comments from the President suggests he supports decoupling⁸⁰ and his second term priorities include ending a reliance on the PRC with financial incentives for companies remove installations from the PRC to the US and no federal contracts with firms that outsource to the PRC.

Over the years, many US policymakers have called out the PRC but none meaningfully changed the direction of the policy until Trump, who campaigned on the need for a paradigm shift with the PRC. If Trump has not explicitly supported decoupling, he has advanced the ball in that policy direction. Indeed, the prospect for decoupling is openly discussed today compared to a few years ago when the notion of deep interdependence with the PRC was considered beneficial and inevitable.⁸¹

The next US President, whomever it is, will be the beneficiary of Trump having done the "dirty job" of disrupting the status quo with the PRC. The next President can continue a hard-line stance against the PRC while claiming to "rebuild" alliances with other nations which are, in fact, already increasing support of policies of the current administration.⁸² Indeed President Obama's PCAST report on semiconductors in January 2017 advocated for many of the steps Trump ultimately undertook.⁸³ However, publishing the document so late in the Obama Presidency meant that the Obama Administration didn't have to suffer political consequences of a policy which could be perceived as less than favorable to the semiconductor industry.



9.2. Center for Security and Emerging Technology

Maintaining China's Dependence on Democracies for Advanced Computer Chips

URL: <https://cset.georgetown.edu/wp-content/uploads/Khan-Flynn%E2%80%9494Maintaining-Chinas-Dependence-on-Democracies.pdf>

Saif M. Khan and Carrick Flynn, April 2020 (16 pages)

Recommendations on Export Controls for Artificial Intelligence

URL: <https://cset.georgetown.edu/wp-content/uploads/Recommendations-on-Export-Controls-for-Artificial-Intelligence.pdf>

Carrick Flynn, February 2020 (16 pages)

Maintaining the AI Chip Competitive Advantage of the United States and its Allies

URL: <https://cset.georgetown.edu/wp-content/uploads/CSET-Maintaining-the-AI-Chip-Competitive-Advantage-of-the-United-States-and-its-Allies-20191206.pdf>

Saif M. Khan, December 2019 (8 pages)

Multilateral Controls on Hardware Chokepoints

URL: <https://cset.georgetown.edu/wp-content/uploads/CSET-Policy-Recommendation-Semiconductor-One-Pagers.pdf> <https://cset.georgetown.edu/wp-content/uploads/CSET-Policy-Recommendation-Semiconductor-One-Pagers.pdf>

Carrick Flynn and Saif M. Khan (1 page)

POLICY CATEGORY: BALANCED APPROACH

Khan and Flynn note that US leadership in artificial intelligence (AI) requires effective semiconductor policy, particularly in the critical area of export controls for semiconductor manufacturing equipment (SME). They argue that the US and its allies should exploit their advantage against the PRC for SME because only a few top factories for high end chips can operate profitably at the state of the art. They make this claim because many firms have dropped out of the business when they cannot maintain the necessary level of investment to build state of the art semiconductor fabs. They note that SME is the most complex input in the construction of fabs, accounting for 80% of the total fab construction cost.

They observe that the US should take advantage of the fact that just three nations control 90% of global market share for SME: the US, Netherlands, and Japan. Moreover, just two companies sell the photolithography equipment needed to manufacture chips at less than 90 nm: Netherlands' ASML and Japan's Nikon. Only ASML produces extreme ultraviolet photolithography equipment, which is necessary to manufacture state-of-the-art 5 nm chips. They observe that the PRC has made inroads into the lower end of the semiconductor market, however when accounting for high quality of chip fab capacity, China's share is a mere 3% compared to Taiwan, South Korea, and the US, collectively at almost 92%.

They observe that if the PRC is empowered with SME, it will use it to advance military technology and to counter the US/allies' attempts to challenge the PRC's conduct in human rights and global stability. That is, the PRC will weaponize any new technological capability into a geopolitical advantage.

They note that if these three states all deny SME to the PRC, then the PRC will find it near impossible to develop or maintain advanced chip factories. Moreover, the export control policy will reduce the PRC's 3% share today to just 0.2%. The sustained pressure will drive production to other democracies and away from the PRC. The policy would have little to no long-term revenue loss for SME companies in the US, Netherlands, or Japan. In fact, they may even increase revenue and profitability in democratic countries.

They authors reference BIS⁸⁴ and suggest semiconductor areas needing greater control including EUV photolithography equipment to fabricate chips with state-of-the-art 5 nm transistors; argon fluoride (ArF) immersion photolithography to fabricate chips with transistors between 45 nm and 7 nm.; e-beam lithography equipment (the United States, Japan, and Germany); chemical mechanical planarization equipment (the United States, Japan, and South Korea); ion implanters (the United States, Japan, and Taiwan); dry stripping equipment (the United States, Japan, the Netherlands, South Korea, and Taiwan), wafer inspection equipment (the United States, Japan, and possibly others); conductor etching equipment (the United States, Japan, and South Korea), and atomic layer etching equipment.



CENTER FOR STRATEGIC &
INTERNATIONAL STUDIES

9.3. Center for Strategic & International Studies

Semiconductors and Modern Defense Spending

URL: <https://www.csis.org/analysis/semiconductors-and-modern-defense-spending>

James Andrew Lewis, September 8, 2020 (blog post)

Managing Semiconductor Exports to PRC

URL: <https://www.csis.org/analysis/managing-semiconductor-exports-china>

James Andrew Lewis, May 2020 (blog post)

POLICY CATEGORY: BALANCED APPROACH

Lewis argues for a re-envisioning of US military spending to support American semiconductor supremacy. He notes that the amount of money needed is minimal, particularly in relation to \$6 trillion spent in wars in Iraq and Afghanistan, an average annual outlay of \$330 billion annually for the last 18 years. Moreover the amount the is trivial compared to what the PRC spends to build a domestic semiconductor industry, some \$60 billion to date, a pledge for another \$60 billion, a 10 year tax exemption for companies producing advanced chips, workforce development, and incentives to locate in PRC. In parallel are the PRC's in illicit tactics of industrial espionage and aggressive efforts to poach engineers from Taiwan Semiconductor Manufacturing Company. Lewis estimates that the PRC will achieve parity in semiconductor manufacturing (memory chips and wafers) in 10 years, though this could be slowed by restricting technology.

Lewis notes that while restricting US chips sales to PRC and blocking PRC's attempt to acquire US assets have worked to slow PRC's growth, they do not strengthen US semiconductor industry. The goal should be to prevent the PRC from catching up and to keep the US in the lead. He calls for US government to invest in the semiconductor industry, to adopt policies to ensure that the US can access global markets, and to pass for the Creating Helpful Incentives to Produce

Semiconductors (CHIPS) for America Act. He notes that US is less attractive for fabs from foreign investors because of lack of financial and tax incentives.

The US can't stop PRC from building a semiconductor industry. If it blocks exports, PRC will get the semiconductors somewhere else. Lewis is concerned that Trump export restrictions harm US business more than PRC. The US should keep its semiconductor industry strong. PRC is becoming competitive in NAND, but not in other areas. Sanctions, not export controls, are appropriate for engaging with a hostile power.

The US needs export control modernization. **Semiconductor manufacturing equipment (SME)** is a chokepoint, but US should not harm itself or allies. US, Japan, and Netherlands produce all SME. Careful restrictions on SME exports to PRC, if used carefully, would slow PRC's semiconductor growth. Though the PRC has lagged in semiconductors, it is competitive with some memory chips (NAND) and is moving in the logic and specialized domains. PRC buys most chips from US companies, many which have fabs in the PRC. New Chinese entrant Yangtze Memory Technologies Corp (YMTC) has Chinese government support but restricting chips to YMTC will accelerate its growth. However, the US should restrict equipment to this company. Continuing US chip sales to PRC lowers the urgency for PRC to develop its own supply. But US equipment should only be sold to US companies.

The US should strengthen its own industry by (1) increasing supply of STEM labor, (2) offering subsidies for TSMC to move to US, (3) support US companies in IP and trade disputes, and (4) coordinate strategy with Japan, South Korea and EU. Also, the US needs better vetting of Chinese intelligence collectors who could be also be posing a garden variety scientists/researcher in the USA.

Shortcomings

It is not evident that a class of "low end" chips can necessarily be identified. As the Department of Defense noted in 2015, "Integrated Circuits are the lowest level of the modern electronics supply chain. However, they are also the most critical and technologically advanced, as they are the 'brains' of any electronic system."⁸⁵ Even if this class of chips could be identified, it's still uncertain that they could be precluded from use in the military applications. Moreover, the notion that the PRC will somehow "slow" its effort to become self-sufficient in semiconductors because of the availability of US chips is unfounded. The PRC does not wish to slow any elements of its industrial plan; the PRC has only been slow on semiconductors is because its model of state support wasteful, inefficient, and corrupt. While there may be reasons for the US government to support R&D in semiconductors, the PRC is not the model to emulate.



9.4. Eurasia Group

The Geopolitics of Semiconductors

URL: <https://www.eurasiagroup.net/files/upload/Geopolitics-Semiconductors.pdf>

September 2020 (15 Pages)

POLICY CATEGORY: NO RESTRICTIONS

The contest between US and PRC on semiconductors will have global consequences. The US has the upper hand; the PRC is vulnerable, and Taiwan caught in the middle. The US has seized on Huawei's vulnerability and its success has helped European nations to come aboard to its policy. Further US actions put the global semiconductor industry revenue at risk. The PRC has made massive investment in semiconductors but has not yet succeeded and does not appear to be positioned well to enter top tier of manufacturers, leaving it related electronics manufacturers reliant on foreign chips.

The US moves to toward Taiwan Semiconductor Manufacturing Company (TSMC) raise the political stakes for China and the world to choose between "blue" (US) and "red" (PRC) supply chains. The US is likely to provoke retaliation from China by using Taiwan as a wedge, if not in military means, then in other risks to the supply chains. The consequences of continuing in the current path include nationalization of TSMC facilities in PRC, IP theft, recruiting key industry talent, retaliatory actions against US and other Western technology firms operating in PRC, and greater investment in the domestic technology sector. US action will hasten decoupling and spur China to establish its own system. The process will be messy, costly, risky, and will continue in next administration regardless of the President. Future US actions targeting PRC in semiconductors could include adding domestic foundry leader SMIC and memory producers Changxin and Yangtze Memory Technologies to the entity list, under an expanded US definition of "military end use."

Shortcomings

The paper asserts that the administration's policy will harm the revenue of the semiconductor industry, but this is not necessarily empirical. SIA reports that the industry continues to earn increasing revenue in the face of restriction. Moreover, related industries are not necessarily harmed. Indeed, some firms in democratic nations advance as a result of restrictions. As a series of empirical investigations by Strand Consult show,⁸⁶ the Huawei restrictions have not harmed the telecom industry, and South Korea's Samsung has benefitted from the demise of Huawei. Huawei asserted that restrictions would increase the cost and delay 5G rollout. They also claimed that the cost to rip and replace its equipment in Europe would be \$60 billion when it was only \$3.6 billion. Telecom operators have merely switched suppliers. The telecom industry has proven quite adaptable and flexible with export restrictions, as its financial statements demonstrate. In fact, Huawei's revenue increased in 2019 following the Entity List designation. It switched from selling network equipment abroad to selling smartphones in the PRC.

Empirically many semiconductor firms have limited revenue in PRC today, so restricting their access to it now does not hurt their balance sheet now. Naturally, firms would like to access the

PRC market, but this is predicated that it will be safe to do so, that the PRC won't commandeer their assets, or reverse engineer their technology.

EG claims that the policy will be messy. However, how easy will it be to implement this policy in a year when the PRC is presumably even further along, it's military even larger, and the US further weakened economically from PRC's predatory actions? It is likely to be even more messy and costly to delay actions that must be taken today and that should have been taken years ago.

EG states that further action from the US will draw PRC retaliation. If this is the case, then it's time to drop the pretense that the PRC is a fair dealer and that this is a question of "market competition". The experience of Huawei in Denmark among other European countries highlights that many countries were subject to a series of threats from both Huawei officials and PRC ambassadors, contradicting the Huawei's claim that it is not associated with the PRC.⁸⁷

In any event, the warning that further US restriction will accelerate China's own development does not hold. The PRC has made known its goal to be self-sufficient through whatever means necessary. It has no reason to slow any of its five-year plans. In any event, this is no excuse for the US to stop or delay needed efforts to strengthen its own security.

The view that the world would evolve into "red" and "blue" stacks is not necessarily a bad thing. If anything, it would give consumers transparency and choice they don't have today. Moreover, the PRC, together with Huawei has long been architecting its own version⁸⁸ of the internet, which was submitted to the United Nations (See PowerPoint presentation⁸⁹ and an official standard proposal⁹⁰). As described in *The Great Firewall of China: How to Build and Control an Alternative Version of the Internet*,⁹¹ the PRC sees the purpose of the internet to promote an infrastructure to prevent collective action against the state.

Furthermore, there is no commandment that says the US, or any nation, must accept the conditions of the PRC. Part of any relationship is the ability to negotiate, and if need be, to walkway. The US and its allies are sovereign nations which can choose with whom they want to do business. Notably the US exercised its power with allies by imposing sanctions on South Africa, which ultimately brought down apartheid.



9.5. Information Technology & Innovation Foundation

An Allied Approach to Semiconductor Leadership

URL: <https://itif.org/sites/default/files/2020-allied-approach-semiconductor.pdf>

Stephen Ezell, September 2020 (58 pages)

POLICY CATEGORY: NO RESTRICTIONS

The report describes a collaborative approach which like-minded allied nations can take to advance their semiconductor leadership, notably through ecosystem development, IP protection, and trade. The report makes a powerful case for re-establishing and modernizing semiconductor manufacturing in the US and reciprocation by like-minded countries. It advocates many policy improvements such as more flexible federal contract guidelines, better coordination of

semiconductor R&D across the federal government, trusted foundry programs, and cross-national moonshot projects which share IP based upon proportional investments.

The paper advocates “coordinated technology protection”, so just as allied nations cooperate on technology development, they should ensure the protection of their innovations. In response to Americans’ increasing concerns about the PRC’s Military Civil Fusion, Congress promulgated the 2018 Export Control Reform Act (ECRA) which updated the Export Administration Regulations (EAR) administered by DOC BIS. ECRA codifies BIS practices into law and enhances the export control authorities. BIS is required to lead interagency efforts to identify “emerging” and “foundational” technologies that are essential to national security and which are not already covered in existing regimes such as the Wassenaar Arrangement. BIS has identified 14 such categories, though it has not progressed on implementing its mandate, a point highlighted both by Ezell and Scissors.

The paper calls for limiting export controls only to cases where the US is the only producer and removing the control when other countries develop the capability. It rejects unilateral controls in favor of a “plurilateral” (more than 2 countries) approach with other countries with indigenous production. It calls for coordinating foreign investment screening with like-minded nations to identify unfair practices, subsidizing of state-owned enterprises, and sensitive foreign direct investment (FDI). This could include expanding the list of nations with fast-tracked approval for FDI to France, Germany, Netherlands, Italy, Japan, and South Korea (among others). Allied countries should also coordinate more closely on combatting IP theft and espionage by sharing a comprehensive list of malicious actors as well as better protection of trade secrets and greater penalties for theft. It advocates creating a Global Strategic Supply Chain Alliance (GSSCA) and to develop an allied approach to expand market-based trade approaches in the Indo-Pacific region. The paper further calls for like-minded nations to add security as a procurement feature in addition to price, cost, and quality.



9.6. National Bureau of Asian Research

Partial Disengagement: A New US Strategy for Economic Competition with China

URL: <https://www.nbr.org/publication/partial-disengagement-a-new-u-s-strategy-for-economic-competition-with-china/>

Aaron L. Friedberg and Charles W. Boustany Jr. November 4, 2019 (13 pages)

POLICY CATEGORY: TECHNOLOGY DECOUPLING

The paper describes the continuum of the US-PRC relationship from free trade/openness to containment/closedness. It describes the status quo in which the US is relatively open to PRC trade while the PRC is partially closed to the US and deploying predatory tactics such as subsidies, tariffs, and other non-tariff barriers such as designating “strategic sectors” of its economy. It observes that the Trump Administration has pursued conflicting strategies of openness and containment, but the strategy has shifted in the last two years, given growing US bipartisan consensus of security and economic risks and legislations that strengthens investment screening and export control regulations.

The paper advocates for a clearer strategy toward “partial disengagement” that “**strengthen[s] defensive measures to reduce vulnerabilities to surveillance, sabotage, or disruption and to slow diffusion of critical technologies to China.**” This will require constricting the outward flows of some technology to China, while regulating the inward flows of some Chinese goods, capital, and people to the U.S.” Notably the strategy would be complemented by increasing trade, cooperation and sharing with allies.



9.7. President’s Council of Advisors on Science and Technology (Obama)

Ensuring U.S. Leadership and Innovation in Semiconductors

URL:https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/PCAST/pcast_ensuring_long-term_us_leadership_in_semiconductors.pdf

January 6, 2017 (44 pages)

POLICY CATEGORY: BALANCED APPROACH

The report observed the industry facing major challenges with implications for the US economy and national security. The PRC attempts to shape the market to favor their needs and threatens US competitiveness. It is critical that the US continue to innovate at the cutting edge for its own sustainability as well as to counter predation by the PRC. The US must adopt a strategy that increase US semiconductor innovation, pushes back at the PRC, and improves the business environment for US semiconductor industry. Moore’s Law is reaching its physical limits, make it harder to deliver returns to scale. PRC strategies can also reduce US competitiveness, for example internal policies to distort market prices. The US should pursue semiconductor “moonshots” (cutting-edge medical technologies and game-changing biodefense detection systems etc.) with broad and valuable applicability across multiple dimensions. Specific recommendations include

1. Improving transparency of PRC investment controls.
2. Reshape the application of national security tools to deter and respond to PRC policies. U.S. export and investment controls should focus on national security concerns rather than economic goals.
3. Respond directly to PRC policies that violate trade rules and distort the global market.
4. Work with allies to strengthen global export controls and inward investment security.

The report also recommends adopting domestic policy such as

1. Sustaining a world-class workforce through education and immigration policy.
2. Boosting government investment in general-purpose scientific research.
3. Enacting prudent business tax reform.
4. Responsibly speeding facility permitting while maintaining environmental protections.

The Obama report was published in January 2017, following a series of meetings that were convened in October 2016. The report came too late in the Obama administration to be actioned. However, the Trump Administration has made progress on all the fronts, though at different speeds.

Tax reform and facility permitting were the first recommendations to be delivered. The other items have some progress, but work remains.



9.8. Semiconductor Industry Association

2020 State of the U.S. Semiconductor Industry

URL: <https://www.semiconductors.org/wp-content/uploads/2020/07/2020-SIA-State-of-the-Industry-Report-FINAL-1.pdf>

20 pages

2020 Factbook

URL: https://www.semiconductors.org/wp-content/uploads/2020/04/2020-SIA-Factbook-FINAL_reduced-size.pdf

PowerPoint Presentation. 30 slides.

Winning the Future: A Blueprint for Sustained U.S. Leadership in Semiconductor Technology

URL: <https://www.semiconductors.org/wp-content/uploads/2019/04/FINAL-SIA-Blueprint-for-web.pdf>

April 4, 2019 (18 pages)

POLICY CATEGORY: NO RESTRICTIONS

SIA wants federal investment in research, skilled workforce, IP protection, and access to global markets. Semiconductor industry sales are forecast to reach \$433 billion in 2020 and \$460 billion in 2021. The US semiconductor industry has 47 percent share of the global market and have experienced steady annual growth for the last two decades. The leading categories of chips are logic and memory, each exceeding \$100B annually in sales. Another \$200 billion is comprised of chips for other purposes. Asia Pacific is the single largest region for the sales of chips (62.5 percent) with PRC being the single largest market (35 percent). The Americas are 19.1 percent; Europe 9.7 percent, and Japan 8.7 percent. The US semiconductor industry invests significantly, some \$72 billion in 2019, accounts for roughly 30 percent of sales, and demonstrates a compound annual growth rate of 6.2 percent, which has been steadily increasing for the last two decades. Current direct employment is roughly 240,000. Each semiconductor job supports 4.89 jobs in other parts of the economy.

From SIA's perspective, the militarization and industrialization of the PRC is not described, and indeed, does not appear to be a problem that needs fixing. SIA data show that US share of all semiconductors has been relatively stable, that US industrial R&D is high, and that revenue is increasing. The PRC is a key market, and the SIA wants to do business. Naturally, SIA is concerned with the returns to SIA member companies' shareholders and to thereafter to member company employees. The welfare and safety of Americans are not necessarily its concern. Naturally, SIA offers a marketing document characteristic of a trade association.

SIA has bolstered its position with a series of reports prepared by the Boston Consulting Group. One report offers scenarios of what restrictions would do to the industry's revenue and market share.⁹² While this model suggests that restrictions could reduce US market share from 47 percent today to as low as 30 percent depending on the type of restrictions, the model does not include a counterfactual, that is how US market share could be reduced if US companies were empower the PRC with access to US technology. Presumably if the PRC were to become self-sufficient, having

US SME brought to its door, would increase its likelihood to reverse engineer, steal, coerce or otherwise illicitly acquire the US technology.



9.9. SEMI

Global Advocacy Position on Export Controls

URL: <https://www.semi.org/en/global-advocacy/export-control>

Statement on New U.S. Export Control Regulations

URL: <https://www.semi.org/en/news-media-press/semi-press-releases/semi-export-control>

August 24, 2020 (blog post)

Letter to President Donald Trump

URL: <https://www.semi.org/sites/semi.org/files/2020-04/Apr%20203%20SEMI%20FDPR%20Letter.pdf>

April 3, 2020

SEMI Warns Against New Unilateral U.S. Export Controls on Commercial Technology

URL: <https://blog.semi.org/semi-news/semi-warns-against-new-unilateral-u.s.-export-controls-on-commercial-technology>

Joe Pasetti, March 3, 2020 (blog post)

SEMI Global Trade Seminars in China Focuses on Shifting U.S.-Sino Relations

URL: <https://blog.semi.org/semi-news/semi-global-trade-seminar-in-china-focuses-on-shifting-u.s.-sino-relations>

Jay Chittooran, November 20, 2018 (blog post)

POLICY CATEGORY: NO RESTRICTIONS

SEMI describes themselves as “the industry association serving the global electronics design and manufacturing supply chain.” The organization acts as the trade association representing companies that make semiconductor manufacturing equipment. With reference to policy efforts to constrain China’s rise, the organization primary asserts three main arguments.

First, SEMI suggested that national security is an “excuse”, as when they sent a thank you letter to President Trump for having said, when speaking about Huawei, “the always used National Security excuse” is causing people to “get carried away with it.” But national security is not SEMI’s primary consideration. As one industry analyst said about the equipment makers:

“Most companies in the semiconductor production space are used to operating globally. They have Chinese customers, Korean customers, Japanese customers and EU customers, and they’re used to deriving about 80 percent of their revenue outside of the U.S. They are agnostic [about the U.S.] — they don’t care where demand is coming from. As long as the ducks are quacking. they are generally not concerned where the end market resides.”

Second, SEMI argues that America’s security is partly due to US equipment manufacturers’ large trade surplus. Responding to the 9/17/20 Notice of Proposed Rulemaking, SEMI argued the rule would “undermine U.S. national security interests by harming the semiconductor industry in the U.S. and creating substantial uncertainty and disruption in the semiconductor supply chain.” As proof, SEMI asserts the proposed 5/15 proposed rulemaking had already resulted in \$17 million in lost sales of US-origin firms unrelated to Huawei.

Third, SEMI asserts their customers will simply buy equipment from competitors in other countries because they do not have the same restrictions, thus costing American jobs without inhibiting China's rise.

Shortcomings

SEMI asserts that earning revenue is essential to the ability to invest in R&D, and any reducing of revenue harms national security. These assertions should be unpacked. While it is true that semiconductor firms use revenue to invest in R&D, to a high degree in fact, it is not the case that revenue must be earned from the PRC to invest in R&D. Indeed, any revenue earned anywhere could be invested in R&D. The problem is that revenue from the PRC comes with an increased security risk and indeed, the revenue itself is at risk given the PRC's goal to stop using foreign technology as soon possible. As such, the industry should pursue revenue from safe countries. The industry could also receive investments from the government to support its R&D efforts and offsets ostensible loss in the PRC.

Semiconductor industry actors have attempted to equate their profits with national security and to argue that any restrictions on their business will ultimately harm national security. The litany of US corporations which have brazenly sold strategic technology to PRC actors which have subsequently incorporated this into PLA operations includes such celebrated firms as IBM, Microsoft, Cisco, and Intel.⁹³ As such, Scissors' call for a CFIUS to review outbound investment from the US is much needed.

The PRC could take its business to other countries, but international collaboration with South Korea, Japan, Taiwan, and Europe can preclude this outcome. After all, the policy to restrict Huawei is gaining European and Asian allies, and the same can be done with SME.



9.10. United States International Trade Council

Health and Competitiveness of Semiconductor Manufacturing

URL:

https://www.usitc.gov/publications/332/working_papers/id_058_the_health_and_competitiveness_of_the_sme_industry_final_070219checked.pdf

John VerWey, 2019 (30 pages). See VerWey's series on the PRC Semiconductor Industry.⁹⁴⁹⁵

POLICY CATEGORY: NO RESTRICTIONS

The US has had controls on semiconductor manufacturing equipment (SME) for decades, as they are "dual use" (commercial and military applications) technologies. These controls are administered by the Department of Commerce Bureau and Security (BIS) and State Department's Directorate of Defense Trade Controls, have been formalized in the Wassenaar Arrangement, and adopted by NATO countries. A 2002 General Accountability Office report claims that US export controls have kept the PRC two generations behind in semiconductors.⁹⁶ However the license and sale of chips is a different story; BIS has limited ability to ensure that the PRC does not use its chips for military purposes.

The 2019 National Defense Appropriation and Authorization added two additional regulations on semiconductors. The Export Control Reform Act (“ECRA”) mandated that BIS establish new controls on the export of “emerging and foundational technologies”. The ***Foreign Investment Risk Review Modernization Act*** of 2018 (FIRRMA) stipulates that Commerce review its licensing processes of goods which may be “emerging” or “foundational” and specifically identified semiconductor manufacturing equipment as well as the semiconductors themselves as subjects of interest for future controls and likely ends the ability of PRC to acquire a US semiconductor company.

Many US semiconductor companies have opposed restrictions on exports, claiming that controls lead to loss of the US industry’s worldwide market share as non-U.S. firms will fill the gap. The PRC has tried for decades to build a domestic semiconductor industry but with limited success. Being a “latecomer” offers the PRC some advantages including the ability leverage existing supply chains, free-rider effects, reduced investment requirement in R&D, better market information, human capital, and state support, which can also distort prices in latecomers favor. It claims that further US restrictions will sharpen the PRC’s resolve to succeed in semiconductors once and for all. The country is highly motivated because the present offers the best set of factors yet including the world’s largest market for chips and a \$200B trade deficit with US.

The detailed and informative papers by VerWey are essential to understanding the PRC’s semiconductor strategy, though they might not necessarily conclude the optimal export control policy. On the one hand, VerWey recognizes that US restrictions have worked to slow the PRC’s growth in semiconductors, but on the other, he opposes further restrictions, claiming that it will harm US industry.

10. Works Cited

-
- ¹ “Export Controls for Conventional Arms and Dual-Use Goods and Technologies,” *The Wassenaar Arrangement* (blog), December 2019, <https://www.wassenaar.org/control-lists/>.
- ² “CHAPTER 58—EXPORT CONTROL REFORM,” US House, accessed September 28, 2020, <https://uscode.house.gov/view.xhtml?path=/prelim@title50/chapter58&edition=prelim>.
- ³ Stigler, G. (1971). The Theory of Economic Regulation. *The Bell Journal of Economics and Management Science*, 2(1), 3-21. doi:10.2307/3003160
- ⁴ “About Commerce,” U.S. Department of Commerce, accessed September 28, 2020, <https://www.commerce.gov/about>.
- ⁵ “About BIS,” Bureau of Industry and Security, accessed September 28, 2020, <https://www.bis.doc.gov/index.php/about-bis>.
- ⁶ “Entity List,” Bureau of Industry and Security, accessed September 28, 2020, <https://www.bis.doc.gov/index.php/policy-guidance/lists-of-parties-of-concern/entity-list>.
- ⁷ <https://www.aei.org/foreign-and-defense-policy/the-department-of-commerce-ignores-congress/>
- ⁸ “Identification and Review of Controls for Certain Foundational Technologies,” Federal Register, August 27, 2020, <https://www.federalregister.gov/documents/2020/08/27/2020-18910/identification-and-review-of-controls-for-certain-foundational-technologies>.
- ⁹ Yuan Yang, Kathrin Hille, and Qianer Liu. “China’s biggest chipmaker SMIC hit by US sanctions. Move further hurts semiconductor sector after penalties on Huawei.” *Financial Times*. September 26, 2020.
- ¹⁰ Mulvenon, James. “BLUE HERON: Semiconductor Manufacturing International Corporation.” SOS International LLC. August 2020
- ¹¹ RICHARD WINDSOR Richard is, “USA vs. China – Semi Chokehold Pt. II. – Radio Free Mobile,” September 28, 2020, <https://radiofreemobile.com/2020/09/28/usa-vs-china-semi-chokehold-pt-ii/>.
- ¹² “Addition of Fujian Jinhua Integrated Circuit Company, Ltd (Jinhua) to the Entity List,” U.S. Department of Commerce, accessed September 28, 2020, <https://www.commerce.gov/news/press-releases/2018/10/addition-fujian-jinhua-integrated-circuit-company-ltd-jinhua-entity-list>.
- ¹³ “Commerce Department Further Restricts Huawei Access to U.S. Technology and Adds Another 38 Affiliates to the Entity List,” U.S. Department of Commerce, August 17, 2020, <https://www.commerce.gov/news/press-releases/2020/08/commerce-department-further-restricts-huawei-access-us-technology-and>.
- ¹⁴ “U.S. Department of Commerce Adds 28 Chinese Organizations to its Entity List.” U.S. Department of Commerce. October 7, 2019. <https://www.commerce.gov/news/press-releases/2019/10/us-department-commerce-adds-28-chinese-organizations-its-entity-list>
- ¹⁵ “Commerce Department to Add Nine Chinese Entities Related to Human Rights Abuses in the Xinjiang Uighur Autonomous Region to the Entity List,” U.S. Department of Commerce, May 22, 2020, <https://www.commerce.gov/news/press-releases/2020/05/commerce-department-add-nine-chinese-entities-related-human-rights>.
- ¹⁶ “Commerce Department Adds 24 Chinese Companies to the Entity List for Helping Build Military Islands in the South China Sea,” U.S. Department of Commerce, August 26, 2020, <https://www.commerce.gov/news/press-releases/2020/08/commerce-department-adds-24-chinese-companies-entity-list-helping-build>.
- ¹⁷ “Commerce Department Statement on U.S. District Court Ruling on TikTok Preliminary Injunction,” U.S. Department of Commerce, September 27, 2020, <https://www.commerce.gov/news/press-releases/2020/09/commerce-department-statement-us-district-court-ruling-tiktok>.
- ¹⁸ Alexandra Alper Nellis Toby Sterling, Stephen, “Trump Administration Pressed Dutch Hard to Cancel China Chip-Equipment Sale: Sources,” *Reuters*, January 6, 2020, <https://www.reuters.com/article/us-asml-holding-usa-china-insight-idUSKBN1Z50HN>.
- ¹⁹ U.S. Semiconductor Manufacturing: Industry Trends, Global Competition, Federal Policy (Rep.). (2016). Washington, DC: Congressional Research Service.
- ²⁰ Kilby is co-inventor handheld calculator and thermal printer, was awarded Nobel prize for physics in 2000.
- ²¹ “DRAM, 3D NAND Face New Challenges,” *Semiconductor Engineering* (blog), September 21, 2020, <https://semiengineering.com/a-mixed-bag-of-memory-bits/>.

-
- ²² Information Technology & Innovation Foundation. An Allied Approach to Semiconductor Sector. September 17, 2020. <https://itif.org/events/2020/09/17/allied-approach-semiconductor-sector-competitiveness>
- ²³ A Congressional Semiconductor Caucus emerged in 2015 co-chaired by Senator James Risch (R-ID), Senator Angus King (I-ME), Congressman Pete Sessions (R-TX) and Congresswoman Zoe Lofgren (D-CA).
- ²⁴ Export Administration Regulations: Amendments to General Prohibition Three (Foreign-Produced Direct Product Rule) and the Entity List, Bureau of Industry and Security § 15 CFR Parts 730, 732, 736, and 744 (2020).
- ²⁵ Ibid
- ²⁶ Defense, D. O. (2020, September 1). DOD China Military Power Report. Retrieved from <https://media.defense.gov/2020/Sep/01/2002488689/-1/-1/1/2020-DOD-CHINA-MILITARY-POWER-REPORT-FINAL.PDF>
- ²⁷ Mulvenon, James. "BLUE HERON: Semiconductor Manufacturing International Corporation." SOS International LLC. August 2020
- ²⁸ Annual Industrial Capabilities Report to Congress (Rep.). (2016). Washington, DC: Office of the Undersecretary of Defense.
- ²⁹ Huntington, S. (1981). *The Soldier and the State: The Theory and Politics of Civil-Military Relations*. New York, NY: Belknap Press
- ³⁰ Joffe, E. (1996). Party-Army Relations in China: Retrospect and Prospect. *The China Quarterly*, (146), 299-314. Retrieved May 15, 2020, from www.jstor.org/stable/655470
- ³¹ State, D. O. (2020, May). Military-Civil Fusion and the People's Republic of China. Retrieved from <https://www.state.gov/wp-content/uploads/2020/05/What-is-MCF-One-Pager.pdf>
- ³² "NATO SUPPORT AND PROCUREMENT AGENCY (NSPA) PROCUREMENT OPERATING INSTRUCTION," March 18, 2019, <https://www.nspa.nato.int/resources/site1/General/business/procurement/General%20info/OI-4200-01-EN.pdf>.
- ³³ "CFIUS' Growing Power to Protect American Security from China Tech Threats: Examining TikTok and Lenovo" (China Tech Threat, June 26, 2020), https://chinatechthreat.com/wp-content/uploads/2020/06/CFIUS-Paper-062420_.pdf.
- ³⁴ "GPS Next-Generation Operational Control System." *Raytheon Intelligence and Space*
- ³⁵ Proposed Rule. (2020). Identification and Review of Controls for Certain Foundational Technologies (Publication). Washington, DC: Industry and Security Bureau.
- ³⁶ Jinping, X. (2014). THE CHINESE DREAM OF THE GREAT REJUVENATION OF THE CHINESE NATION. <https://www.amazon.com/CHINESE-DREAM-GREAT-REJUVENATION-NATION/dp/7119086960>
- ³⁷ Angang, H.; Honghua, M. (n.d.). *The Rising of Modern China: Comprehensive National Power and Grand Strategy* (Rep.). Tsinghua University.
- ³⁸ Qiao, L., Wang, X., & Santoli, A. (2002). *Unrestricted warfare : China's master plan to destroy America*. Panama City: Pan American Publishing Company.
- ³⁹ MADE IN CHINA 2025. (2016). Retrieved from http://www.gov.cn/zhuanti/2016/MadeinChina2025-plan/index.htm?_sm_au_=_iVVbN6VM35s7Nk2501TfKK3Qv3fc4
- ⁴⁰ "China's Technonationalism Toolbox: A Primer | U.S.- CHINA | ECONOMIC and SECURITY REVIEW COMMISSION," March 28, 2018, <https://www.uscc.gov/research/chinas-technonationalism-toolbox-primer>.
- ⁴¹ Yang, Y., & Liu, N. (18, September 18). SMIC scores mainland China's biggest listing in a decade. Retrieved from <https://www.ft.com/content/6a87d390-fdad-43c7-8ff9-c99f3b94294c>
- ⁴² Defense, D. O. (2020, August 28). DOD Releases List of Additional Companies, in Accordance with Section 1237 of FY99 NDAA. Retrieved from <https://www.defense.gov/Newsroom/Releases/Release/Article/2328894/dod-releases-list-of-additional-companies-in-accordance-with-section-1237-of-fy/>
- ⁴³ Eliza Gkritsi, "A Chinese Firm Made a Memory Chip that Can Compete with Samsung. What's Next?," *TECHNODE* (Apr. 23, 2020), <https://technode.com/2020/04/23/ymtc-memory-chip>
- ⁴⁴ See Eva Dou and Robert McMillan, "China's Tsinghua Unigroup Buy Small Stake in U.S. Chip Maker Lattice," *Wall St. J.* (Apr. 14, 2016), www.wsj.com/articles/chinas-tsinghua-unigroup-buys-small-stake-in-u-s-chip-maker-lattice-1460654877
- ⁴⁵ Tsinghua University. (2019, November 21). Retrieved from https://unitracker.aspi.org.au/universities/tsinghua-university/?_sm_au_=_iVVnpNHbKsVZHL6q01TfKK3Qv3fc4
- ⁴⁶ Ben Yeh, "Competition in NAND Flash Market to Intensify in 2021 as YMTC Unveils 128L Products on Schedule, Says TrendForce," *TRENDFORCE* (Apr. 20, 2020), www.trendforce.com/presscenter/news/20200420-10280.html.

-
- ⁴⁷ Cheng Ting-Fang and Lau Li, “How China’s Chip Industry Defied the Coronavirus Lockdown,” NIKKEI ASIAN REV. (Mar. 19, 2020), <https://asia.nikkei.com/Spotlight/The-Big-Story/How-China-s-chip-industry-defied-the-coronavirus-lockdown>
- ⁴⁸ “首颗‘合肥造’存储器今年有望下线,” accessed September 28, 2020, www.sohu.com/a/228578667_163577.
- ⁴⁹ Junko Yoshida, “EETimes - ChangXin Emerging as China’s First & Only DRAM Maker -,” *EETimes* (blog), December 3, 2019, <https://www.eetimes.com/changxin-emerging-as-chinas-first-only-dram-maker/>.
- ⁵⁰ Ibid
- ⁵¹ 拓璞产业研究院, “长鑫存储新路线图公布, 另计划再建两座DRAM晶圆厂,” 商业新闻网, accessed September 28, 2020, <https://www.shangyexinzhi.com/article/349156.html>.
- ⁵² SOSI: “Blue Heron: Semiconductor Manufacturing International Corporation,” August 2020
- ⁵³ Ibid
- ⁵⁴ Ibid
- ⁵⁵ “首颗‘合肥造’存储器今年有望下线,” accessed September 28, 2020, www.sohu.com/a/228578667_163577.
- ⁵⁶ Junko Yoshida, “EETimes - ChangXin Emerging as China’s First & Only DRAM Maker -,” *EETimes* (blog), December 3, 2019, <https://www.eetimes.com/changxin-emerging-as-chinas-first-only-dram-maker/>.
- ⁵⁷ 拓璞产业研究院, “长鑫存储新路线图公布, 另计划再建两座DRAM晶圆厂,” 商业新闻网, accessed September 28, 2020, <https://www.shangyexinzhi.com/article/349156.html>.
- ⁵⁸ Eliza Gkritsi, “A Chinese Firm Made a Memory Chip that Can Compete with Samsung. What’s Next?,” *TECHNODE* (Apr. 23, 2020), <https://technode.com/2020/04/23/ymtc-memory-chip>
- ⁵⁹ See Eva Dou and Robert McMillan, “China’s Tsinghua Unigroup Buy Small Stake in U.S. Chip Maker Lattice,” *Wall St. J.* (Apr. 14, 2016), www.wsj.com/articles/chinas-tsinghua-unigroup-buys-small-stake-in-u-s-chip-maker-lattice-1460654877
- ⁶⁰ Cheng Ting-Fang and Lau Li, “How China’s Chip Industry Defied the Coronavirus Lockdown,” NIKKEI ASIAN REV. (Mar. 19, 2020), <https://asia.nikkei.com/Spotlight/The-Big-Story/How-China-s-chip-industry-defied-the-coronavirus-lockdown>
- ⁶¹ Ben Yeh, “Competition in NAND Flash Market to Intensify in 2021 as YMTC Unveils 128L Products on Schedule, Says TrendForce,” *TRENDFORCE* (Apr. 20, 2020), www.trendforce.com/presscenter/news/20200420-10280.html.
- ⁶² Lewis, J. A. (2020). *Managing Semiconductor Exports to China* (Publication). Washington, DC: Center for Strategic and International Studies.
- ⁶³ Yoshida, J. (2019, December 05). ChangXin Emerging as China's First & Only DRAM Maker -. Retrieved September 18, 2020, from <https://www.eetimes.com/changxin-emerging-as-chinas-first-only-dram-maker/>
- ⁶⁴ The White House, President Barack Obama. (2017, January 9). Ensuring U.S. Leadership and Innovation in Semiconductors [Press release]. Retrieved from <https://obamawhitehouse.archives.gov/blog/2017/01/09/ensuring-us-leadership-and-innovation-semiconductors>
- ⁶⁵ For example, prior to the placement of Huawei on the Entity List, it was restricted in the US by the National Defense Authorization Act and Federal Communications Commission and was indicted by the Department of Justice for various transgressions.
- ⁶⁶ Roslyn Layton, “Trump Just Extended The Huawei Ban. Is The Policy Working?,” *Forbes*, May 15, 2020, <https://www.forbes.com/sites/roslynlayton/2020/05/15/trump-just-extended-the-huawei-ban-is-the-policy-working/>.
- ⁶⁷ Jorgensen, B. (2020, July 28). For Now, Chip Gear Immune to U.S. Export Controls -. Retrieved September 18, 2020, from <https://www.eetimes.com/for-now-chip-gear-immune-to-u-s-export-controls/>
- ⁶⁸ Scissors notes that based upon this accounting, the US should calculate and apply the countervailing duties. US authorities could also put the burden of proof on Chinese enterprises, basing their ability trade with proof that they don’t receive.
- ⁶⁹ “The Logic of Collective Action — Mancur Olson, Jr.,” January 1, 1971, <https://www.hup.harvard.edu/catalog.php?isbn=9780674537514>.
- ⁷⁰ U.S. Views of China Turn Sharply Negative Amid Trade Tensions (Rep.). (2019). Washington, DC: Pew Research Center.
- ⁷¹ Toby Sterling, “ASML Sees No Impact from China Trade War, Good Growth in 2020,” *Reuters*, January 22, 2020, <https://www.reuters.com/article/us-asml-results-idUSKBN1ZL1YQ>.
- ⁷² Criteria for Security and Trust in Telecommunications Networks and Services (Rep.). (2020). Washington, DC: CSIS.

-
- ⁷³ Lewis, J. A. (2020). *Managing Semiconductor Exports to China* (Publication). Washington, DC: Center for Strategic and International Studies.
- ⁷⁴ Lewis, J. A. (2020). *Managing Semiconductor Exports to China* (Publication). Washington, DC: Center for Strategic and International Studies.
- ⁷⁵ Layton, R. (2020, September 07). State Department's 5G Clean Network Club Gains Members Quickly. Retrieved September 18, 2020, from <https://www.forbes.com/sites/roslynlayton/2020/09/04/state-departments-5g-clean-network-club-gains-members-quickly/>
- ⁷⁶ Aaron L. Friedberg & Charles W. Boustany Jr. (2020) Partial Disengagement: A New US Strategy for Economic Competition with China, *The Washington Quarterly*, 43:1, 23-40, DOI: [10.1080/0163660X.2020.1736882](https://doi.org/10.1080/0163660X.2020.1736882)
- ⁷⁷ Aaron Friedberg, "The United States Needs to Reshape Global Supply Chains," *Foreign Policy* (blog), accessed September 28, 2020, <https://foreignpolicy.com/2020/05/08/united-states-reshape-global-supply-chains-china-reglobalization/>.
- ⁷⁸ Aaron L. Friedberg, "An Answer to Aggression," September 15, 2020, <https://www.foreignaffairs.com/articles/china/2020-08-11/ccp-answer-aggression>.
- ⁷⁹ Bob Davis, "Pentagon Blocks Clampdown on Huawei Sales," *Wall Street Journal*, January 25, 2020, sec. Politics, <https://www.wsj.com/articles/pentagon-blocks-clampdown-on-huawei-sales-11579870801>.
- ⁸⁰ Trump again raises idea of decoupling economy from China. (2020, September 08). Retrieved September 18, 2020, from <https://www.reuters.com/article/us-usa-trump-china/trump-again-raises-idea-of-decoupling-economy-from-china-idINKBN25Y1V9>
- ⁸¹ Witt, M. (2020, August 17). Prepare for the U.S. and China to Decouple. Retrieved September 18, 2020, from <https://hbr.org/2020/06/prepare-for-the-u-s-and-china-to-decouple>
- ⁸² Layton, R. (2020, September 07). State Department's 5G Clean Network Club Gains Members Quickly. Retrieved September 18, 2020, from <https://www.forbes.com/sites/roslynlayton/2020/09/04/state-departments-5g-clean-network-club-gains-members-quickly/>
- ⁸³ The White House, President Barack Obama. (2017, January 9). Ensuring U.S. Leadership and Innovation in Semiconductors [Press release]. Retrieved from <https://obamawhitehouse.archives.gov/blog/2017/01/09/ensuring-us-leadership-and-innovation-semiconductors>
- ⁸⁴ "U.S. Commerce Control List, Supplement No. 1 to Part 774, Category 3," (Washington, DC: Bureau of Industry and Security, May 23, 2019), 38-39, <https://www.bis.doc.gov/index.php/documents/regulations-docs/2334-ccl3-8/file>
- ⁸⁵ Annual Industrial Capabilities Report to Congress (Rep.). (2016). Washington, DC: Office of the Undersecretary of Defense.
- ⁸⁶ "Understanding the Market for 4G RAN in Europe: Share of Chinese and Non-Chinese Vendors in 102 Mobile Networks," *Strand Consult* (blog), June 6, 2020, <https://strandconsult.dk/understanding-the-market-for-4g-ran-in-europe-share-of-chinese-and-non-chinese-vendors-in-102-mobile-networks/>. "The Real Cost to Rip and Replace Chinese Equipment from Telecom Networks," *Strand Consult* (blog), June 19, 2019, <https://strandconsult.dk/the-real-cost-to-rip-and-replace-chinese-equipment-from-telecom-networks/>.
- ⁸⁷ Scott Bicheno, "Huawei Threatened to Pull Investment from Denmark in Response to New Screening Law," *Text, Telecoms.com*, May 14, 2020, World, <https://telecoms.com/504302/huawei-threatened-to-pull-investment-from-denmark-in-response-to-new-screening-law/>.
- ⁸⁸ Murgia, M. (2020, March 27). Inside China's controversial mission to reinvent the internet. Retrieved September 22, 2020, from <https://www.ft.com/content/ba94c2bc-6e27-11ea-9bca-bf503995cd6f>
- ⁸⁹ Network 2030 and the Future of IP. (n.d.). Retrieved 2020, from http://prod-upp-image-read.ft.com/eff4a82a-70e6-11ea-95fe-fcd274e920ca?_sm_au_=iVVhJsqn3MRT60cH01TfKK3Qv3fc4
- ⁹⁰ Sector, T. (2017-2020). *New IP, Shaping Future Network* (Rep.). Geneva: International Telecommunication Union.
- ⁹¹ Baron, J. (2019, April 08). Cyber-Sovereignty and China's Great Firewall: An Interview With James Griffiths. Retrieved September 22, 2020, from <https://www.forbes.com/sites/jessicabaron/2019/04/08/cyber-sovereignty-and-chinas-great-firewall-an-interview-with-james-griffiths/>
- ⁹² Varas, A., & Varadarajan, R. (2020). *How Restrictions to Trade with China Could End US Leadership in Semiconductors* (Rep.). Boston, MA: Boston Consulting Group.
- ⁹³ Rossini, M. (2016, October 30). *US Tech Companies and Their Chinese Partners With Military Ties*. Retrieved September 18, 2020, from <https://www.nytimes.com/search?query=%22US+tech+companies+and+their+Chinese+partners+with+military+ties%22>

⁹⁴ VerWey, John, Chinese Semiconductor Industrial Policy: Past and Present (July 2019). United States International Trade Commission Journal of International Commerce and Economics, July 2019, Available at SSRN: <https://ssrn.com/abstract=3441951>

⁹⁵ VerWey, John, Chinese Semiconductor Industrial Policy: Prospects for Future Success (August 2019). United States International Trade Commission Journal of International Commerce and Economics, August 2019, Available at SSRN: <https://ssrn.com/abstract=3441959>

⁹⁶ GAO, Rapid Advances in China's Semiconductor Industry, 2002, 2–3.