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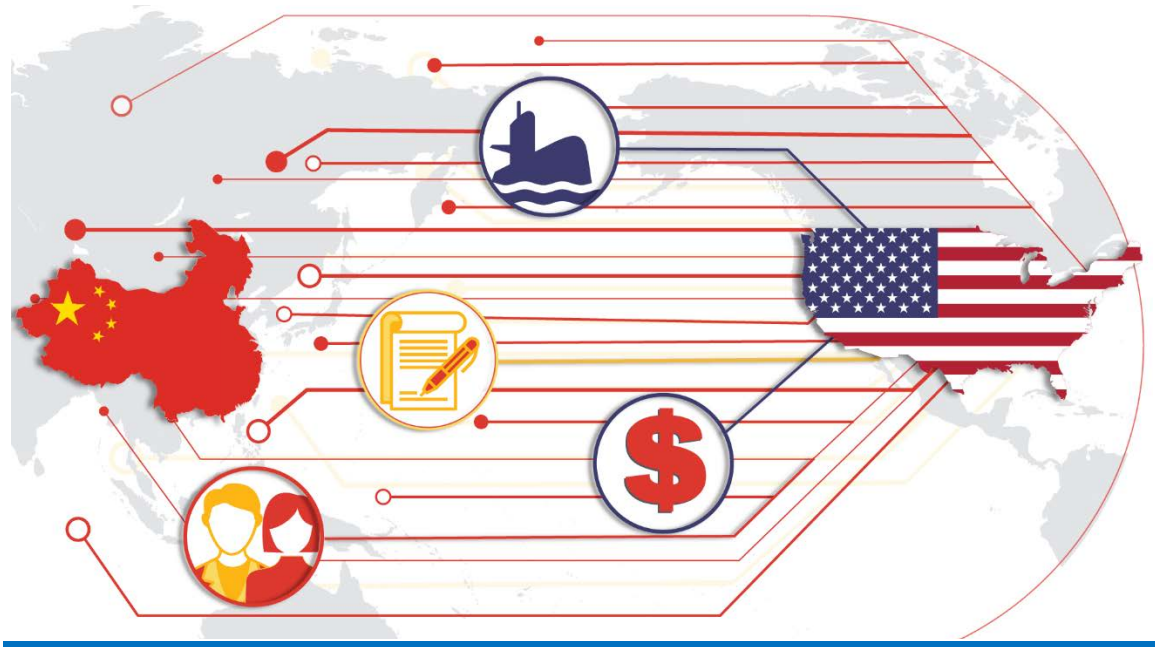

Economic Statecraft: How China Legally Accesses Foreign Technologies to Build Military Capabilities

Rose Tenyotkin, April Herlevi, Alison Kaufman, and Anthony Miller

Graphics created by Sue N. Mercer.

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Abstract

The People's Republic of China (PRC) pursues its national security objectives through a wide variety of cross-domain activities. The PRC's legal economic statecraft activities are connected directly to China's growing military power. China's legal means of obtaining technology damages the technological superiority of the United States and its partners and allies. This report illustrates the pathways by which China legally acquires foreign technology and builds capabilities to support its national security objectives. These pathways include: (1) trade, (2) market access requirements, (3) overseas investment, and (4) the transfer of human capital.

This report also identifies key challenges for the United States in countering China's efforts. First, the PRC is ambitious and adapts it economic techniques to deal with changing regulatory environments. Second, the United States has multiple "leakage points" that provide avenues for the PRC to access emerging technology. Third, China offers appealing incentives that put the US and other countries as risk of technology loss. Thus, a comprehensive strategy for technology protection is needed to address China's foreign technology acquisition.

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Maryanne Kivlehan-Wise, Director
China Studies Program
CNA China & Indo-Pacific Security Affairs Division

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Executive Summary

This report provides an overview of the legal economic tools that the People's Republic of China (PRC) uses to obtain foreign technology and build capabilities in support of China's national security objectives. The report is intended to help readers recognize the means by which China's government, affiliated firms, and/or individuals attempt to access sensitive technologies and knowledge in ways that undermine the security and commercial interests of target nations.

Key findings

China uses a multifaceted approach to develop defense capabilities that fuses both legal and illegal acquisition of foreign technologies, reverse engineering, and indigenous production. Some key aspects of this approach include:

- Acquiring technology from foreign countries to provide China with a model to study, test, learn from, and then replicate.
- Reverse engineering foreign weapons or technology in order to build China's own indigenous capability.
- Integrating civilian and military sectors, allowing China to repurpose civilian technologies into military capabilities.

Many of China's tools for acquiring foreign technology are legal. Although China has engaged in illegal activities to support its military modernization, the PRC uses a wide range of legal economic tools at its disposal.

China's targets for technology acquisition are tied directly to PRC national strategic objectives. Publicly available PRC government planning documents, such as Five-Year Plans and *Made in China 2025,* identify priority industries and capabilities for development, including advanced technologies such as aerospace, biotechnology, and maritime equipment. China's state-driven effort to fuse civilian and military resources to achieve PRC national security goals complicates US responses.

The stakes are high for the United States and its partners and allies. China's legal economic statecraft activities are directly connected to the PRC's growing military power—and to other countries' loss of technology and intellectual property (IP).

- China's ability to access critical technology could erode the technological superiority of the US military and the defense industrial base of the US and its partners and allies.
- Countries at the leading edge of scientific and defense research are vulnerable to having their IP accessed through a wide range of PRC economic activities.

China's legal economic toolkit for acquiring technology

We identified four categories of economic tools that China uses to access foreign technologies:

Trade: China buys technology

China has legally purchased weapons systems and components from abroad to create a foundation for developing indigenous capabilities. Historically, China has relied on Russian arms purchases to fill gaps in its defense capabilities. Although Russia remains China's largest arms provider, the overall patterns of China's arms purchases are shifting:

- **China is moving from the purchase of whole systems to purchasing individual parts and components from a variety of countries.** Such purchases are focused especially on parts such as engines and sensors, which China is not yet able to produce indigenously.
- **China is increasingly purchasing commercially available dual-use technology,** such as autonomous vehicles. Because some items are not considered dual-use in their countries of origin, they are not necessarily subject to export control restrictions.

Market access requirements: China bargains for technology

The appeal of the Chinese market allows the PRC government to establish extensive administrative requirements for foreign companies that wish to do business in China.

- Chinese licensing agreements often require foreign companies to disclose their IP, so that foreign knowledge is transferred to Chinese entities.
- Foreign companies that license their technologies to Chinese companies risk losing ownership of the technology both while the agreement is ongoing and after it has expired.

Overseas investment: China bets on technology acquisition

China may access emerging technology by investing in foreign firms. China's government actively encourages investment in foreign firms specializing in high technology, advanced manufacturing, information technology, machinery and robotics, aerospace and aviation equipment, and maritime engineering and vessel manufacturing.

- Chinese firms seeking to acquire or gain access to foreign companies may use complex and varying corporate structures that can disguise a firm's investors, obfuscate ultimate ownership, and evade investment controls.

Human capital: China uses people to access technology

China leverages US-based experts in the public and private sector to gain access to US knowledge and technology. In exchange, the PRC provides financial and other benefits to US experts. The PRC government sponsors recruitment programs, encourages joint research collaborations, and offers dual academic affiliations to gain access to foundational US research—potentially including Department of Defense-funded research.

Key challenges in countering China's technology acquisition

The PRC uses the tools of economic statecraft across multiple domains, regions, organizations, and individuals. Key challenges include:

Challenge 1: China is adaptive in its use of economic leverage. China is nimble in adapting its economic toolkit to meet evolving PRC national strategic priorities and shifts in external regulatory environments. As the US and other nations have erected barriers to China's attempts to access sensitive technologies, China has found new ways to overcome or evade these regulations. China's state-driven effort to fuse civilian and military resources complicates US responses because the end user for a technology is not always obvious.

Challenge 2: There are multiple US "leakage points" through which sensitive technologies can flow to China. The US is an open society that encourages innovation. US technology is developed, and can be accessed, from multiple points across the economy. Three key "leakage points" that are vulnerable to Chinese exploitation are:

- **Industry:** US firms developing new and advanced technologies are attractive investment targets for PRC actors. Conversely, the importance of the "bottom line" to US firms makes China's large markets and low labor costs appealing. Thus, some firms may be willing to give up some IP to enter Chinese markets.
- **Academia:** US universities value open research environments and international collaboration, providing opportunities for PRC state-directed actors to access cutting-edge research. In addition, declining US research funding makes Chinese offers of funding, lab space, and other incentives attractive to many US researchers.
- **Partners and allies:** Chinese companies have been known to route investments through third-party countries. Different standards and laws across the US, Europe, and other advanced industrial economies allow China to shop around for the most permissive environments to access technology.

Challenge 3: China offers appealing incentives. China offers a range of appealing incentives to industry, academia, and partners and allies that make it difficult to close the leakage points. To encourage technology protection, the US and its allies will have to consider incentives and arguments that appeal to the interests of each of these communities.

Recommendations

The US government should continue to encourage research and development but must also remain cognizant that the United States' open environment creates challenges for US national security, defense innovation, and the protection of IP. China's state-directed effort to acquire technology takes advantage of some of the best aspects of the US economy, academic environment,

and openness with partners and allies. In response, the US should enact a comprehensive strategy for protecting critical technologies with national security and defense uses, while remaining an open and transparent hub for technological innovation. Some initial recommendations include:

- **Raise awareness:** For partnering with industry, the US will need to ensure companies understand the financial costs they bear from losing their technology and IP. For their part, companies in the national security arena or in emerging technology sectors will need to remain diligent in evaluating their investors and joint venture partners.
- **Create incentives:** For industry partners to be able to protect technology that has national security implications, appropriate incentives need to be in place. For academics, incentives such as prestige and research funding need to be considered in strategies to promote protection of foundational research that could have national security implications.
- **Strengthen coordination mechanisms:** The US government, industry partners, academics, and allied countries will need to work together to protect critical technologies. Greater harmonization of export controls and investment screening will require appropriately resourced coordination mechanisms to ensure compliance across these many distinct stakeholders.

Contents

1. Introduction

This report provides an overview of the legal economic tools that the People's Republic of China (PRC) uses to acquire foreign technology and build defense capabilities in support of its national security objectives and in ways that potentially harm the interests of the United States.

As China's military modernizes, it requires knowledge and technology from more advanced militaries to meet its ambitious goals. **Part of China's strategy for developing its military capabilities involves a multifaceted approach that fuses foreign acquisition, reverse engineering, and indigenous production.**

This report focuses on the sometimes-overlooked *legal* economic pathways that China uses for acquiring foreign technologies. These pathways represent forms of *economic statecraft*—which we define as "the use of economic resources by political leaders to exert influence in pursuit of foreign policy objectives"—and they play a central role in China's development of domestic capabilities in critical security domains including maritime technology, semiconductors, and aerospace.[1]

The stakes for the US and other nations are high. China's ability to access critical technologies could erode the technological superiority of the US military as well as the defense industrial base of the US and its allies and partners. Countries at the leading edge of scientific and defense research are vulnerable to having their intellectual property (IP) accessed through a wide range of PRC means that are legal and sometimes quite overt.

This report is intended to help readers recognize the means by which China's government, affiliated firms, and/or individuals attempt to access sensitive technologies and knowledge in ways that undermine the security and commercial interests of target nations. The report addresses four main categories of economic statecraft that China has used for technology acquisition. They include the following:

1. Trade (buying technology)
2. Market access requirements (bargaining for technology)
3. Overseas investment (betting on technology)
4. Human capital (boosting technology talent)

Background: Using economic statecraft to achieve national development

The use of economic statecraft to access technology from abroad has been deeply ingrained in China's approach to development since the beginning of the Reform Era in 1978. Starting in the late 1970s, PRC leadership made the decision to open China to foreign investors in part so the country could gain access to foreign technology and know-how. Deng Xiaoping, China's "paramount leader" and architect of China's initial economic reforms, frequently stated that China should target advanced industrial countries to acquire technology for both defense needs and overall economic growth.[2] China's explosive economic development over the four decades since gave the PRC government ever more sophisticated tools to achieve these goals.

A key target for such efforts is foreign technologies that could benefit China's military modernization. China's acquisition of foreign defense technology serves two purposes. First, it alleviates some of China's immediate defense needs in support of national objectives. Second, it provides China's manufacturing base with a prototype to study, reverse engineer, and develop as a foundation for building future indigenous capabilities.

In recent years, this process has been accelerated by China's state-driven effort to fuse civilian and military resources. This effort was formalized at the 18th Chinese Communist Party (CCP) National Party Congress in 2012, when President Xi Jinping announced a national strategy of "civil-military integration." This strategy brings together military and civilian industries and resources for simultaneous economic and defense development, making it increasingly difficult for outside observers to discern the ultimate end users for technologies that the PRC acquires from abroad.[3]

PRC national technology priorities

How do Chinese entities know which foreign technologies to target? China uses national strategic guidance to encourage government ministries, state-owned and private firms, and other PRC actors to access and develop key technologies. Much of this guidance is publicly available. For example, to discern China's national priorities for economic and technological development out to 2025, we can examine two policy documents that the PRC central government issued:

- The *13th Five-Year Science and Technology Innovation Plan,* along with its sub-sets
- *Made in China 2025* (MIC 2025)

13th Five-Year Science and Technology Innovation Plan

On March 16, 2015, the PRC's State Council promulgated the *13th Five-Year Plan,* a central government blueprint for national development during the 2015–2020 time period.[4] Five-Year Plans set national priorities for economic development and are the benchmark for government performance. Under this overarching *13th Five-Year Plan* are sector-level plans that outline in greater detail specific benchmarks and plans for how China will achieve its objectives. For example, the Ministry of Science and Technology (MOST) published the *13th Five-Year Science and Technology Innovation Plan,* which sets research and development (R&D) goals for government industries. Table 1 shows the targets outlined in that plan.

Table 1. The 13th Five-Year Science and Technology Innovation Plan targets

Key Sectors for Development	2015	2020
China's global innovation ranking	18	15
Research and Development Funding (as a % of GDP)	2.1	2.5
Contribution of Science and Technology to Economic Growth (%)	55.3	60
Number of R&D personnel per 10,000 people employed per year	48.5	60
Global ranking for science and technology papers citations	4	2
Patents filed per 10,000 people	6.3	12

Source: State Council of the People's Republic of China, *13th Five-Year Science and Technology Innovation Plan*, August 8, 2016.

Nested within the *13th Five-Year Science and Technology Innovation Plan*, in turn, are industry-level plans such as the *13th Five-Year Plan for Technology Innovation in Marine Areas*, which describes specific technologies that China seeks to develop in service of its broader objectives.[5] As an example, Table 2 summarizes some of the maritime-related technologies identified in the *13th Five-Year Plan for Technology Innovation in Marine Areas*.

China's 14th Five Year Plan, which will cover 2021 to 2025, may include updates to these targets; as of the time of writing no release date for that plan had been announced.

Table 2. Technology targets in the 13th Five-Year Plan for Technology Innovation in Marine Areas

Technology
Deep Sea Stations
Autonomous and Remotely Controlled Vehicles and Key Frontier Technologies
Submersible Operation Capacity and Depth of 1,000–7,000 meters
Far-Sea Nuclear Platform Technologies
Marine Observation/Monitoring Sensor Technologies
Marine Environmental Quality Integrated Monitoring Platform
Independent Numerical Forecasting Model
Near-Shore Monitoring/Early-Warning Technologies
Marine Environment Security Safeguard System Platform Prototypes
Deep-Water Oil and Gas Exploration
Collection and Transportation Equipment
Seawater Desalination

Source: State Council of the PRC, *13th Five-Year Plan for Technology Innovation in Marine Areas*.

Made in China 2025 (MIC 2025)

Adopted by the State Council in 2015, the MIC 2025 plan is a 10-year blueprint for building China's indigenous production capabilities. MIC 2025 emphasizes the importance of expanding China's high-tech sectors and producing advanced technology domestically.[6] MIC 2025 also prioritizes specific industries for government support. Table 3 shows the 10 priority industries.

Table 3. *MIC 2025* priority industries

Key Industries	
New energy and energy-saving vehicles	New generation information technology
Biotechnology	New materials
Aerospace and astronautics	Maritime equipment and technology
Robotics	Advanced rail transportation equipment
Energy equipment	Advanced agricultural equipment

Source: State Council of the PRC, *Made in China 2025,* May 8, 2015.

From Acquisition to Capability

Reverse engineering is the connective tissue bridging China's acquisition of foreign weapons or technology to building an indigenous capability. China's acquisition of technology and knowledge from abroad is only the starting point for building a new or improved military capability. Technology acquired from foreign countries provides a model for the People's Liberation Army (PLA) to study, test, learn from, and eventually reverse engineer. The end result may be a weapon or technology that is a near-replica of the original, but with "Chinese characteristics." As this report will show, PLA has made near-replicas of foreign models and also acquired parts and components that help fill gaps in China's indigenous capabilities.

China's deliberate integration of military and civilian sectors through government policies such as the *13th Five Year Plan* and MIC 2025 creates an even easier pathway for technology from abroad to make its way into the PLA since commercial products may not trigger export controls or other restrictions on military technology.

Reverse engineering, although at times considered illegal depending on the licensing agreement, can be entirely legal when authorized under appropriate agreements. When legal methods are combined with illicit activities, such as hacking and other types of data breaches, the information gained can contribute to PRC military capabilities. We focus on the legal pathways, but the combination of activities all have the potential to contribute to indigenous production. The rest of this report identifies and describes the main legal pathways.

2. Trade: Buying Technology

Key findings

The first, and earliest, pathway by which China has acquired weapons and military technology from abroad is through trade, or the legal purchase of arms. This section focuses on China's legal purchase of arms and dual-use technology as a means to acquire weapons and military technology from abroad.

- *Legally purchasing weapons systems, components, or dual-use technology from abroad has enabled China to modernize its military and build indigenous capabilities.* These purchases are often the first step in China's process of building indigenous capabilities through reverse engineering, and often result in a weapon or technology that is a near-replica of the original but with "Chinese characteristics."
- *As China's indigenous capabilities have improved, and as foreign nations have restricted weapons sales to the PRC, China's purchasing patterns have shifted.*
    - China is shifting from the purchase of entire platforms and weapons systems, such as aircraft and submarines, to purchasing components, such as engines and sensors, which can be used with indigenously developed capabilities.
    - China is increasingly purchasing commercially available dual-use technology and parts.

Arms purchases

Advances in China's indigenous production capabilities and military modernization can be linked directly to Chinese legal arms purchases from abroad.[8] The outright purchase of weapons systems, components, and parts provides China with both a technology that can support its immediate defense needs and a prototype that can be reverse engineered to build indigenous production capabilities in the longer run.

> "We should seize the opportunity . . . to make a substantial study of all kinds of foreign machines and weapons in order to learn their secret completely."[7]
>
> — 19th-century Chinese official

Although China has imported arms and military technologies from a number of countries, Russia (or, formerly, the USSR) has been China's primary supplier of conventional arms and weapons systems for the past 70 years.[9] According to 2019 Stockholm International Peace Research Institute (SIPRI) data, since the 1950s, Russia/the USSR has accounted for 87 percent

of China's arms imports.[10] Examples of weapons and systems purchases from Russia that have contributed to significant improvements in China's defense technological base include the following:

- Su-30MKK multirole fighter aircraft
- Kilo-class submarine
- SS-N-22/Sunburn supersonic antiship cruise missile (ASCM)
- S-300 air-defense system
- Sovremenny-class destroyers[11]

China has also purchased military equipment and technology directly from a variety of other countries, including France, Israel, Italy, and even the US.[12] During a brief window from 1981 to 1989, the US and the European Union (EU) contributed to China's defense capabilities by selling it an array of arms and military equipment, including transport helicopters, gas turbine engines, and antisubmarine warfare (ASW) torpedoes.[13]

In the wake of the 1989 Tiananmen Square Massacre, this window for arms purchases largely closed when the US and the EU imposed arms embargoes on China. However, the embargo did not represent a complete cessation of arms sales from the West. The EU allows each individual member state to determine the definition of "arms embargo" and set its own national regulations, leading to a variety of interpretations.[14] Some nations do not consider all technologies with potential military application to fall under the embargo. Thus, they have continued to export arms to China in the post-1989 period, including French ASW helicopters and UK airborne early warning radar.

Illustration: Improving China's antiship capabilities through direct purchases of submarines and cruise missiles

China's purchases of Kilo-class submarines and accompanying equipment provide a useful illustration of how legal arms sales have helped China alleviate immediate gaps in its capabilities, enhance domestic production through reverse engineering, and upgrade its antiship capabilities.[15]

The Kilo-class submarine is a diesel-electric, single-shaft vessel with a double hull, designed primarily for antiship and antisubmarine warfare.[16] Between the 1990s and the early 2000s, China purchased 12 Kilo-class submarines from Russia.

The PLA Navy (PLAN) received the first two submarines in 1995, and Russia delivered two improved versions in 1997 and 1998.[17] These first four Russian submarines apparently served as a foundation for Chinese indigenous production: in 2004, China launched the Type 039A Yuan-class submarine, which appears to be a reverse engineered, near-replica of the Kilo. Open-source imagery analysis of China's Yuan-class submarine indicates that its hull bears a strikingly similar design to that of the Kilo-class submarine.[18]

Similarly, in a 2002 deal, China agreed to purchase eight additional Kilo-class submarines from Russia, each of which came equipped with the Russian SS-N-27B "Sizzler" (3M-54E "Klub"), an advanced antiship cruise missile (ASCM).[19] In 2015, China deployed its latest indigenous ASCM, the YJ-18, on the Type 052D Luyang III–class DDG. Several reports indicate that the YJ-18 is a sophisticated replica of the "Sizzler."[20]

Figure 1. Kilo-class submarine

Source: WikiMedia Commons.

Purchase of dual-use technology

When arms embargoes or other restrictions mean that outright purchase of arms is impossible, China has increasingly been able to exploit dual-use technologies to further the development of the PLA's next-generation military capabilities.[21] China's purchase of dual-use technology has helped it to develop many of its key defense technologies, including artificial intelligence, aerospace, unmanned aerial vehicles, nuclear, and aviation capabilities.

The blurred line between the defense and civilian sectors is leading to increased concerns from other nations over China's acquisition of dual-use technology. For example, the US Department of Commerce requires that dual-use technology be licensed prior to export, to ensure that an item is delivered only to commercial, nonmilitary entities.[22] However, China's civil-military integration policy makes determining the end user for a product significantly more difficult.

Two examples help illustrate how China has exploited dual-use technologies to improve defense capabilities. The first example is China's purchase of civilian-use helicopter engines from two French-based aviation companies, Turbomeca and Eurocopter, which were later placed into PLA Army and PLAN helicopters.[23] The French companies claim that the items exported were not classified as military and that sales proceeded with the full approval of French authorities.[24]

Figure 2. Eurocopter EC 155 Dauphin

Source: WikiMedia Commons.

A second example is China's purchase of a civilian nuclear reactor that could, in theory, help the PLAN develop indigenous nuclear submarine technology. In 2007, Westinghouse Electric Company, a US-based firm, signed a multibillion-dollar deal with China's government-owned State Nuclear Power Technology Corporation to construct four AP-1000 pressurized water reactors in China. In 2008, two former US Navy nuclear submarine officers and analysts working for the US Department of Energy reported that, while significant engineering would be required, it is possible to adapt several of the advanced components of the AP-1000 reactor design, such as reactor coolant pumps, for use in China's nuclear submarine program.[25]

Such transactions are possible because the end-user for dual-use technology is not always clear, and because of variation in individual nations' approaches to restricting arms sales to China. In 2015, EU spokesperson Michael Mann noted that the EU arms embargo on China does not apply to dual-use technology.[26] For example, China's domestically produced Song- and Yuan-class submarines incorporate engines imported from abroad under the auspices of civilian use, such as those built by German firms MTU and Man Diesel and Turbo.[27]

Table 4 highlights China's publically identified purchases of weapons and defense components from countries *other than Russia* between 1982 and 2018. Notably, many of these purchases have taken place during the embargo period. To close this avenue completely, future multilateral arms embargoes would need to include specific definitions of key terms and uniform enforcement policies for all participating members.

Table 4. Chinese foreign arms purchases (excluding Russia/USSR), 1982–2018

Supplier	Weapon	Year(s) of Delivery
Belarus	Transport aircraft	2013
France	Diesel engines	2004
France	Antisubmarine warfare (ASW) sonar	1993–2001
France	Sea Tiger air/sea search radar	1987–2006
France	AS-365F ASW helicopter	1989–2018
France	Diesel engine	1992–2005
France	Castor-2 fire control radar	1993–2005
France	AS-350 light helicopter	1995–2011
France	ASA-321 Super Frelon heavy transport helicopter	2001–2016
France	Multiple diesel engines	2005–2019
Germany	BF8L diesel engine	1982–2018
Germany	MTU-1163 diesel engine	1993–2007
Germany	BF-12L413 diesel engine	1996–2000
Germany	MTU-396 diesel engine	2001–2006
Germany	MTU-1163 diesel engine	2013–2015
Germany	MTU-956 diesel engine	2014–2018
Israel	Short-range air-to-air missile (SRAAM)	1990–2001
Switzerland	Anti-aircraft gun	1997–2018
Switzerland	Fire control radar	1997–2018
Ukraine	Self-propelled gun	2000
Ukraine	SRAAM	2000
Ukraine	Air search system	2002
Ukraine	Aircraft carrier	2012
Ukraine	Gas turbine	2014
Ukraine	Turbofan	1997–2004
Ukraine	Beyond-visual-range air-to-air missile (BVRAAM)	2000–2009
Ukraine	Gas turbine engine	2004–2007
Ukraine	Turbofan engine	2005–2009
Ukraine	Amphibious combat vehicle (ACV)/landing craft	2012–2017
Ukraine	Diesel engine	2013–2014
Ukraine	Gas turbine	2013–2018
Ukraine	Turbofan	2013–2018
United Kingdom	Airborne early warning (AEW) radar	1999–2001
United Kingdom	Turbofan	2000–2005
Uzbekistan	Transport aircraft	2015–2016

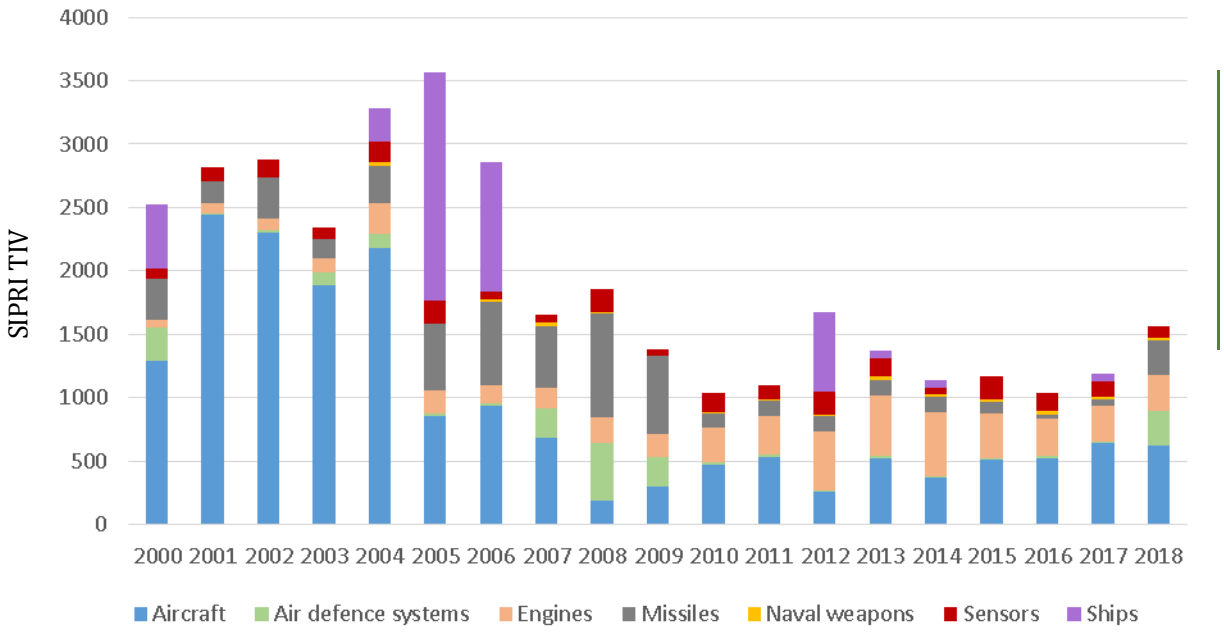
Source: SIPRI, "Importer/Exporter TIV Tables," SIPRI Arms Transfer Database, August 8, 2019, http://armstrade.sipri.org/armstrade/page/values.php.

Trends in Chinese arms purchases

As China's indigenous manufacturing and production capabilities have improved, the PRC's overall arms imports have declined.[28] Arms sales are now a less dominant aspect of China's foreign defense technology acquisition relative to other approaches discussed in this report. Since their peak in 2005, the total value of China's arms imports has decreased by about 50 percent. China's purchases of naval platforms, warships, and aircraft have all declined. Indicative of this trend, the last complete warship China purchased from Russia was in 2002; China purchased an incomplete warship from Ukraine in 2012.[29]

Figure 3 illustrates trends in Chinese arms imports from their peak in 2005. In 2017–2018, aircraft remained the largest imported systems (although well below their peak in the early 2000s), followed by air defense systems, engines, and missiles.[30]

Figure 3. China's global arms imports, 2000–2018[a]



Source: SIPRI Arms Transfer Database, http://armstrade.sipri.org/armstrade/page/values.php.
[a] TIV or "trend-indicator value," is a common unit developed by SIPRI to measure the volume of international transfers of major conventional weapons.[32]

China's arms imports are increasingly focused on parts and components that it can incorporate into largely indigenously produced systems. As shown in Figure 3, China's purchase of parts, such as engines and sensors, are often not subject to the same restrictions that complete systems may face.[33] The purchase of parts is a prominent part of China's efforts and this trend seems likely to continue.

The willingness of some companies to ignore potential dual-use application of their products means that Chinese military and domestic defense industries can acquire such technologies on the commercial market.[34] In this way, both China and foreign companies are able legally to evade the intent of international regulations without violating the letter of the law. In discussing the EU-China Civil Aviation Cooperation Project, which dates back to 1999, Dr. May-Britt U. Stumbaum, director of Berlin-based NFG Research Group, writes "from the Europeans' viewpoint, opportunities lie in market access." [35] Her report added that security concerns over the dual-use potential of a product are often secondary to companies' commercial concerns about access to China's large market, low labor costs, and investment opportunities.[36]

3. Market Access: Bargaining for Technology

Key findings

A second approach China uses for accessing foreign technologies is to establish licensing requirements for foreign companies seeking entry to the Chinese market.

- *The size of the Chinese market and its relatively low labor costs make it an attractive target for foreign investment and manufacturing.*
- *As a requirement of entry, the Chinese government has established licensing processes that enable Chinese entities to gain access to a foreign company's sensitive technological information.*
- *Evidence suggests that foreign firms have little control over where their technology goes within China once the technology leaves their hands.* Foreign companies that license their technologies to Chinese companies risk losing ownership of the technology, while the agreement is ongoing and after it has expired.

This approach, which we call "bargaining for technology," is deliberate. In the 1990s, the PRC coined the term "'market for technology' strategy," through which China developed foreign investment regulations with the intent of obtaining technology from foreign investors.[37] By the 2000s, the Chinese government had successfully established a broad range of regulations, many of which require the disclosure of IP and necessitate the transfer of foreign technology or knowledge to Chinese entities in exchange for market access. Foreign companies are often willing to navigate those requirements in exchange for entry to the lucrative Chinese market.

In this section, we discuss two types of licensing the PRC uses to access foreign technology from foreign firms seeking to do business in China:

- **Administrative licensing:** A license required for a foreign company to operate legally in another country. The Chinese government has established extensive administrative licensing procedures for foreign companies seeking to enter the Chinese market, which require foreign companies to reveal sensitive business information, proprietary technology, or other know-how in exchange for a license to operate in the country.
- **Technology licensing:** A license that allows a licensee (domestic company) to use a foreign company's (licensor) technology under agreed-upon conditions. China uses opaque language in technology licensing agreements to gain access to foreign IP.

Administrative licensing

As part of its administrative licensing process, the PRC often uses extensive disclosure requirements and expert review panels that require foreign firms to transfer sensitive technological information in exchange for access to Chinese markets.

China is not alone in requiring administrative licensing for access to its domestic market. However, foreign companies seeking to conduct business in China have expressed major concerns over China's administrative licensing process.[38] In particular, two aspects of China's licensing process that force foreign companies to reveal technical information are:

- *Disclosure requirements*, which require foreign companies to reveal sensitive technical information as a condition of the approval process, allowing Chinese regulators to transfer foreign technologies and knowledge to Chinese entities.[39]
- *Expert review panels,* which are necessary to obtain administrative approval and often require foreign companies to disclose proprietary information when providing documentation to the review panel.[40]

Expert review panels are particularly useful tools for China to access proprietary information. The experts on the review panels are responsible for reviewing documentation submitted by the foreign company. In theory, the panel members are selected for their expertise in the field. In practice, the Chinese government holds the authority to appoint members to the review panels, and in the past has included experts affiliated with a competing domestic company.[41]

For example, in 2019 Bloomberg News reported on a Chinese expert panel review of Huntsman Corporation, a US chemical manufacturing company seeking a license to enter the Chinese market. The report noted that, as part of the licensing process, a Huntsman representative was required to go before a Chinese expert review panel and turn over sensitive information on the company's chemicals, formulas, and production processes. Not long afterward, Huntsman discovered that a Chinese competitor was using Huntsman's proprietary technologies to manufacture its own products.[42]

Technology licensing

China's technology licensing agreements are often structured to grant Chinese firms legal access to foreign technology without allowing the foreign entity to change the contract language. A technology licensing agreement is a contract between two parties in which a licensor (foreign company) of a specific technology allows a licensee (domestic firm) to use the technology under specific, agreed-upon conditions and a set timeframe.[43]

Technology licensing provides incentives for both the foreign companies that own the technologies and the Chinese firms that wish to use them. For example:

- Smaller foreign firms can license their technologies to enter the Chinese market, which they would not otherwise be able to access.
- Larger foreign firms can license technologies to Chinese companies to avoid some of the financial and legal risk that comes when entering a new market.[44]
- Chinese firms can advance national development while avoiding the costly process of researching and developing new technologies.[45]

However, the specific requirements that China builds into its licensing regime effectively mean that foreign firms have little control over where their technology goes within China after it leaves their hands. According to the Office of the US Trade Representative, the PRC's *Regulation on the Administration of the Import and Export of Technologies* does not permit foreign companies to include any clause in technology licensing contracts that prevents the Chinese company from improving the technology and using it for its own benefit. Even after the agreement has formally ended, Chinese regulations contain language that generally allows Chinese companies to continue using the technology licenses.[46]

Illustration: Unintentionally providing microchip designs to the PLA

Technology licensing may have allowed a PRC firm with military ties to acquire advanced microchip designs from the US.

In early 2019, Sugon, a PRC-based high-performance computer manufacturer with ties to the PLA, built its next-generation supercomputer based on US semiconductor technology. The process by which it did so illustrates two tools that China uses to access foreign technology: technology licensing and Chinese investment in foreign firms (discussed in the next section of this report). In simplified form, the sequence of events was as follows:

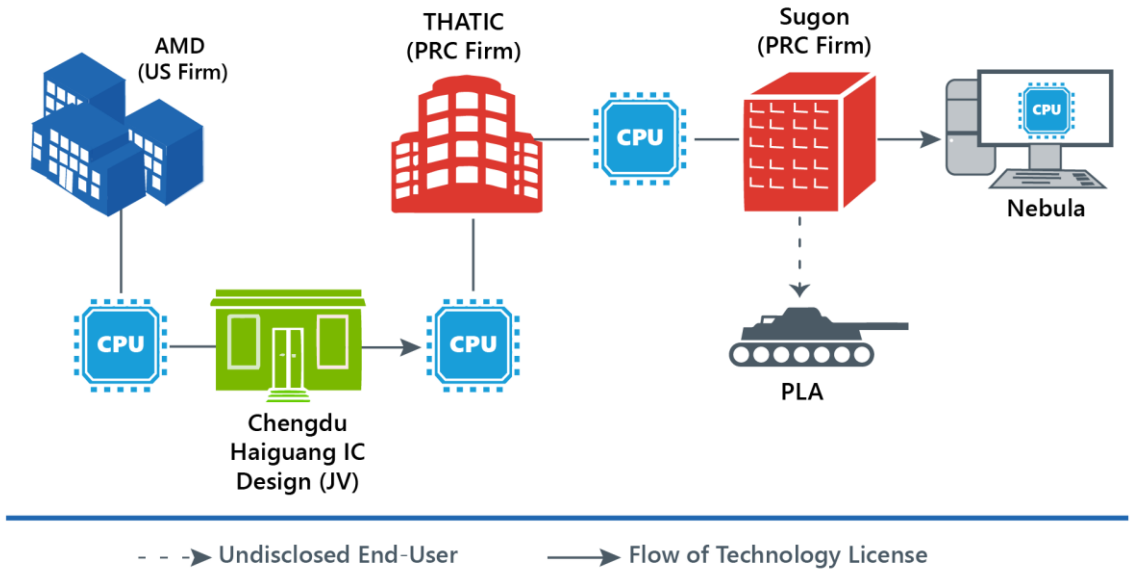
- In 2016, AMD, a US semiconductor company, created two joint ventures with a Chinese holding company, Tianjin Haiguang Advanced Technology Investment Co. Ltd. (THATIC). One of these joint ventures, Chengdu Haiguang IC Design, is majority-owned (70 percent) by THATIC, and 30 percent owned by AMD.[47]
- AMD provided THATIC, through Chengdu Haiguang IC Design, with the technology license for AMD's x86 chip designs.[48] Market observers conjectured that AMD did so to earn revenue to compete with other chip design firms, such as Intel.[49]
- Sugon is a shareholder in THATIC, and it appears that Sugon gained access to AMD chip designs through this pathway.
- In early 2019, Sugon showcased its next-generation supercomputer, Nebula, which contains more than 300 AMD x86 central processing units (CPUs) made in China.

- In June 2019, the US Bureau of Industry and Security labeled these Chinese companies a risk to national security, noting that Sugon supplies high-performance computers to the Chinese government, military, and aerospace industry.[50]
- Thus, technology licensing enabled THATIC to develop AMD CPUs domestically and, in turn, enabled THATIC's parent company Sugon to obtain the CPUs necessary for its next-generation high-performance computer.[51]

At the time they occurred, all of these actions were legal and took place openly under the terms of the licensing agreements. In response to critical press coverage of these events, AMD responded publically stating, "Starting in 2015, AMD diligently and proactively briefed the Department of Defense, the Department of Commerce and multiple other agencies within the US government before entering into the joint venture."[52] Later in AMD's statement, the company also noted that "the Department of Commerce notified AMD that the technology proposed was not restricted or otherwise prohibited from being transferred."

Figure 4 illustrates this process.

Figure 4. Sugon's pathway for chip technology access



Source: CNA graphic adapted from Pressman, "AMD Denies Improperly Giving Sensitive Chip Technology to China," June 28, 2019.

A Potential Pathway for Technology Acquisition?—Offset Agreements

Another pathway by which countries may legally acquire foreign technology is an offset agreement. Offsets include a broad range of agreements that are attached to the purchase of a defense product, such as technology transfer, training, installation assistance, or co-production rights.[53] Governments often require offsets from foreign suppliers to decrease the direct cost of defense procurement. [54]

In the past, China has used favorable offset agreements from foreign companies to build indigenous capabilities, both commercial and military. For example, the PLA's indigenous helicopters are based on technology accessed via a 1980 offset agreement with France to co-produce the French AS 365N in China.[55] By 1992, China had used the knowledge gained from that partnership to release the Z-9B variant, which was built with more than 70 percent Chinese-manufactured parts.[56] In 1994, the Z-9B entered service in the PLA.[57]

Although US policy prohibits offsets for defense procurements with China, offsets for commercial transactions are largely unregulated. While we did not find recent Chinese attempts to access US technology through commercial offset agreements, it is an avenue that should be monitored. [58]

Trends in market access

China's use of licensing procedures to gain access to foreign technologies has gained increasing attention in recent years. In 2018, a White House Office of Trade and Manufacturing Policy report labeled such practices as "coercive and intrusive regulatory gambits to force technology and IP transfer [to China]."[59]

Prompted by criticism of forced technology transfers, the National People's Congress recently passed laws and regulations governing inbound foreign direct investment (FDI). The *Foreign Investment Law* of the PRC took effect in January 2020, replacing three previous laws. The new law declares that the Chinese government "shall protect the intellectual property rights of foreign investors and foreign-funded enterprises." Article 22 specifically states that "no administrative department or its staff member shall force any transfer of technology by administrative means," and the law also states that China will establish punitive measures for IP infringements. [60] Le Keqiang, premier of the State Council of the PRC, confirmed that the law would go into effect once "matching regulations" were created. [61] According to Li Keqiang's speech at the May 2020 National People's Congress, regulations have been promulgated,[62] but it is not yet clear whether or how strictly these new rules will be enforced.

Shortly before the investment law was passed, the EU Chamber of Commerce in China argued that the language in the draft version still did not completely solve the issue of forced technology transfer, stating that it "leaves open the possibility for any non-administrative body to use any other means to compel technology transfers."[63]

4. Investment: Betting on Technology

Key findings

A third pathway China uses to access technology from abroad is through direct and indirect investments in foreign firms in ways that comport with national strategic objectives. Although levels of overall Chinese outbound FDI have been waning since their peak in 2016, foreign investment remains an important element of China's overall economic development strategy.

- *China has aligned its overseas investments with its national strategic priorities.* Chinese investment in advanced industrial economies is increasingly concentrated in officially "encouraged" sectors such as high technology, advanced manufacturing, information technology, machinery and robotics, aerospace, and maritime engineering and vessel manufacturing.[64]
- *China's approach to overseas investment has evolved to adapt to a changing regulatory environment.* As scrutiny of Chinese investment has grown in some countries, China's strategy has shifted from traditional direct investment to a variety of more creative financing vehicles.
- *China uses a wide variety of corporate structures that can disguise the identity of investors and obfuscate ownership.* This obfuscation makes it more difficult for foreign corporations and national regulatory agencies to assess the risks of technology loss that could result from Chinese foreign investment.

This section of the report focuses on China's overseas investment in two main categories:

- **Direct investments,** which include mergers, acquisitions, majority, and minority stakes in foreign companies.
- **Indirect investments,** which include venture capital funds, joint ventures, and other types of special purpose financing vehicles.

Direct investments

FDI occurs when an individual or corporation from one country purchases or invests in an enterprise in another country. Direct investment allows the investor to gain influence over the management of a company and, perhaps, access to the technology or knowledge held by that company.[65]

Differentiating between levels of investment (such as majority ownership, minority stakes, and portfolio investment) is important for FDI data collection and national statistics, but all types of direct investment could potentially enable investors to access sensitive data and technology. Types of direct investment include:

- **Mergers and acquisitions (M&A):** M&A occur when one firm purchases another. To constitute a "controlling share" of ownership, a firm must hold at least 51 percent of shares.[66]
- **Majority investments** occur when a firm is the largest single investor in a corporation, but the amount of investment does not exceed the 51 percent threshold to be considered a "controlling share."
- **Minority investments** occur when the direct investor has a share in a foreign entity but is not the largest single external investor in that firm. If the investment is less than 10 percent, it may be classified as a portfolio investment.[67]

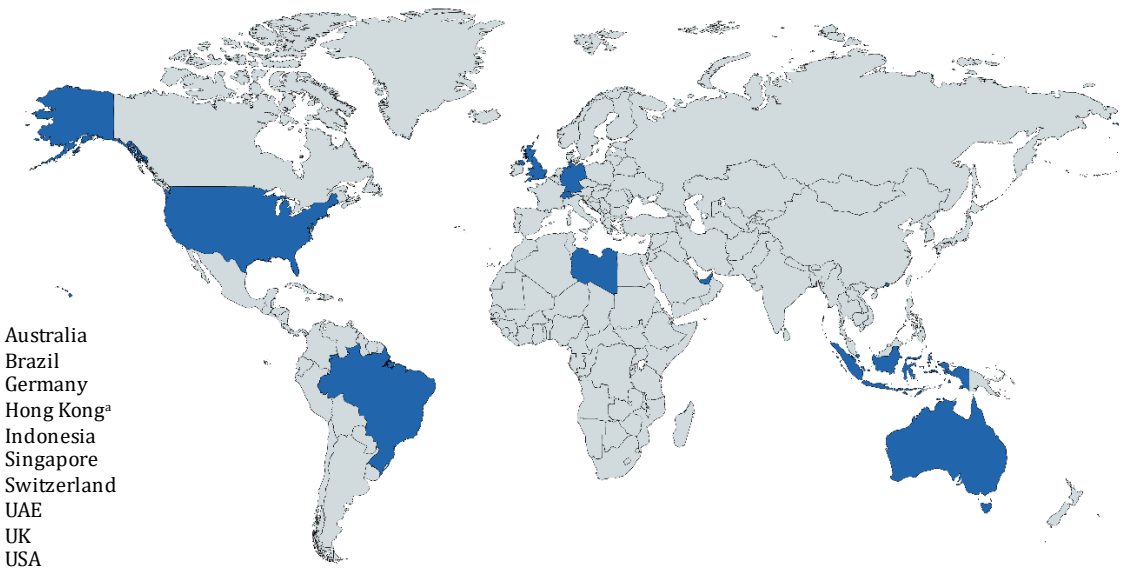
Where and how does the PRC invest?

In 2017, Chinese entities acquired foreign companies in 56 different countries, mostly in advanced industrial economies.[68] Figure 5 (next page) shows China's top 10 targets for M&A that year, based on the PRC Ministry of Commerce's *2017 Statistical Bulletin of China's Outward Foreign Direct Investment.*

Both private firms and state-owned enterprises (SOEs) in the PRC undertake M&A of foreign companies. Private Chinese firms tend to seek out company targets in large economies to ensure continued market access in those countries.[69] In contrast, academic research indicates that SOEs make investments "with a strategic intention of acquiring technology, brands, marketing, management, and other know-how."[70]

SOEs, in particular, are important vehicles through which the Chinese government can acquire technologies in prioritized industries or sectors. SOEs owned by the PRC State-owned Asset Supervision and Administration Commission (SASAC) often target such foreign technologies.[71] SASAC, a Chinese government organization that reports directly to the PRC State Council, is responsible for managing roughly 100 centrally owned SOEs.[72] SASAC's responsibilities include appointing or removing top executives, assessing performance, approving M&A, and drafting laws governing the SOE operations.[73] In 2006, SASAC explicitly defined a subset of industries—including defense, energy, telecommunications, aviation, and shipping—as "strategic" and encouraged its SOEs to invest in those sectors abroad.[74]

Figure 5. Top 10 countries for Chinese M&A transactions in 2017



Source: *2017 Statistical Bulletin of China's Outward Foreign Direct Investment*, p. 91.
Note: Estimates are in terms of the total volume of "actual" transactions completed in that year.
[a] Hong Kong investment is captured separately in all PRC data.

Evolution in the FDI environment

In recent years, two major shifts have altered the environment in which Chinese firms can directly invest in overseas companies.

The first change is that China issued new guidelines on overseas FDI in 2017 and 2018 that further restrict the sectors in which Chinese firms are permitted to invest. These regulations aimed to decrease the amount of Chinese capital leaving the country and better align investments with national priorities. Some of the relevant guidelines include:

- *"Guiding Opinions on Further Guiding and Regulating the Direction of Outbound Investment,"* which categorizes Chinese overseas investments by industry into encouraged, restricted, or prohibited investments.[75]
- *"Measures for the Administration of Outbound Investment by Enterprises,"* which streamlines the administrative process for Chinese firms seeking to invest in industries that advance China's national priorities and increases scrutiny of investments in restricted industries.[76]
- *"Catalogue of Sensitive Industries for Overseas Investment,"* which lists restricted sectors for overseas FDI.[77]

These guidelines and regulations encourage and discourage (or even prohibit) investment in particular sectors outlined in Table 5 below.

Table 5. Chinese FDI: Encouraged and discouraged sectors after 2017 regulations

Encouraged Sectors	Discouraged Sectors
Infrastructure	Real estate
High technology	Hotels
Advanced manufacturing	Movie theaters
Energy	Entertainment industry
Agriculture	Sports clubs

Sources: State Council of the People's Republic of China, "State Council Guiding Opinion on Outbound Investment Regulations," Dec. 26, 2017; National Development and Reform Commission of the PRC, "Measures for the Administration of Outbound Investment by Enterprises," Dec. 26, 2017; National Development and Reform Commission of the PRC, "Catalogue of Sensitive Industries for Overseas Investment," Jan. 31, 2018.

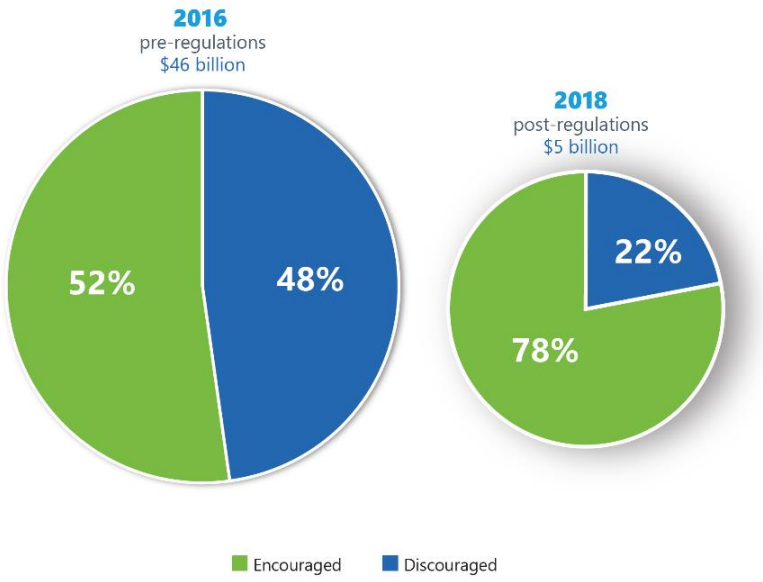
China's new regulations have already had an impact on Chinese investments in the US. The total amount of Chinese investment in US industries has declined massively from $46 billion at its peak in 2016 to $5 billion in 2018 (see Figure 6 on the next page). Of this $5 billion, 78 percent occurred in the "encouraged areas" of overseas FDI, which directly translate to stated national priorities. Yet, this decline cannot be attributed solely to PRC regulations.

The second change is that the US government has increased the authority of the Committee on Foreign Investment in the United States (CFIUS), an interagency committee authorized to review transactions that could result in control of a US business by a foreign person or entity. The US government's heightened scrutiny of Chinese investment in US firms has impeded or rejected some Chinese attempts to invest in US businesses.

Chinese firms are sometimes quite open about the challenges that these restrictions pose for achieving their goals. For example, in 2016, a consortium of Chinese investors led by Beijing Jianguang Asset Management Co. Ltd. acquired the Dutch firm Nexperia, a semiconductor designer and manufacturer.[78] Two years later, PRC-based Wingtech Technology Co. Ltd announced that it would purchase the majority stake of the consortium and thus would indirectly own more than 75 percent of Nexperia.[79]

In announcing the deal, Wingtech explicitly noted that "given increasingly stringent transaction" barriers in the US and Europe, it had been difficult for Chinese "domestic enterprises to catch up with foreign high-quality semiconductors." The press release described "the successful acquisition of Nexperia Group by [PRC] domestic enterprises" as "extremely precious."[80]

Figure 6. Comparison of PRC investment in the US in 2016 versus 2018



Source: Derived from Rhodium Group's US-China Investment Hub, 2019, https://www.us-china-fdi.com.

In response to these and other changes in the international investment environment, China has diversified its investment tactics to avoid increasingly strict investment barriers and gain access to "encouraged" industries in foreign countries. As we will see in the next section, the PRC has adapted and is now turning to less direct investment approaches to gain access to key technologies.

Indirect investments

Over the past decade, China has increasingly relied upon indirect vehicles to invest abroad. Multinational corporations often use creative ownership structures to diversify their investments or avoid taxes. The Organization for Economic Cooperation and Development (OECD) defines these various investment groups as "special purpose entities," which include investment funds, private equity and venture capital funds, holding companies, or other types of legal "shell" companies. These special purpose entities have been especially helpful for Chinese firms seeking to invest in US firms while not triggering US investment controls.

PRC-backed equity investment funds are an increasingly prominent tool for China's attempts to acquire foreign technology.[81] Government-backed equity investment funds pool resources from across the PRC government bureaucracy into one fund intended to serve a dedicated purpose. These investment funds typically support startups and non-publically traded companies in a specific sector. The Chinese government has encouraged the use of government-financed industry-specific investment funds to support national economic development priorities and policies, such as the *MIC 2025* policy. As of March 2018, over 1,800 such funds were in existence.[82] The US-China Business Council has noted, "As part of military-civil fusion, Chinese firms obtain dual-use technologies through overseas acquisitions supported by government funding."[83] These financing vehicles have a variety of corporate structures, comprise a large number of shareholders, and often use holding companies.

Illustration: Linking acquisitions to government priorities

China's acquisition of Silex Microsystems, a Swedish firm, provides one example of how the PRC uses indirect investment techniques to target specific foreign companies in the service of publicly stated PRC national strategic goals. This example also illustrates the challenges of regulating dual-use technology.

In 2016, an apparently private Chinese company, NAV Technology Company Limited (NavTech), acquired the Swedish-based Silex Microsystems. Silex specializes in developing and manufacturing micro-electromechanical systems (MEMS), a crucial component inside the chips embedded in most electronic devices.[84] Although not immediately apparent, NavTech maintains close ties to the Chinese state and military. Thus, in agreeing to this acquisition, "Sweden may inadvertently assist the Chinese military in modernizing its capabilities."[85]

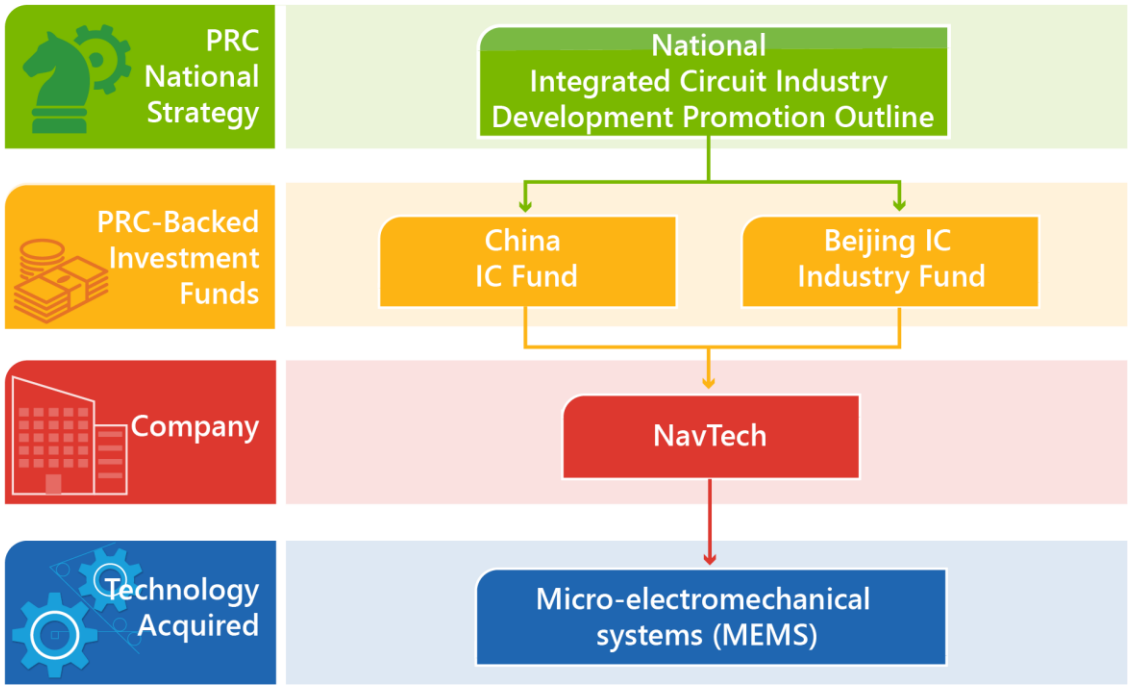
The Silex case illustrates the links between PRC government priorities and the targeting of specific foreign firms for acquisition. For example:

- PRC guiding national strategies, such as the *National Strategic Emerging Industry Development Plan* and the *National Integrated Circuit Industry Development Promotion Outline,* emphasize China's need to develop MEMS and integrated circuit (IC) technology.[86]
- In 2014, the PRC pooled resources from across several SOEs to establish the China National Integrated Circuit Industry Investment Fund (China IC Fund).[87] Two PRC government agencies also jointly established the Beijing Integrated Circuit Industry Development Equity Investment Fund (Beijing IC Industry Fund). Both of these PRC-backed private investment funds are tasked with providing capital for the R&D of integrated circuitry.[88]
- According to NavTech's website, these two funds are its second- and third-largest investors.[89]

- Likely unknown to Silex, NavTech maintains ties to the Chinese state and military. NavTech's parent company, Beijing Naiwei Times Technology, has received multiple certifications from the PLA for engaging in military R&D, production, and sales.[90]

Figure 7 illustrates this process.

Figure 7. Linking China's national strategic guidance to technology acquisition targets using indirect investment vehicles



Source: Derived from "NavTech Participates in the Investment of Beijing IC Industry Fund."

Illustration: Combining tactics to access US technology

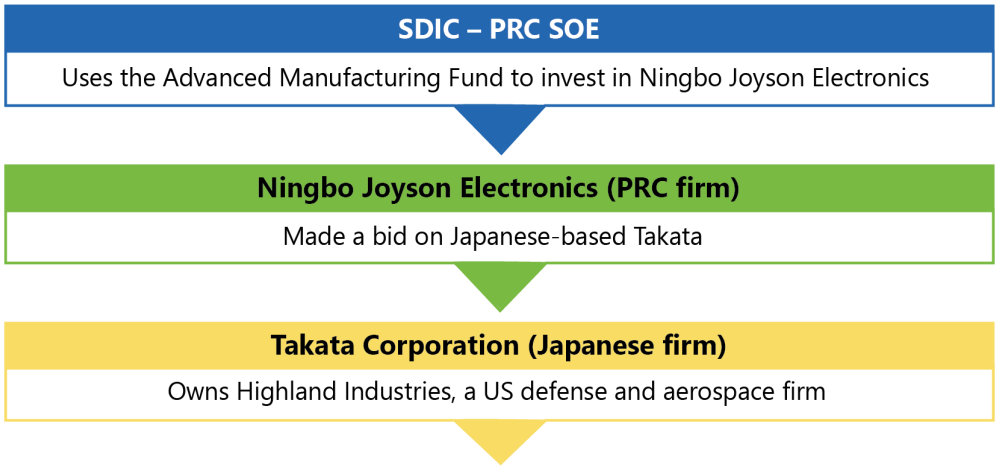
A recent case involving China's State Development and Investment Corporation (SDIC) illustrates two trends in China's investment toolkit: **use of indirect investment vehicles and investment via third countries.** SDIC is a SASAC-controlled, state-owned enterprise created in the mid-1990s that manages a variety of SOEs and other types of investment funds meant to target the "advanced manufacturing industry."[91] Many of SDIC's subsidiary organizations are responsible for undertaking goals associated with MIC 2025.[92]

SDIC used one of its investment funds to invest in Ningbo Joyson Electronics, a privately owned automotive components manufacturer based in Ningbo, China.[93] In 2017, Ningbo Joyson

Electronics announced that it would attempt to acquire the Japanese firm Takata.[94] Takata Corporation owns several US firms, one of which, Highland Industries, specializes in composite materials for the defense and aerospace industry, including "rocket components, satellite components, munitions tubing, protective gearing," and other materials.[95] Thus, through this deal, Chinese state-owned and private firms could potentially gain access to technology associated with Highland Industries.

As of April 2018, the purchase of Takata was complete with the new, combined company called "Joyson Safety Systems."[96] The new consortium remains owned by the Chinese parent firm but will be "based in Michigan."[97] Figure 8 illustrates this pathway.

Figure 8. SDIC's pathway of technology access



Source: Derived from Highland Industries, "Highland Composite Structures"; *Automotive News*, "China's Ningbo Joyson Considers Bid for Takata Following Key Safety Acquisition"; SDIC Fund Management, "Advanced Manufacturing Industry Investment Fund," http://www.sdicfund.com/. See endnotes for full citations.

Trends in China's overseas investment strategies

China's overseas investment strategies continuously evolve and adapt to a dynamic regulatory environment. Over time, China's use of overseas investment vehicles has changed considerably. Initially, the focus was on direct investment. Since 2015, the focus has shifted to indirect investment vehicles, especially investment funds and venture capital funds.

In reviewing more than 50 cases of Chinese investment in the US since 2017, we identified the following tactics to monitor:

- China's use of a wide variety of corporate structures to obfuscate ultimate ownership or the role of the PRC government in the corporate entity.
- PRC attempts to acquire or gain access to US firms by routing the transactions through third countries.
- China's increasing use of special purpose financing vehicles, including a variety of dedicated investment funds, to acquire companies that have technology relevant to the strategic sectors the PRC has identified in national guidance.

5. Human Capital: Boosting Technology Talent

Key findings

Human capital transfers and person-to-person exchanges of expertise and know-how are the fourth conduit through which China is able to legally acquire foreign technology. China employs a range of programs to appeal to international scientists and researchers and, through them, gain access to research and technology.

- *The PLA leverages talent recruitment programs, joint research collaboration, and dual affiliations to gain access to foundational US research—potentially including DOD-funded research.*
- *The close ties between China's civilian and military research organizations mean that when basic scientific research and technological expertise are transferred to China, they may eventually be accessed by the PLA.*

Foreign and overseas Chinese scholars positioned to access sensitive technologies and know-how have supported China's technology R&D for decades. For example, following the establishment of the PRC in 1949, the government sent thousands of Chinese students to the Soviet Union and Eastern Europe to study science and engineering.[98] As China's economic power and technological sophistication grows, it is increasingly able to offer the funding, facilities, and prestige that act as important currency for many academics and researchers worldwide to bring their knowledge to China.

> "We should make use of the intellectual resources of other countries by inviting foreigners to participate in key development projects … in various fields."
>
> — Deng Xiaoping, 1983

This section of the report describes two common routes by which the PRC may access foreign individuals' expertise and bring that knowledge back to China. They are:

- **PRC-backed talent programs.** The PRC government funds hundreds of programs to attract scientists to work in China.[99]
- **Joint research collaboration.** Principal investigators for US-based research (including US military research) may receive funds from both DOD and PRC government sources. Academic researchers—including some who work on DOD-funded research—may hold concurrent appointments with US and PRC institutions.

PRC-backed talent programs

The PRC government organizes and funds talent recruitment programs that bring foreign individuals and expertise to China. National, provincial, and municipal-level talent recruitment programs provide opportunities for overseas Chinese nationals or foreign experts to work in key sectors identified in PRC national strategic guidance.[100] PRC talent recruitment programs offer a wide variety of incentives to participants who are willing to bring their work to China, such as prestigious honorific titles, access to state-of-the-art research facilities, and guaranteed scientific research funds.[101] While participation in foreign talent recruitment programs is not illegal in the United States, experts who engage in these programs risk violating either deemed export laws or IP rights by transferring controlled information.[102] For example, if a US researcher transfers certain types of knowledge to a foreign national without a proper export license, then the US citizen may potentially violate deemed export laws.[103]

Through the recruitment of overseas talent to Chinese institutions, China is able to gain access to research and knowledge in specific emerging technology sectors, some of which may have benefited from research supported by US government funding.[104] These talent programs have come under increasing scrutiny in the United States in recent years. According to a US Senate report on China's Thousand Talents Program (TTP), the program is intended "to facilitate the legal and illicit transfer of US technology, intellectual property and knowhow" to China.[105] In 2019, the FBI labeled PRC-backed talent programs as a threat to US economic and national security.[106]

Illustration: Thousand Talents Program

The TTP, established in 2008 by the CCP, provides incentives for both foreign and Chinese professionals to pursue scientific research in China. The program initially sought to recruit 2,000 senior professionals within the first five years; having exceeded this goal, the program expanded its scope and lifecycle until 2020.[107] According to the TTP website, the program "targets people under 55 years of age who are willing to work in China on a full-time basis, with full professorships or the equivalent in prestigious foreign universities and R&D institutes, or with senior titles from well-known international companies or financial institutions."[108]

The TTP offers high levels of financial support to overseas scientists and experts to conduct research in high-tech industries. The program website states that experts can serve on projects under China's National High Technology Research and Development Program ("863 Program") or the National Program on Key Basic Research Project ("973 Program").[109] These are MOST-funded programs to promote applied and basic research in key areas related to advanced technology, national security, and economic competitiveness.

Some of the fields covered by the 863 Program include space flight, information technology, lasers, optoelectronics, very large integrated circuits, turbofan engines, automation, energy, new materials, and oceanography.[110] The 973 Program was established by MOST to bolster basic research in fields such as agriculture, energy, information technology, environmental resources, populations and health, and materials.[111]

TTP awardees sign legally binding contracts with Chinese institutions that may contain the following:

- A nondisclosure agreement
- Requirement to transfer the US scientists' intellectual capital to the host Chinese institution
- Establishment of a "shadow lab" identical to the awardee's US research facility[112]

A critical element of the talent programs is that, over time, they may blur the lines between legal and illegal behavior. In the United States, IP rights law and export controls place legal restrictions on the transfer of knowledge, but many of China's activities involving human capital can best be described as "extralegal"—that is, transactions that are not normally "subject to outside scrutiny," thus making it unclear whether they are legal or not.[113]

If such affiliations are not disclosed, the US government and research institutes may not be aware that their research is at risk in this manner. An investigation conducted by the US National Institutes of Health (NIH), focused on the TTP and its ties to scientists or institutions receiving NIH grants, identified more than 100 instances of contractual violations in which NIH grantees failed to disclose their foreign ties even if their home institutions require it.[114] The NIH deputy director for extramural research asserted, "These [cases] all represent forms of theft."[115]

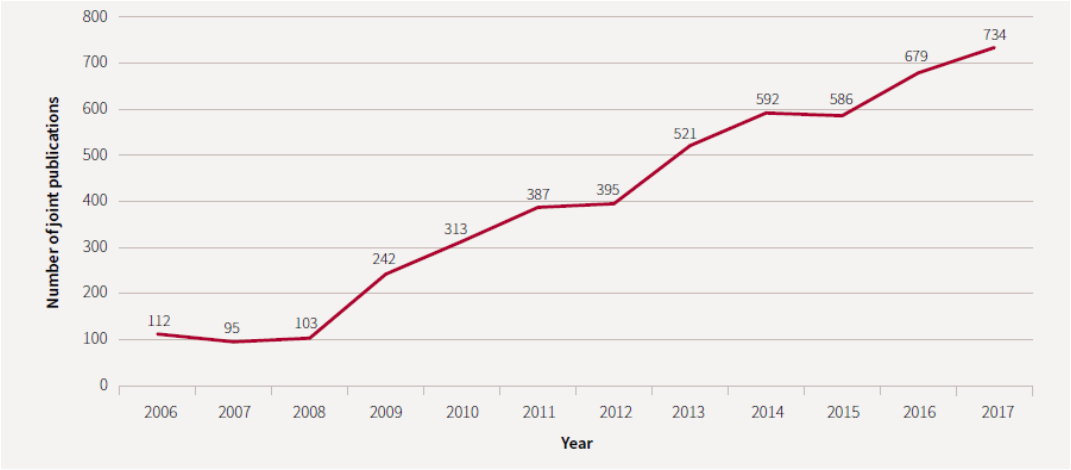
Joint research collaboration

The PLA may leverage joint research collaboration and offer dual affiliations to US scholars to gain access to US government-funded research. If the PRC's talent programs are about bringing foreign expertise into China, joint research programs are about sending PRC researchers out to the rest of the world. At times, an outcome of this practice is that foreign research finds its way into the Chinese military.

As part of its civil-military integration strategy, the PRC government is building stronger connections between China's civilian universities and its military research institutes.[116] This fusion of resources, in turn, increases the risk that US university joint research collaboration with PRC universities may eventually be leveraged by the PLA.

In 2018, the Australian Strategic Policy Institute (ASPI) reported that "greater numbers of Chinese universities are engaged in defense research, training defense scientists, collaborating with the military and cooperating with defense industry conglomerates and are involved in classified research." Through these connections, the PLA is expanding its research collaborations with foreign universities.[117] ASPI further states, "since 2007, the PLA has sponsored more than 2,500 military scientists and engineers to study abroad and has developed relationships with researchers and institutions across the globe."[118] Figure 9 shows PLA collaboration with overseas scientists from 2006 to 2017.

Figure 9. Number of joint publications by PLA and overseas scientists, 2006 to 2017



Source: Alex Joske, "Picking Flowers, Making Honey: The Chinese Military's Collaboration with Foreign Universities," *The Australian Strategic Policy Institute (ASPI)* (2018), https://www.aspi.org.au/report/picking-flowers-making-honey.

In 2017, the leading countries for collaboration between the PLA and overseas institutions were the US, the UK, Canada, Australia, and Germany.[119] A 2014 report from the US-China Economic and Security Review Commission stated, based on the number of co-authored journal articles, that the US and China are each other's main partner for scientific collaboration.[120] This finding has been echoed in more recent investigations as well.[121]

Given the increase in both the number of PLA scientists going abroad and scientific collaboration between the US and China, there is a growing risk that PLA personnel may gain (or have already gained) access to DOD-funded research.

Case: Harvard's Chemistry and Chemical Biology Department Chair

The participation of a senior Harvard scientist in the TTP, while simultaneously conducting research for DOD and NIH, could potentially have resulted in the transfer of US technology and research to the PRC. However, since the case is ongoing, we simply lay out the publically available details of the case as known at the time of our writing.

On January 28, 2020, the US Department of Justice announced that Dr. Charles Lieber, chair of Harvard's Department of Chemistry and Chemical Biology and a nanoscience specialist, was being charged with fraud. Dr. Lieber had concealed from Harvard his long-term involvement in the TTP and affiliation with Wuhan University of Technology (WUT).

Dr. Lieber's US-based laboratory, the Lieber Research Group, focused on nanomaterials, nano-bioelectronics, and brain science.[122] According to the Department of Justice, the lab had received more than $15 million USD in grant funding from the NIH and DOD.[123] The Lieber Research Group also lists the Office of Naval Research and the Defense Advanced Research Projects Agency as primary sponsors of its research, suggesting that US government agencies regard at least some of his research as pertaining to national security.[124]

In 2011, Dr. Lieber became a participant in China's TTP and received a position at WUT. In his role as a "Strategic Scientist" at WUT, Dr. Lieber published papers, applied for patents, and established the "WUT-Harvard Joint Nano Key Laboratory." The laboratory focused on research nearly identical to that undertaken in Dr. Lieber's US laboratory.

Dr. Kelvin Droegemier, director of the White House Office of Science and Technology Policy, argued that Dr. Lieber's participation in the TTP, while simultaneously receiving funding from DOD and NIH, resulted in "hidden transfers of information, know-how and time."[125]

Trends in leveraging human capital

China's use of human capital to access foreign nations' basic scientific research reflects a concentrated effort by the PRC government to acquire specific technologies and expertise through open and legal means. As China has acquired a more prestigious reputation as a global center of science and technology research, its ability to offer status, funding, and facilities to foreign researchers has also grown. Foreign researchers may not be aware that PRC collaborative research and talent programs may be aimed at exploiting their knowledge. As the US Attorney for the District of Massachusetts stated in early 2020, "all the Thousand Talents program does is induce people who are doing research in the United States to come to China, and do the same research, by offering them money, and *that is not illegal, per se.*"[126]

China continues to adapt its strategies for leveraging human capital to new regulatory environments. For example, as international scrutiny on the TTP increased, the PRC

government deleted all online data and names of participating scientists from its public websites. A US Senate staff report concluded, "the Chinese government has also instructed talent recruitment organizations that the phrase 'Thousand Talents Plan' should not appear in written circulars/notices."[127] In compliance with these instructions, Chinese organizations that had participated in recruiting foreign talent through the TTP are gradually removing any written advertisement of their connection to the program.

The PRC government is likely to continue to rely on talent recruitment programs to attract foreign talent. In 2019, the MOST launched the National High-end Foreign Experts Recruitment Plan, which according to some reports is intended to replace the TTP.[128] The program opened applications for the 2020 class of awardees on February 1, 2019.[129] The stated goal of this new plan is to recruit "foreign experts who are engaged in cutting-edge basic research, science and technology industry innovation, and engineering technology innovation around [China's] major scientific and technological innovation needs."[130]

6. Conclusion

This report has illustrated pathways by which China has legally acquired foreign technology and built capabilities in support of its national security and defense objectives. The report highlighted four types of tools that China uses to access foreign technology legally, including (1) trade, (2) market access requirements, (3) overseas investment, and (4) transfer of human capital. Looking at China's economic statecraft activities across all these pathways, we can draw some general conclusions.

China's legal economic statecraft activities are directly connected to the PRC's growing military power—and to other countries' loss of technology and IP. China has modernized its military and built new capabilities in part through economic pathways that are entirely legal and often quite open. Although these activities take place in the economic domain, they have implications—for the US and other nations—that stretch far beyond economics into every other domain of competition, including national security.

The PRC system is well-suited to pursue national objectives through such cross-domain activities. Chinese leadership can concentrate resources from a wide range of government and non-governmental actors to pursue specific goals. China's one-party system is also able to sustain these efforts over an extended period. Actors that carry out China's policies have spent many years honing their techniques for acquiring foreign technology; they have become experts in technology acquisition and are able to adapt quickly as rules and regulations in foreign countries evolve.

Countering China's use of legal economic tools to obtain foreign technologies is challenging. China's activities in this realm affect national security, industry, and academia in a wide variety of countries. Because China's activities operate across multiple domains, regions, and public and private organizations and individuals, it is not simple to counter them.

Key challenges in countering China's economic statecraft

We identified several challenges to combatting China's efforts to obtain critical technologies. Three of these challenges are as follows:

- **China is ambitious and adaptive.** Countries that want to protect their technology must create comprehensive and flexible policies in response.

- **The United States has multiple "leakage points."** The US is an open society with many avenues by which the PRC can obtain technology.
- **China offers appealing incentives.** Incentives in the US are not necessarily aligned to prevent technology loss.

Challenge #1: China is ambitious and adaptive

China has been nimble in responding to changing internal and external environments. The PRC government has ambitious technology and national security objectives, in service of which it has identified hundreds of technology and innovation targets to help modernize the PLA. Over the years, China has adapted many of the tools it uses to meet those targets, in response to both evolving national strategic priorities and regulatory barriers in other nations.

Once national technology goals have been set, the PRC employs a wide variety of both legal and illegal economic statecraft tools to attain these objectives. In this report, we focus on the legal economic pathways to access foreign technology, but the PRC also uses illegal tactics and techniques. Many examples of Chinese technology acquisition from foreign nations combine or straddle the line between legal and illegal. Over nine months, we analyzed nearly 90 cases of Chinese private and state-owned enterprises obtaining foreign technology, and, at times, it was difficult to classify specific cases as purely legal or illicit.

China's state-driven effort to fuse civilian and military resources to achieve PRC national security goals complicates US responses. US export control policy requires that dual-use technology be licensed prior to export to ensure that it is going to a civilian end-user.[131] However, the PRC policy of "civil-military integration" means that domestic Chinese laws can require civilian firms to share products and technology with military actors. Essentially, PRC civil-military integration means that technology from abroad has the potential to make its way into the PLA regardless of the export control policies of the home nation. This means that the current "end user" construct may not be a useful framework for limiting access to technology that enters China.

Challenge #2: Multiple "leakage points"

The United States is an open society that encourages technological innovation across the economy. Technology is developed, and can be accessed, in many different places. We use the term "leakage points" to describe these possible pathways. Our analogy is to that of a pipeline. Technological expertise "flows" from many sources before being turned into a specific military capability; along that pipeline, there are many opportunities for expertise or technology to escape. An entire military capability does not need to be compromised for a leakage of critical components to occur.

We identified three key leakage points within the US defense industrial base: (1) industry, (2) academia, and (3) partners and allies.

Industry: In the United States, turning technological expertise into new products and services occurs primarily in the private sector. US firms are profit-driven and must therefore seek out the most beneficial places to do business. Thus, US firms have sought access to Chinese markets to sell their products, and have pursued a wide variety of joint ventures or other arrangements with Chinese firms to access capital investment. These market-driven activities allow foreign industrial firms to become an attractive target for PRC actors seeking to access these technologies.

Academia: American universities have many reasons for maintaining an open research environment. Chinese students have provided an important source of revenue, and many of China's talent programs offer extremely generous funding for US-based researchers. Moreover, international collaboration is a central element in many people's image of the research endeavor. While many of these activities are perfectly legal, opportunities exist for PRC state-directed actors to access cutting-edge research in a variety of scientific areas and bring it back to China in service of PRC national strategic objectives.

Partners and allies: PRC firms do not necessarily need to invest in the United States to access advanced technology. Chinese companies have been known to route investments in US companies through third-party countries, or to target countries with less strict regulations. Given the complex corporate structures and the increasing number of PRC-backed investment funds now active, it is relatively easy for the PRC to cloak the ultimate target of its investments.

Moreover, many different standards and laws regulate access to critical technology across the United States, Europe, and other advanced industrial countries. Often what is illegal in one country may be legal in another. Therefore, China can undertake a type of "regulatory arbitrage" that allows it to shop around for the most permissive environment to offer incentives and access priority technology.

Challenge #3: China offers appealing incentives

Exacerbating the existence of these three "leakage points" is the fact that China offers a range of appealing incentives to the foreign companies, academics, and countries that it chooses to target for technology acquisition. Some foreign companies acknowledge that they may put their technology at risk when entering the Chinese market but are willing to do so in pursuit of future profits, based on the assumption that the lucrative Chinese market will make the risks worth it. For academics, China has offered generous funding opportunities and prestige amid a more financially constrained environment in the United States. Similarly, China has offered many partner nations loans, grants, and other sources of funding that are difficult for those countries to ignore.

Addressing these challenges: How can we protect US technology?

To effectively address China's ambitious efforts to obtain technologies with military applications, the United States and its partners and allies need to develop policies tailored to a wide range of stakeholders and incentives. Current US export control and investment screening policies, as well as other regulatory initiatives, are necessary components of a system to protect critical US technology, but the government by itself cannot fully address the current challenge. For long-term efforts to be successful, the US government will need to collaborate with industry, academia, and key allies and partners to block the "leakage points" that allow China to access sensitive technologies.

Understanding and tracking Chinese economic statecraft can be a labor-intensive endeavor. The due diligence research required to establish the connections between technology acquisition targets, the tools used to acquire them, and the way in which they are integrated into the PRC defense industrial base requires dedicated analysis and expertise.

Partnering with industry

Technological innovation in the United States occurs primarily in the private sector. Thus, industry must play a key role in any efforts to protect IP and technological expertise. The US government can encourage private companies to consider broad national security concerns when they decide where to invest or what partners to court, but without accompanying incentives, those policies are likely to be ineffective. **Therefore, efforts to stop leakage of technology from industry need to include incentives that appeal to the private sector's bottom line.**

An obvious place to start is by helping industry understand the extent of the crisis as it pertains to their interests—that is, the financial costs they bear from China gaining access to their knowledge base and products. Businesses need to be aware that they are potential targets of the PRC's extensive, state-directed efforts to acquire foreign technology. Firms seeking to do business with the PRC should not assume that Chinese promises to protect IP will be honored. Foreign firms need to be increasingly diligent about whom they do business with and require that legal agreements be upheld. They must also be willing to abandon seemingly good opportunities when these agreements are violated.

Finally, companies that work in the national security arena or in emerging technology fields need to be diligent in evaluating investors and joint venture partners. We found that Chinese firms use a variety of corporate structures that can make determining ultimate ownership difficult. Firms should be willing to ask uncomfortable questions about the ultimate source of funding and ownership of potential joint venture partners; a lack of transparency about

investors should prompt additional questions. Although these discussions may be difficult, they are critical for companies to determine with whom they will do business.

Addressing academia

US universities should and do welcome talent from across the world, but they need to be mindful that Chinese academic institutions do not operate in the same open environment. Chinese universities, think tanks, and research institutions are not independent and do not enjoy the same types of academic freedoms that US institutions do. Knowledge and innovation developed in a US university, if taken to China, may make its way into the Chinese defense system and thus into the Chinese military itself. US universities may need to upgrade their export control and other compliance policies, and spend more time evaluating the Chinese organizations that seek to partner with them. Universities with compliance policies in place, may need to re-evaluate those policies in light of China's civil-military integration policies.

Partners and allies

Increased cooperation among nations may be necessary to counter China's efforts to obtain technology. Given the pace of technological change, the US cannot assume that technological expertise created in one location will remain exclusively in that location. Thus, working with partners to update multilateral regimes and harmonize investment-screening mechanisms are essential elements of the US response to China's technology acquisition efforts. Several countries in Asia and within the EU have been updating their investment screening and export control regimes. The US should encourage these efforts and be willing to share lessons learned about US efforts to update and reform these procedures. Future multilateral arms embargos need to include specific definitions of key terms and uniform enforcement policies for all participating members.

Where do we go from here?

The United States should remain an open and transparent hub for technological innovation. The US government must continue to encourage R&D, the free flow of ideas, and innovation but must also be cognizant that this open environment creates challenges for US national security, industrial innovation, and the protection of IP. China's state-directed effort to acquire technology takes advantage of some of the best aspects of the US economy, academic environment, and openness with partners and allies. In response, the US must develop a comprehensive strategy for protecting critical technologies with national security and defense uses.

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Figures

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Tables

Abbreviations

ASW	antisubmarine warfare
ASPI	Australian Strategic Policy Institute
ASCM	antiship cruise missile
CFIUS	Committee on Foreign Investment in the United States
CCP	Chinese Communist Party
DOD	Department of Defense
EU	European Union
FDI	foreign direct investment
HAMC	Harbin Aircraft Manufacturing Company
IC	integrated circuit
IP	intellectual property
M&A	mergers and acquisitions
MEMS	micro-electromechanical systems
MIC 2025	*Made in China 2025*
MOST	PRC Ministry of Science and Technology
NIH	National Institutes of Health
OECD	Organization for Economic Cooperation and Development
PLA	People's Liberation Army
PLAN	People's Liberation Army Navy
PRC	People's Republic of China
R&D	research and development
SASAC	State-owned Asset Supervision and Administration Commission
SDIC	State Development and Investment Corporation
SIPRI	Stockholm International Peace Research Institute
SOE	state-owned enterprise
THATIC	Tianjin Haiguang Advanced Technology Investment Company, Ltd.
TTP	Thousand Talents Program
WUT	Wuhan University of Technology

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