Researchers at the RAND Corporation created a repeatable methodology for assessing the strengths and weaknesses of any country’s defense industrial base (DIB) across six topics:

- Economics
- Governance and Regulations
- Raw Materials
- Manufacturing
- Workforce, Labor, and Skills
- Research, Development, and Innovation

They then applied this methodology to assess the DIB of the People’s Republic of China (PRC). The study was required by Section 1260C of the Fiscal Year 2021 National Defense Authorization Act. (The methodology and more detailed findings are available in the full report at www.rand.org/t/RRA930-1.)
In 2021, China’s gross domestic product (GDP) was $16.9 trillion, second only to that of the United States, at $22.9 trillion. China’s overall economic size is a strength for supporting its DIB. \[1\]

Seven of the 15 Largest Defense-Related Firms in the World Are Chinese State-Owned Enterprises (SOEs). \[2\]

In 2017, the last year for which official data are available, China reported that it exported $4 billion in arms goods and services, compared with $8.8 billion for Russia and $153.3 billion for the United States. \[3\]

<table>
<thead>
<tr>
<th>Type</th>
<th>U.S. companies</th>
<th>Chinese companies</th>
<th>European company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ships</td>
<td>622</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aircraft</td>
<td>359</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Armored vehicles</td>
<td>271</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Missiles</td>
<td>159</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensors</td>
<td>42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Artillery</td>
<td>19</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Chart shows the trend-indicator value (TIV) for each country, which is a measure used to compare weapon sales that accounts for different currencies and for discounted costs of refurbished used weapons, legacy weapons, and newer, more advanced weapons.
TENSION BETWEEN DESIRE FOR ENTREPRENEURIAL INNOVATION WHILE SECURING PARTY CONTROL YIELDS UNCERTAINTY AND INEFFICIENCIES

**ADVANTAGES**

The Chinese government’s centralized power and decisionmaking help drive whole-of-government strategies.

President Xi Jinping and the Chinese Communist Party (CCP) have been working to increase their influence and even direct decisionmaking within defense firms.

By linking defense budget to GDP, China can reliably forecast and plan future defense spending.

China’s military-civil fusion (MCF) allows the state to direct university-based research to prioritized science and technology areas.

**DISADVANTAGES**

Topics not prioritized may falter without leadership’s spotlight—a risk if the government bets on the wrong technology or businesses are afraid to innovate.

Confidence in intellectual property (IP) protections is low—China has been ranked 49th out of 129 in the world in IP protections.[5]

Lack of independent judicial, legislative, and media oversight requires the CCP to directly monitor, regulate, and control DIB cost or time overruns and quality deficiencies.

There is a lack of transparency about the true objectives in anti-corruption efforts.
TREMENDOUS CAPACITY FOR MANUFACTURING AND DELIBERATE EFFORTS TO SECURE SUPPLY CHAIN INPUTS NECESSARY TO MANUFACTURE MILITARY CAPABILITIES

18 of 37 minerals relevant to defense applications are concentrated in China

Only 5 defense-related minerals are concentrated in the United States, Australia, and Canada.

14 more are concentrated in countries with strong diplomatic and economic relationships to China, including Russia, Brazil, and Belt and Road Initiative (BRI) countries.

18 defense-related minerals are concentrated in China.

CHINA’S MANUFACTURING ACCOUNTS FOR ~25% OF THE WORLD’S MANUFACTURING OUTPUT; ~50% OF THAT CAN BE CONSIDERED DUAL USE

Dual-use 49%

Not defense 51%

Basic metals

Food, beverages, tobacco

Textiles, wearing apparel, leather

Other non-metallic mineral products, glass ceramics, stone

Manufacture of coke, refined petroleum products

Fabricated metal products (not machines)

Rubber and plastics products

Wood products, paper products

Furniture

Printing, recorded media

Office machinery; communication equipment; medical instruments

Chemical products

Machinery and equipment

Motor vehicles, trailers and semi-trailers

Electrical equipment

Other transport equipment
DEFENSE-RELATED MINERALS CONCENTRATED OUTSIDE CHINA

IRON AND FERRO-ALLOY METALS
- Niobium: Brazil
- Cobalt: Congo
- Chromium: South Africa
- Tantalum: Congo

NON-FERROUS METALS
- Beryllium: United States
- Lithium: Australia
- Rhenium: South Africa

PRECIOUS METALS
- Rhodium: South Africa
- Platinum: South Africa
- Palladium: Russia, South Africa

INDUSTRIAL MINERALS
- Asbestos: Russia
- Boron: Turkey, United States
- Perlite: Turkey
- Diatomite: United States
- Zircon: Australia
- Industrial diamonds: Russia, Australia

MINERAL FUELS
- Oil shales: Estonia
- Oil sands (part of petroleum): Canada
- Uranium: Kazakhstan

Herfindahl-Hirschman Index score → More concentrated
China’s DIB Relies on U.S. Allies and Partners for Critical Military Technology Inputs

China relies on imports for weapon systems, particularly for aircraft and naval engines, despite efforts to develop them domestically.

**Top Weapon System Imports to China, by Country, in 2020[^9]**

<table>
<thead>
<tr>
<th>Year</th>
<th>Unit of measurement</th>
<th>Russia</th>
<th>France</th>
<th>Ukraine</th>
<th>UK</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>600</td>
<td>98</td>
<td>78</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>2019</td>
<td>1,108</td>
<td>126</td>
<td>78</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>1,696</td>
<td>121</td>
<td>78</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>

[^9]: Global weapon sales decreased during the pandemic. It would be premature to consider this decrease as a trend.

Unit of measurement is TIV.

In 2019, researchers at the Center for Advanced Defense Studies (C4ADS) found that the United States—not Russia—was the largest supplier to China’s DIB, at almost 20 percent of all of China’s DIB imports. C4ADS also found that:

- **Eight of the top ten countries supplying China’s DIB were U.S. allies.**
- Some products being imported were listed on the European Union’s list of export-controlled goods.
- Many imported goods—including U.S. goods—were not export-controlled but have potential dual-use applications, including aerospace and nuclear applications.
## TOP FIVE AREAS OF PRC MANUFACTURING IMPORT RELIANCE IN 2019 [10]

<table>
<thead>
<tr>
<th>Rank</th>
<th>Sector</th>
<th>Amount</th>
<th>Key Suppliers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Electrical machinery and equipment</td>
<td>$497</td>
<td>Taiwan, South Korea, Vietnam</td>
</tr>
<tr>
<td></td>
<td></td>
<td>billion</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Machinery, mechanical appliances, nuclear</td>
<td>$190</td>
<td>Japan, Germany, South Korea</td>
</tr>
<tr>
<td></td>
<td>reactors, boilers</td>
<td>billion</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Optical, photographic, cinematographic,</td>
<td>$99</td>
<td>Japan, Taiwan, USA</td>
</tr>
<tr>
<td></td>
<td>measuring</td>
<td>billion</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Vehicles other than railway</td>
<td>$75</td>
<td>Germany, Japan, USA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>billion</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Pharmaceuticals</td>
<td>$33</td>
<td>Germany, USA, Ireland</td>
</tr>
<tr>
<td></td>
<td></td>
<td>billion</td>
<td></td>
</tr>
</tbody>
</table>
China is a global S&T power and is capable of world-leading military technology innovation, but inter-relationships within China’s innovation system are inefficient.

China’s quality-adjusted military patent output grew at an average annual rate of **16 percent** between 2015 and 2019. In contrast, the United States’ average annual growth decreased by roughly **6 percent** per year over the same period.\(^6\)

**Linkages among research institutions in China are weak**

In 2020, China had only 1,946 university-firm co-authorships between firms and universities on scientific publications; the United States had 8,162.

**China** | **1,946**
---|---
**United States** | **8,162**

**Linkages between the government and research institutions are weak**

China had one government agency linked to 70 percent of government-funded scientific publications, whereas the United States’ largest government agency was responsible for funding only 25 percent of scientific publications.

**China** | **70%**
---|---
**United States** | **25%**
CHINA WILL BE VULNERABLE TO SIGNIFICANT WORKFORCE UPHEAVAL OVER THE NEXT TEN YEARS

The DIB and other sectors will face labor shortages and lower profits because of wage hikes and other trends, including

- China faces a low fertility rate and an aging workforce.
- Chinese university classes generally lack academic rigor; the system incentivizes professors to publish while slighting education outcomes.
- China’s STEM workforce is insufficient in both quantity and quality to meet demand.
- Pervasive gender inequality might exacerbate potential labor shortages.
CHINA RELIES ON U.S. AND ITS ALLIES AND PARTNERS FOR TRAINING, BUT CHINA IS INVESTING IN "TALENT PROGRAMS" TO IMPROVE QUALITY AND QUANTITY OF THE S&T WORKFORCE

In 2019, 1 million Chinese students were studying abroad, including more than 300,000 in the United States. Many will not return to China.[7]

But more educated workers means higher workplace and income expectations and a smaller pool of manufacturing labor.

33% quit their first job within 6 months of graduation because of unmet career expectations[8]

In 2019, 1 million Chinese students were studying abroad, including more than 300,000 in the United States. Many will not return to China.[7]
ADDITIONAL INTELLIGENCE CAN IMPROVE FUTURE ANALYSES

RAW MATERIALS
The RAND team was unable to assess the size of China’s stockpiles and the rate at which China uses a material, preventing an assessment of how lack of access would affect the PRC.

SERVICES
There is a lack of information on companies that provide services to the People’s Liberation Army, including ongoing support of major military systems, information systems, cyber services, and others.

SOFTWARE
The RAND team was unable to find data or analyses on the size and quality of the DIB software industry. A notable gap is an understanding of firms that provide software for command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) systems.

TALENT
The RAND team found no systematic analysis of the flow of Chinese students and researchers back to China from foreign universities.

[1] International Institute for Strategic Studies, Military Balance+ (online database), 2021, “China (PRC) and United States Defence Economics.” Amounts are reported in current-year dollars using market exchange rates.