



Innovation Wars: How China Is Gaining on the United States in Corporate R&D

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China wants to displace the United States as the world's leading innovation economy. Business R&D in advanced, traded-sector industries is a key indicator of its progress—and it is catching up rapidly. Congress and U.S. state governments should respond by boosting R&D tax incentives.

KEY TAKEAWAYS

- U.S. headquartered firms' R&D spending in advanced industries rose from 80 percent above the global average in 2013 to nearly 100 percent more in 2021.
- Chinese advanced industries went from 80 percent below the global average to 30 percent below. Leaving out software, they should catch up to the United States by 2034.
- In 2013, U.S. advanced-technology firms' size-adjusted R&D spending exceeded that of Chinese firms in nine advanced sectors. By 2021, Chinese firms' spending was higher in two of nine sectors and tied in a third.
- In wage-adjusted R&D spending as a share of GDP, China is now above the global average in six of nine advanced industries.
- In seven of nine sectors, U.S. firms' size-adjusted R&D spending had either declined or remained stagnant while Chinese spending rose.
- Chinese firms also invested more than U.S. firms in traded sectors that are not advanced, investing \$34 billion in R&D, while U.S. firms invested \$19 billion.
- U.S. firms spent 240 percent more than Chinese firms' spending of \$154 billion. But adjusting for China's lower R&D salaries, U.S. firms only spent 80 percent more than Chinese firms—\$529 billion compared to Chinese firms' \$295 billion.
- To respond, Congress should double the Alternative Simplified Credit rate to 28 percent and restore full expensing of R&D expenditures, and states should take similar steps.

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INTRODUCTION

Advanced, traded-sector industries power the U.S. economy's global competitiveness.¹ A key indicator of strength in those industries is the amount firms invest in research and development (R&D) to produce new innovations. As China vigorously challenges the United States for global leadership in the innovation economy, it is therefore important to assess where the two countries stand in their advanced industries' private R&D spending.²

This report uses the EU R&D 2,500 Scoreboard, which covers 90 percent of the world's private-sector R&D spending, to compare U.S.- and Chinese-headquartered firms' R&D spending in three groups of economic sectors.³ First, we examine nine strategically important advanced, traded-sector industries. Second, we compare U.S. and Chinese firms across all non-advanced traded sectors. Finally, we examine non-traded sectors. There are, however, some caveats about this dataset: the companies' locations are categorized by their headquarters rather than where R&D investments occurred; the R&D spending is in nominal dollars, company sectors are classified by main business activities, and most of the data presented here does not attempt to adjust for purchasing power parity to reflect lower R&D salaries in China. (See appendix 2 for details.)

Each section of the report examines U.S. and Chinese private-sector R&D in those sectors on a size-adjusted basis—first relative to the size of their respective economies; then as proportions of global R&D in each sector or group of sectors; and finally using an industrial concentration ratio known as a location quotient (LQ), which is R&D as a share of a country's national economy versus the global average. We also compare the extent to which private R&D is concentrated among each country's top four firms on the EU R&D 2,500 Scorecard.

The data shows that while U.S. firms' investment in R&D is growing, China is catching up. On a size-adjusted basis, U.S. firms' R&D investments in the nine advanced sectors in 2013 exceeded that of Chinese firms.⁴ But by 2021, U.S. firms had lost their lead in two of the nine sectors, while China closed the gap in the other seven.⁵ The United States could potentially lose global market shares in the other seven sectors as Chinese companies continually expand R&D investment with government support. In addition, because they benefit from extensive intellectual property theft and forced technology transfers, Chinese firms do not have to invest as much in R&D as American firms to get the same innovation results.⁶ Think of China as a free rider, living on the R&D investments of U.S. and other foreign firms. But in addition to that free-riding strategy and the impact of having R&D workers with lower salaries, Chinese firms also are investing more in their own in-house capabilities.

In response, Washington needs to do a better job of incentivizing the private sector to continue investing in R&D. This should include expanding programs that fund joint industry-university research, boosting the Alternative Simplified R&D Credit rate from 14 percent to at least 28 percent, and restoring R&D expensing. It's much easier to keep U.S. industries' global market shares through such policies than to lose them and later have to work much harder to win them back, often in vain.

EXAMINING ADVANCED SECTORS

The following subsections compare the United States' and China's private business R&D spending from firms in nine advanced sectors: aerospace and defense, electronic and electrical equipment, general industrials, industrial engineering, pharmaceutical and biotechnology,

software and computer services, technology and hardware equipment, alternative energy, and automobiles and parts. It is important to note that the sample of firms only includes the top 2,500 R&D spenders globally.

The average U.S. firm in advanced sectors spends more on R&D than does the average Chinese firm. In 2021, 659 U.S. firms and 424 Chinese firms in these nine sectors made the EU R&D 2,500 scoreboard.⁷ (Refer to appendix 2 on detail about Amazon’s addition into the 2021 data.) This is compared with the rest of the world’s 618 firms.⁸ (See table 1.) The average U.S. firm invested \$802 million on R&D, 0.06 standard deviations above the average firm’s R&D spending of \$655 million in the sectors globally.⁹ In comparison, the average Chinese firm invested \$363 million on R&D, 0.12 standard deviations below the average firm.¹⁰

Table 1: Number of firms in nine advanced trade sectors, 2021¹¹

Sector	United States	China	Rest of the World	Total
Pharmaceuticals and Biotechnology	263	79	136	478
Software and Computer Services	197	73	67	337
Technology Hardware and Equipment	71	47	89	207
Electronic and Electrical Equipment	41	106	102	249
Industrial Engineering	28	52	87	167
Automobiles and Parts	28	45	75	148
Aerospace and Defence	15	5	24	44
General Industrials	15	16	33	64
Alternative Energy	2	1	5	8
Total	660	424	618	1,702

Collectively, U.S. firms in these nine advanced sectors continue to invest more in R&D than do Chinese firms. In 2021, U.S. firms spent 3.4 times more than Chinese firms: \$529 billion on R&D, while Chinese firms spent \$154 billion.¹² As a result, U.S. firms’ R&D share was 47.4 percent compared with Chinese firms’ 13.8 percent.¹³ (See figure 1.) This is compared with the rest of the world’s 39 percent.¹⁴ Even when controlling for gross domestic product (GDP), U.S. firms still spent more than Chinese firms. For every \$1,000 of GDP, U.S. firms in these nine sectors spent \$22.70 on private R&D, while Chinese firms invested \$8.67.¹⁵ The rest of the world’s firms spent \$7.80.¹⁶ In other words, both U.S. and Chinese firms invested more in R&D as a share of their R&D compared with the rest of the world, but U.S. firms still outperform Chinese firms.

Figure 1: R&D spending by U.S. and Chinese firms in all advanced sectors (including Amazon), 2021¹⁷

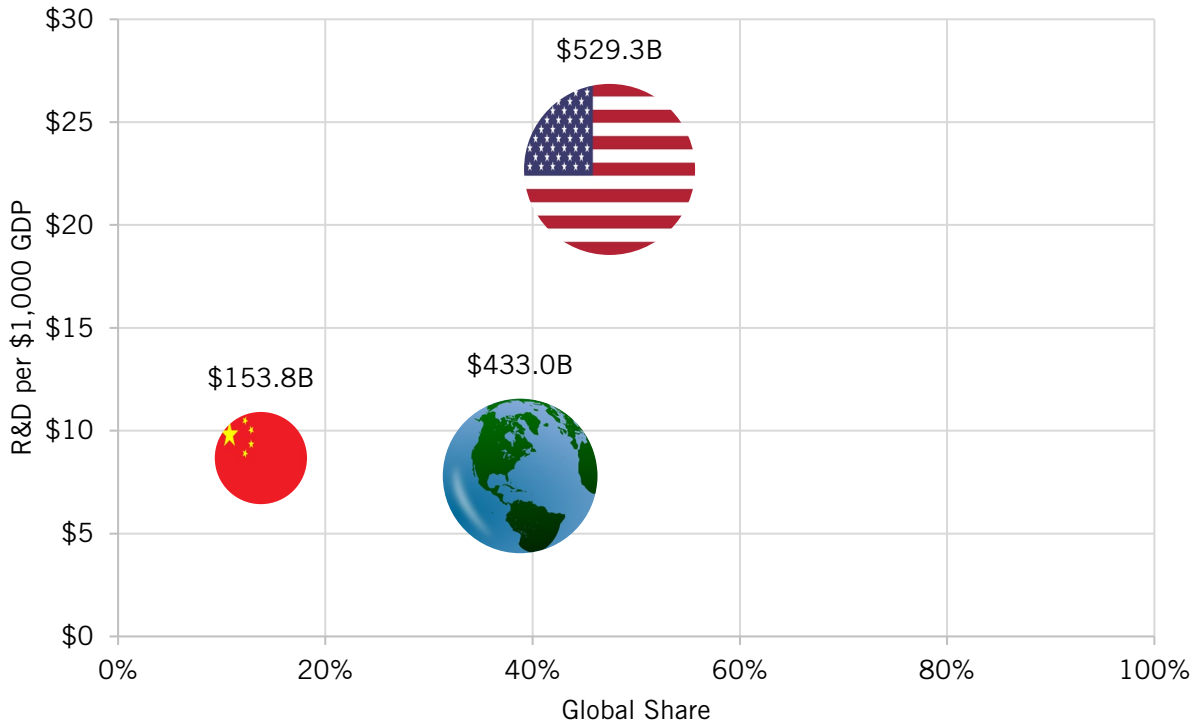
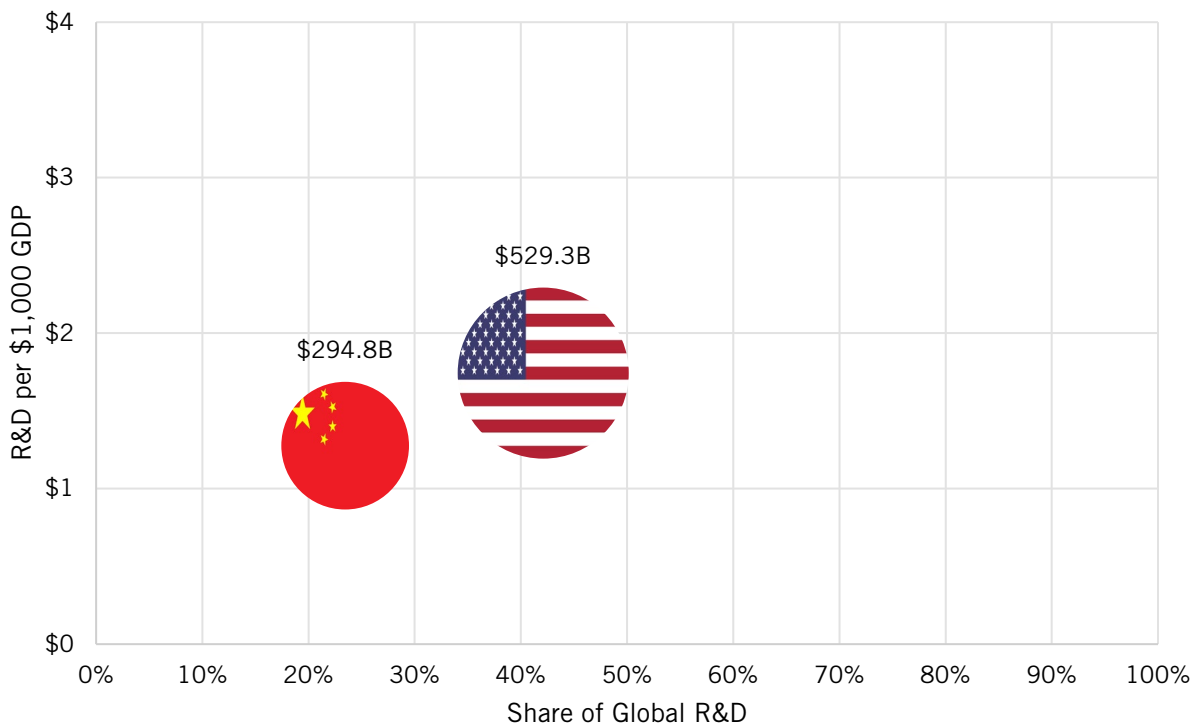


Figure 2: U.S. and Chinese firms' wage-adjusted R&D spending, all advanced sectors (including Amazon), 2021¹⁸



When adjusting for wage differences, Chinese firms are rapidly catching up to U.S. firms' spending. Although wages are difficult to measure, PayScale has estimated that research scientists in China earned 1.9 times less than their U.S. counterparts—\$45,446 compared to \$87,132 in the United States.¹⁹ This difference means Chinese firms' R&D spending goes farther. When wage differences are adjusted for, U.S. firms only spent 80 percent more than Chinese firms—\$529 billion compared to Chinese firms' \$295 billion.²⁰ Moreover, adjusting for both wage differences and GDP, U.S. firms' spending was only 37 percent more than Chinese firms'—\$1.74 per \$1,000 of GDP compared to \$1.28 for Chinese firms.²¹ (See figure 2.)

U.S. firms' size-adjusted R&D spending was larger than Chinese firms' in 2021. The size-adjusted R&D spending compares U.S. and Chinese firms' R&D spending as a share of their respective country's GDP to the global average R&D spending as a share of the world's GDP. This results in an industry concentration ratio known as an LQ, which we express as a multiple. For example, if a country has twice the global average corporate R&D in a given sector, then its LQ in that sector is 2x. The LQ is important in this analysis because it compares the performance of firms in each country with the global average after adjusting for the size of each country's economy. By that measure, U.S. firms' size-adjusted R&D spending was higher than China's in six of the nine sectors. These included the software and computer services, technology and hardware, and pharmaceutical and biotechnology sectors.²² However, in three sectors—general industrials, electronic and electrical equipment, and industrial engineering—U.S. firms either tied or were lower than Chinese firms' size-adjusted R&D spending.²³ (See table 2.) Moreover, Chinese firms are closing the size-adjusted R&D spending gap with U.S. firms in advanced sectors. In seven of nine sectors, U.S. firms' size-adjusted R&D spending had either declined or remained stagnant while Chinese spending rose since 2013.²⁴

Table 2: U.S. and Chinese firms' size-adjusted R&D in nine advanced sectors (2021 LQs)²⁵

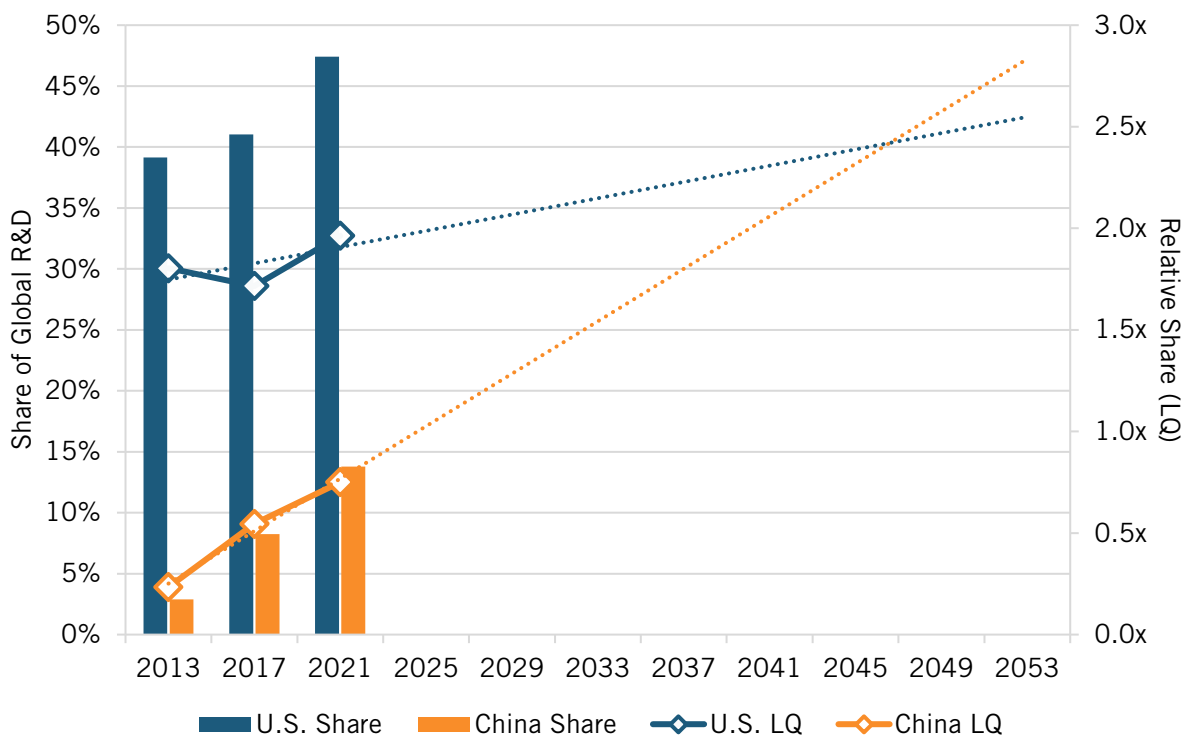
Sector	U.S. LQ	Chinese LQ	Chinese LQ, Wage-Adjusted
Software and Computer Services	3.1x	0.7x	1.2x
Technology Hardware and Equipment	2.2x	1.1x	1.7x
Pharmaceuticals and Biotechnology	2.2x	0.3x	0.6x
Aerospace and Defence	1.8x	0.2x	0.3x
General Industrials	1.1x	1.1x	1.7x
Industrial Engineering	0.8x	1.6x	2.4x
Automobiles and Parts	0.7x	0.6x	1.0x
Electronic and Electrical Equipment	0.5x	1.3x	2.0x
Alternative Energy	0.5x	0.3x	0.6x

U.S. firms have historically exceeded Chinese firms' R&D investments, but Chinese firms' R&D investments are rapidly growing. From 2013 to 2021, U.S. firms' R&D share of these nine global sectors rose from 39.1 percent to 47.4 percent.²⁶ In comparison, Chinese firms' R&D share rose from 3 percent to 13.8 percent.²⁷

Chinese firms in advanced sectors are heavily investing in R&D and catching up to U.S. firms to compete in the global economy.

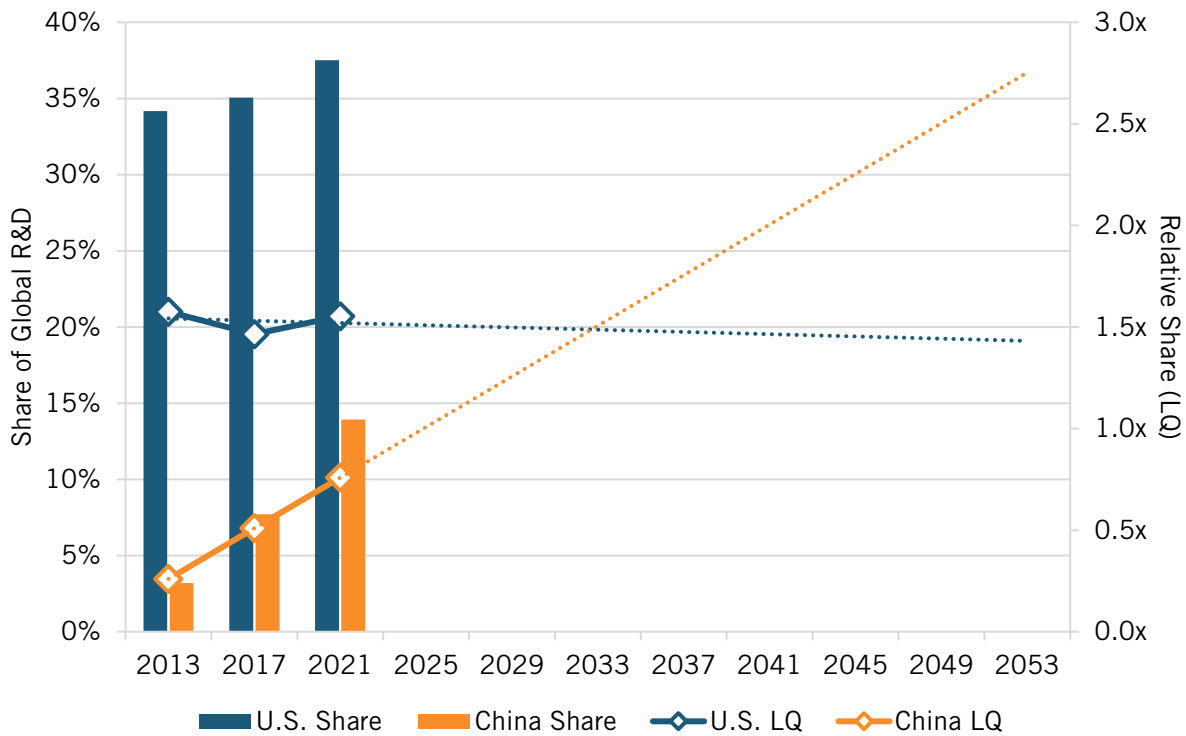
Although Chinese firms' R&D share of the global advanced sectors is still below U.S. firms' because of their smaller economy, their size-adjusted R&D investment is catching up. When controlling for GDP, U.S. firms' R&D investment rose from 80 percent to 100 percent more than the global average (1.8x to 2.0x).²⁸ In comparison, Chinese firms' rose from 80 percent below the global average R&D investment (0.2x) to 30 percent below the global average (0.7x).²⁹ (See figure 3.) This is important because it means that should this trend continue on pace, China would catch up to the United States' current level by 2049.³⁰

Figure 3: Projected R&D spending by U.S. and Chinese firms in all advanced sectors³¹



The United States relies more on firms in the software and services sector to maintain its growth in size-adjusted R&D spending for advanced sectors. According to Statista, the United States is the largest R&D spender in software.³² From 2013 to 2021, U.S. firms' R&D spending grew from 80 percent (1.8x) to 100 percent (2.0x) above the global average. Without the software and services sector, U.S. firms' R&D spending remained stagnant at 60 percent above the global average. In comparison, Chinese firms' R&D spending grew about the same even without the software the sector (0.26x to 0.76x). As a result, without the software sector, Chinese firms are projected to catch up to U.S. firms' R&D spending by 2034. (See figure 4.)

Figure 4: Projected R&D spending by U.S. and Chinese firms in all advanced sectors, excluding software and computer services³³



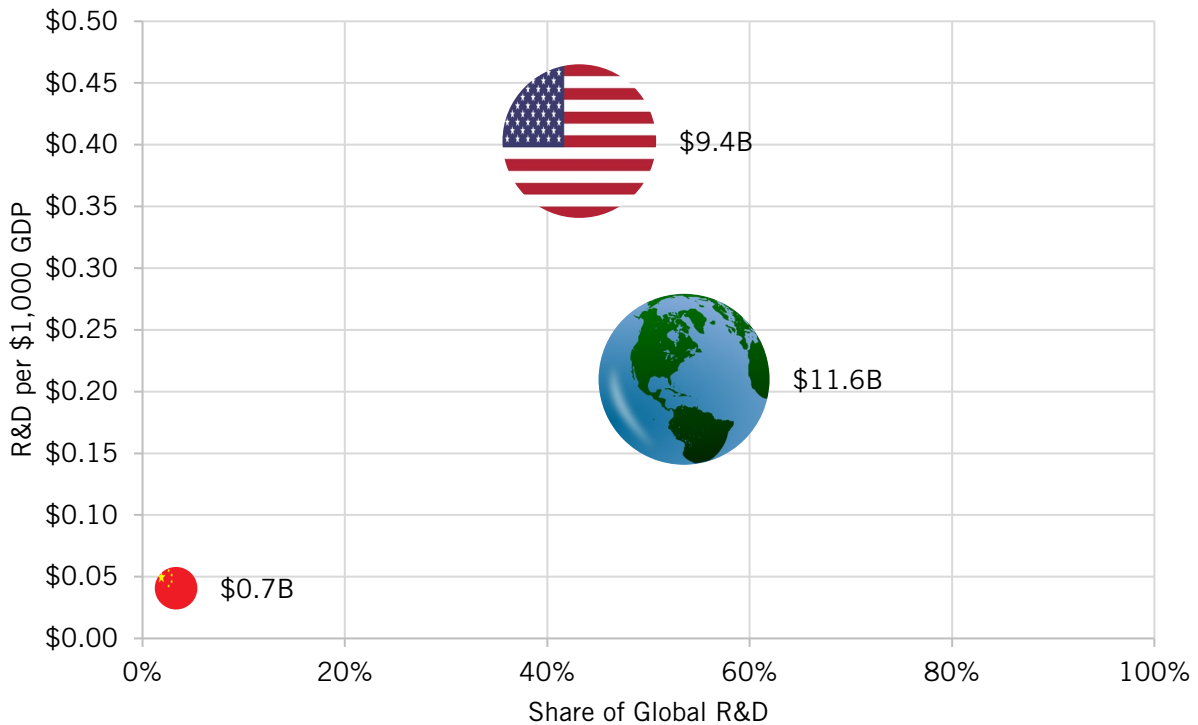
Aerospace and Defense

The aerospace and defense sector includes manufacturers, assemblers, and distributors of aircraft parts, aircrafts, and communication satellites used in both commercial and private air transport.³⁴ The sector also includes producers of military aircraft, radar equipment, and weapons used in the defense industry.³⁵

In 2021, 15 U.S. firms in this sector made the EU R&D 2,500 list, including Raytheon Technologies, Boeing, and Lockheed Martin.³⁶ Five Chinese firms, including AVIC Electromechanical Systems, China Aerospace Times Electronics, and China Avionics Systems, also made the list.³⁷ In 2021, the average U.S. firm in the sector spent \$626 million on R&D, a 0.17 standard deviation above the average firm's R&D spending of \$495 million in the aerospace and defense sector globally.³⁸ In comparison, the average Chinese firm in the sector spent \$144 million, 0.46 standard deviation below the average firm's.³⁹

U.S. firms spent about 13 times more on R&D than did Chinese firms: \$9.4 billion compared with \$721 million.⁴⁰ When controlling for GDP, U.S. firms spent 10 times more than Chinese firms (\$0.40 on R&D for every \$1,000 of GDP compared with \$0.04 in China).⁴¹ As a result, U.S. firms' R&D spending made up 43.2 percent of the global sector's R&D spending compared with 3.3 percent for China.⁴² This is compared with the rest of the world's 53.5 percent and R&D spending of \$0.21 for every \$1,000.⁴³ (See figure 5.) When wages are adjusted for, U.S. firms still spent about 6.8 times more than Chinese firms—\$9.4 billion compared to Chinese firms' \$1.4 billion.⁴⁴

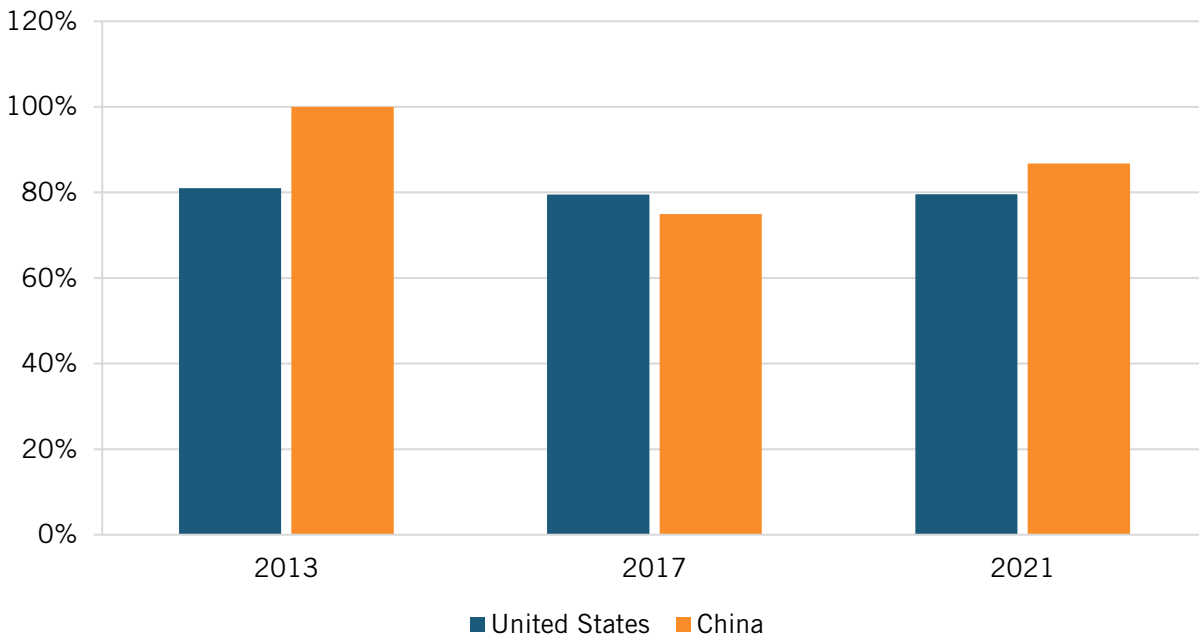
Figure 5: R&D spending by U.S. and Chinese firms in the aerospace and defense sector, 2021⁴⁵



U.S. firms have consistently had a higher global share of R&D spending. From 2013 to 2021, U.S. firms' share of global R&D rose from 35 percent to 43 percent.⁴⁶ Chinese firms' shares rose from 0.1 percent to 3.3 percent.⁴⁷

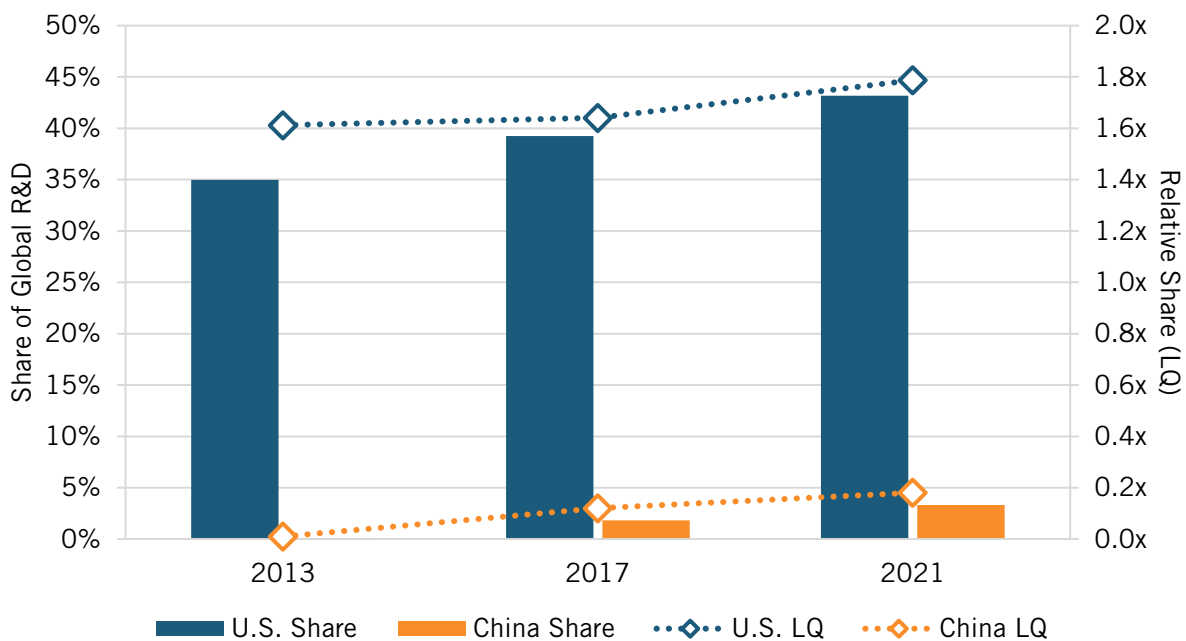
The top four U.S. and Chinese firms with the highest R&D spending have consistently played a crucial role in driving both U.S. and Chinese firms' share of global R&D. In 2013, the top four U.S. firms accounted for 81 percent of the domestic sector's R&D spending.⁴⁸ And in 2021, the top four firms still accounted for 80 percent, meaning these firms made up 34.4 percent of the global sector's R&D spending.⁴⁹ This decreased reliance occurred despite the number of U.S. firms declining from 19 to 15 during this period. Similarly, the top four Chinese firms' R&D spending accounted for 100 percent of the Chinese sector's R&D spending in 2013.⁵⁰ And in 2021, these top four Chinese firms still accounted for 87 percent of the country's spending in aerospace and defense.⁵¹ (See figure 6.) The slight decline in reliance is partially because the number of Chinese firms increased from one to six. In other words, the United States and China depend on their top four firms to maintain current levels of R&D competitiveness.

Figure 6: Top four U.S. and Chinese firms' share of domestic R&D in aerospace and defense⁵²



U.S. firms' size-adjusted R&D spending was 60 percent higher than the global average (1.6x) in 2013, rising to 80 percent above the global average (1.8x) in 2021.⁵³ In comparison, Chinese firms' R&D spending was nonexistent in 2013 and was still 80 percent below the global average (0.0x to 0.2x) in 2021.⁵⁴ (See figure 7.)

Figure 7: U.S. and Chinese firms' shares of global R&D in the aerospace and defense sectors⁵⁵



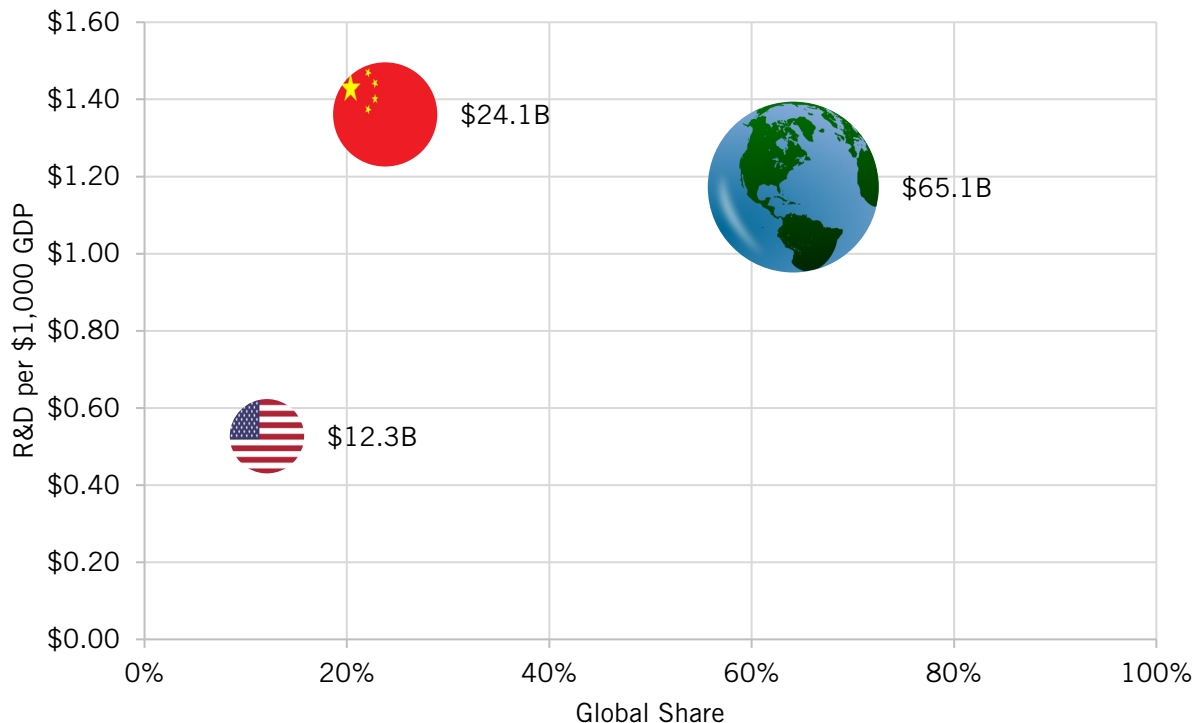
Electronic and Electrical Equipment

The electronic and electrical equipment sector includes makers and distributors of electrical parts for radios and other consumer electronics, including cables and transistors.⁵⁶ The sector also includes companies providing mechanical and electronic security; filtration systems; products used in the measurement of electric, gas, and water; pollution control equipment; and electrical devices and components marketed to businesses.⁵⁷

In 2021, 41 U.S. firms made the EU R&D 2,500 list, including Danaher, Keysight Technologies, and Northrop Grumman, while 106 Chinese firms, including Byd, Boe Technology Group, and Hangzhou Hikvision Digital Technology, also made the list.⁵⁸ That same year, the average U.S. firm spent \$299 million on R&D, while the average Chinese firm spent \$228 million.⁵⁹ This is compared with the global average firm's \$408 million.⁶⁰ In other words, both spent less than the average firm in the sector on R&D, meaning firms in other countries are better at promoting innovation with their higher R&D spending.

Despite U.S. firms' higher average spending on R&D, Chinese firms spend more on R&D than do U.S. firms collectively. In 2021, U.S. firms spent \$12.3 billion on R&D, while Chinese firms spent almost double, or \$24.1 billion.⁶¹ Due to the large number of Chinese firms, their R&D share of the global sector was 23.8 percent, while U.S. firms' share was just 12.1 percent.⁶² Adjusting for GDP, Chinese firms also spent more than U.S. firms. For every \$1,000 of GDP, Chinese firms spent \$1.36 on R&D compared with \$0.53 for U.S. firms.⁶³ This is compared with the rest of the world's R&D share of 64.1 percent and spending of \$1.17 for every \$1,000.⁶⁴ (See figure 8.) Moreover, when adjusting for wages, Chinese firms spent 3.8 times more than U.S. firms—\$46.3 billion compared to U.S. firms' \$12.3 billion.⁶⁵

Figure 8: R&D spending by U.S. and Chinese firms in the electronic and electrical equipment sector, 2021⁶⁶

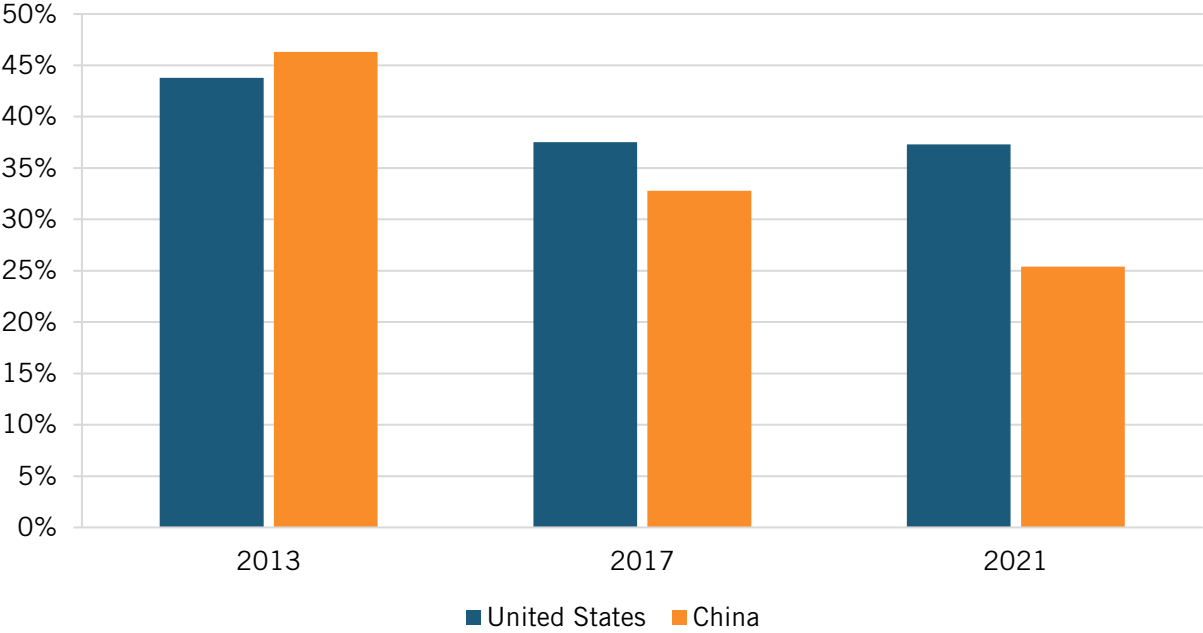


U.S. firms in the sector have not always lagged behind Chinese firms in R&D spending. In 2013, U.S. firms' share of R&D spending in the global sector was 12.2 percent compared with Chinese firms' 2.5 percent.⁶⁷ (See figure 10.) However, U.S. firms did not increase their R&D investment in proportionality to the growth of R&D spending in the global sector. In comparison, Chinese firms' growth exceeded the global sector's growth. As a result, Chinese firms caught up and were roughly on par with U.S. firms in R&D investment by 2017, with each holding about 11 percent of the global R&D spending.⁶⁸ And by 2021, Chinese firms had outspent U.S. firms, holding a global share of 23.8 percent compared with U.S. firms' 12.1 percent.⁶⁹

Chinese firms in the electronic and electrical equipment sector not only caught up but now exceed the United States in promoting R&D and competitiveness.

The top four U.S. firms with the highest R&D spending have consistently played a key role in driving U.S. firms' share of global R&D. In 2013, the top four U.S. firms accounted for 44 percent of the domestic sector's R&D.⁷⁰ In 2021, they still accounted for 37 percent, meaning these firms made up 4.5 percent of the global sector's R&D spending.⁷¹ The decreased reliance occurred despite the number of U.S. firms in the sector declining from 54 to 41 in that period. In comparison, Chinese firms' share of global R&D has become less dependent on the top four Chinese firms.⁷² In 2013, the top four Chinese firms comprised 46 percent of the domestic sector's R&D spending.⁷³ Yet, by 2021, the leading four Chinese firms accounted for only 25 percent.⁷⁴ This decreased reliance occurred principally because the number of Chinese firms increased from 28 to 106. (See figure 9.) In other words, the United States depends more on its top four firms to maintain current private sector R&D competitiveness levels.

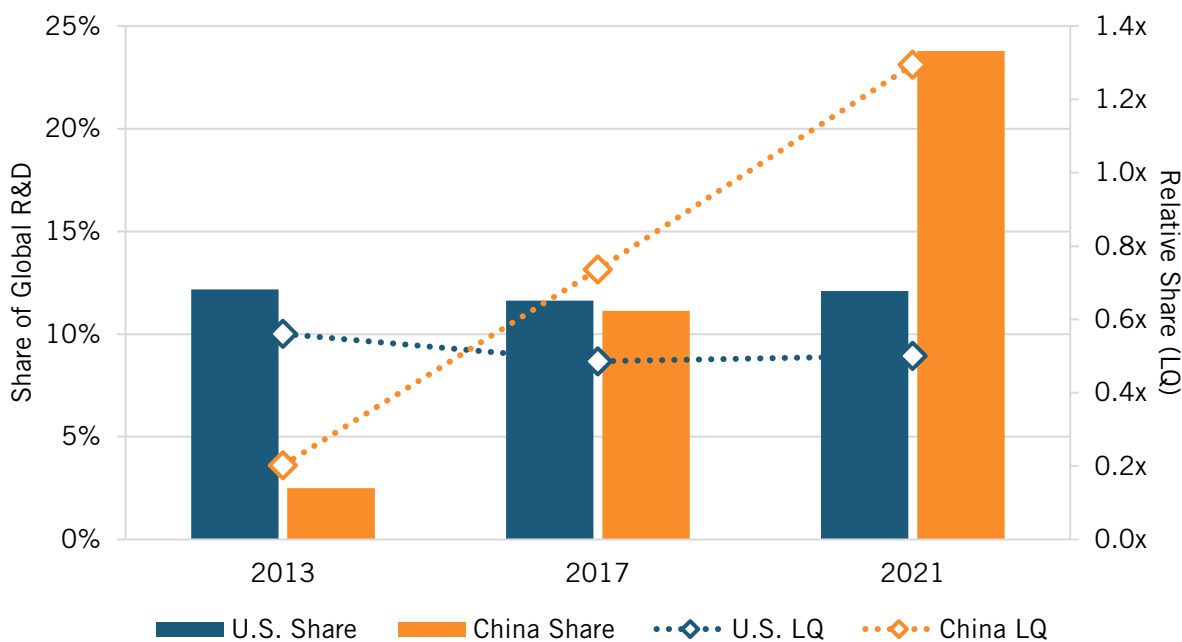
Figure 9: Top four U.S. and Chinese firms' share of domestic R&D in electronics and electrical equipment⁷⁵



Moreover, compared with the global average, U.S. firms' size-adjusted R&D investments worsened from 2013 to 2021, when U.S. R&D spending decreased from 60 percent to 50

percent of the global average (0.6x to 0.5x).⁷⁶ In comparison, Chinese firms' R&D spending increased from 20 percent to 130 percent of the global average (0.2x to 1.3x).⁷⁷ In this period, Chinese firms increased their R&D spending by \$1.22 for every \$1,000 of China's GDP compared with U.S. firms' growth of \$0.13.⁷⁸ (See figure 10.) In other words, Chinese firms have not only caught up but now exceed U.S. firms in promoting R&D and competitiveness.

Figure 10: U.S. and Chinese firms' shares of global R&D in the electronic and electrical equipment sectors⁷⁹



General Industrials

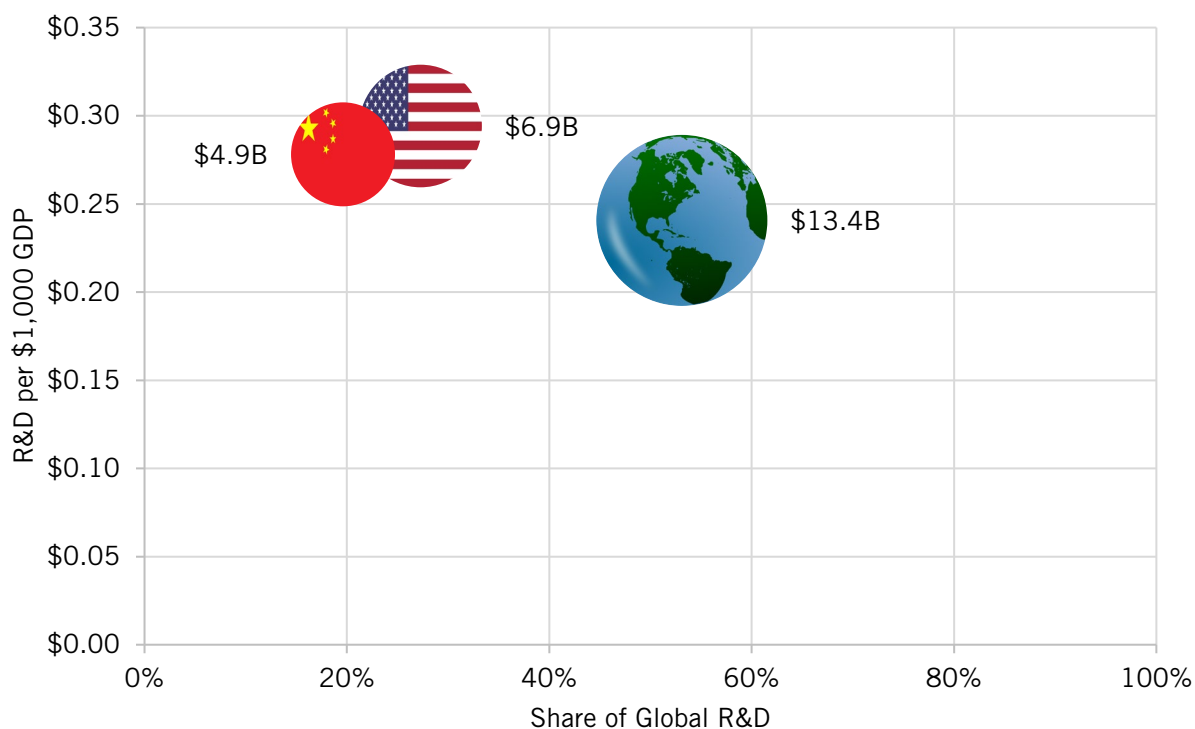
The general industrials sector includes companies “engaged in three or more industrial business activities, none of which is the dominant business line.”⁸⁰ Moreover, the sector also includes companies that manufacture, distribute, and/or produce paint, material coatings, resin, plastic products, chemicals used in plastic, structural glass and other glass products, and packaging products.⁸¹

In 2021, 15 U.S. firms made the EU R&D 2,500 list, including General Electric, Honeywell, and 3M. Sixteen Chinese firms, including Metallurgical Corporation of China, China International Marine Containers, and Sunwoda Electronics, also made the list.⁸² In 2021, the average U.S. firm in this sector spent \$457 million on R&D.⁸³ In comparison, the average Chinese firm spent \$308 million, a 0.15 standard deviation below the average firm globally.⁸⁴ This is compared with the average firm's R&D spending of \$393 million globally.⁸⁵

U.S. firms in the general industrials sector spend more on R&D than did Chinese firms. In 2021, U.S. firms spent \$6.9 billion on R&D compared with Chinese firms' \$4.9 billion.⁸⁶ Due to U.S. firms' higher R&D investments, their R&D spending made up 27.3 percent of the global sector's.⁸⁷ In comparison, Chinese firms' spending only comprised 19.6 percent.⁸⁸ Adjusting for GDP, U.S. firms did not spend a lot more than Chinese firms on R&D. For every \$1,000 of GDP, U.S. firms spent \$0.19 on R&D compared with Chinese firms' \$0.18.⁸⁹ This is compared with the rest of the world's R&D share of 53.1 percent and spending of \$0.24 for every \$1,000.⁹⁰

(See figure 11.) Yet, when adjusting for wages, Chinese firms spent 1.4 times more than U.S. firms—\$9.5 billion compared to U.S. firms' \$6.9 billion.⁹¹

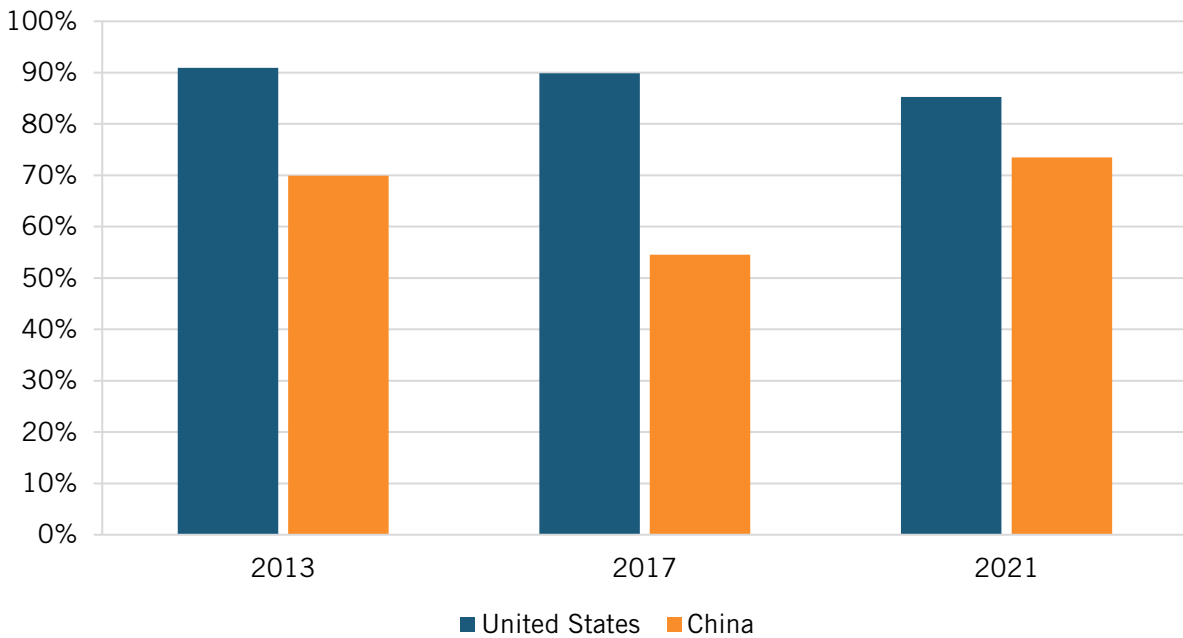
Figure 11: R&D spending by U.S. and Chinese firms in the general industrials sector, 2021⁹²



U.S. firms' R&D share of investment has been declining while Chinese firms' has been rising. From 2013 to 2021, U.S. firms' share of global R&D declined from 37.5 percent to 27.3 percent while Chinese firms' share rose from 4.1 percent to 19.6 percent.⁹³ (See figure 13.) This is partially because U.S. firms started investing less in R&D. From 2013 to 2021, U.S. firms' R&D investment per \$1,000 of GDP declined from \$0.28 to \$0.19.⁹⁴ In other words, U.S. firms' growth in R&D spending lags behind the global sector's growth in R&D investments, while Chinese firms' growth exceeds it.

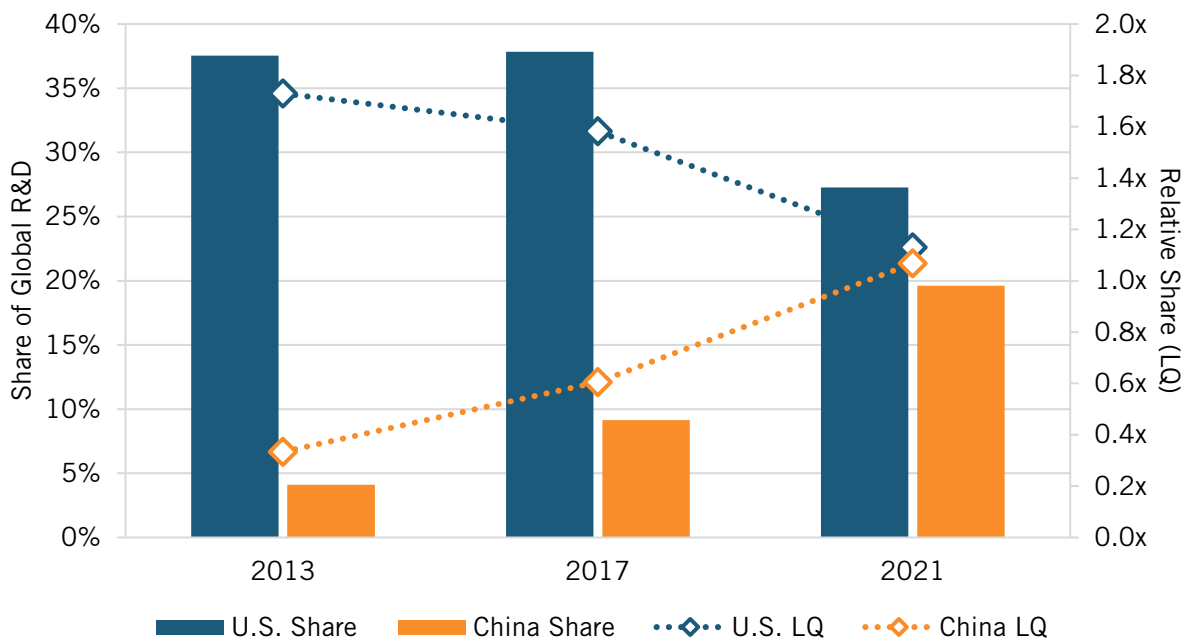
The top four U.S. firms with the highest R&D spending have consistently played a key role in driving U.S. firms' share of global R&D.⁹⁵ In 2013, the top four U.S. firms accounted for 91 percent of the domestic sector's R&D.⁹⁶ In 2021, they still accounted for 85 percent, meaning these firms made up 23.3 percent of the global sector's R&D spending.⁹⁷ This slight decrease in reliance occurred despite the number of U.S. firms declining from 20 to 15 in this period. In comparison, Chinese firms' share of global R&D has consistently been less dependent on the top four firms than has U.S. firms' share. In 2013, the top four Chinese firms made up 70 percent of the domestic sector's R&D spending.⁹⁸ And in 2021, the top four Chinese firms accounted for 73 percent.⁹⁹ This slight increase in reliance occurred despite the number of Chinese firms increasing from 11 to 16. (See figure 12.) In other words, the United States depends slightly more on its top four firms to maintain current levels of private sector R&D competitiveness than China does.

Figure 12: Top four U.S. and Chinese firms' share of domestic R&D in general industrials¹⁰⁰



U.S. firms' size-adjusted R&D investments compared with the global average have also declined since 2013, while Chinese firms' have risen. From 2013 to 2021, U.S. firms' R&D spending declined from 170 percent of the global average to 110 percent (1.7x to 1.1x).¹⁰¹ In comparison, Chinese firms' increased from 30 percent of the global average to 110 percent.¹⁰² (See figure 13.) Said differently, U.S. and Chinese firms in the sector spent the same amount on R&D when controlling for GDP. This is worrisome because it means U.S. firms focus less on competitiveness than their Chinese counterparts do.

Figure 13: U.S. and Chinese firms' shares of global R&D in the general industrials sector¹⁰³



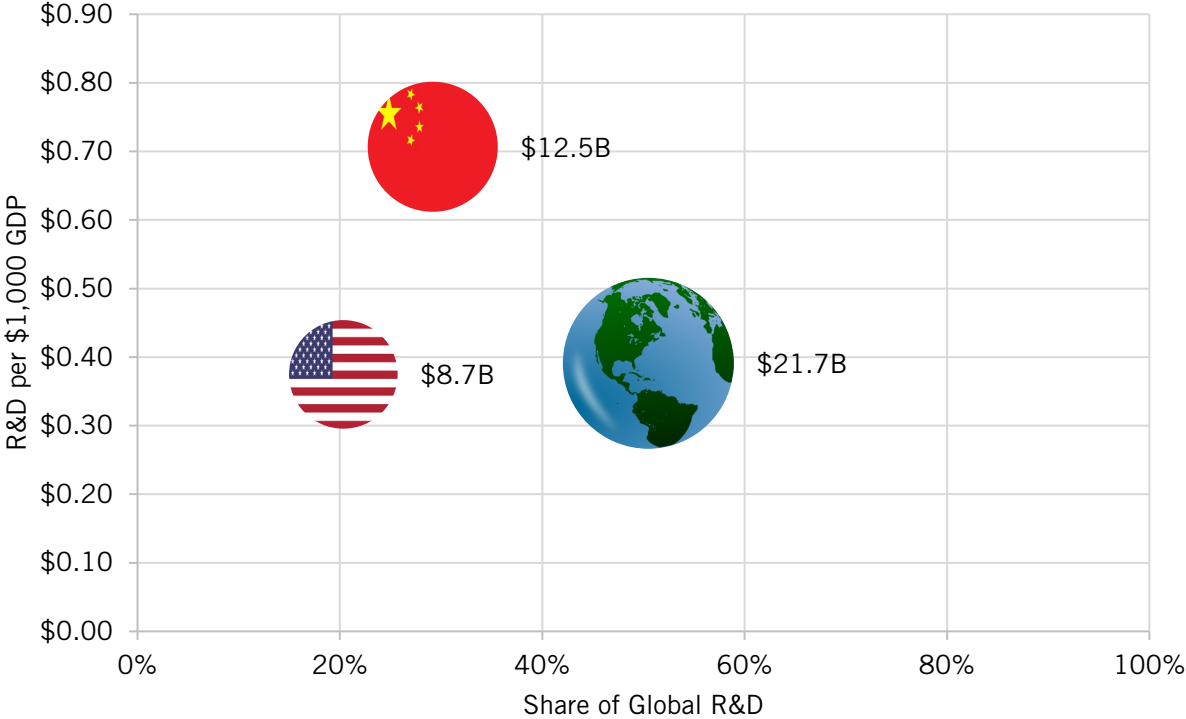
Industrial Engineering

The industrial engineering sector includes “companies that design, develop, manufacture, sell, and support general industrial machines and parts;” manufacture farming equipment; manufacture large construction and port industrial equipment; manufacture and distribute energy output devices (such as diesel engines); manufacture equipment for heavy industries; and manufacture and market specific types or groups of industrial machines and parts.¹⁰⁴

In 2021, 28 U.S. firms made the EU R&D 2,500 list, including Caterpillar, Deere, and Cummins. Fifty-two Chinese firms also made the list, including CRRC China, Sany Heavy Industry, and Hunan Valin Steel.¹⁰⁵ The average U.S. firm spent \$312 million on R&D, a 0.15 standard deviation above the average firm’s in the sector globally.¹⁰⁶ In comparison, the average Chinese firm spent \$241 million on R&D, a 0.04 standard deviation below the average firm’s.¹⁰⁷ This is compared with the average firm’s R&D spending of \$257 million.¹⁰⁸

Despite the average U.S. firm’s higher spending on R&D, Chinese firms in the industrial engineering sector collectively spend more on R&D than U.S. firms because of the higher number of Chinese firms in the sector. In 2021, U.S. firms spent \$8.7 billion on R&D, \$3.8 billion less than Chinese firms did.¹⁰⁹ As a result, Chinese firms’ R&D share of the global sector was 29.2 percent compared with U.S. firms’ 20.3 percent.¹¹⁰ Adjusting for GDP, Chinese firms still spent more than U.S. firms. While U.S. firms spent \$0.37 for every \$1,000, Chinese firms spent \$0.71—almost double that of U.S. firms.¹¹¹ This is compared with the rest of the world’s R&D share of 50.5 percent and spending of \$0.39 for every \$1,000.¹¹² (See figure 14.) Moreover, adjusted for wages, Chinese firms spent 2.8 times more than U.S. firms—\$24 billion compared to U.S. firms’ \$8.7 billion.¹¹³

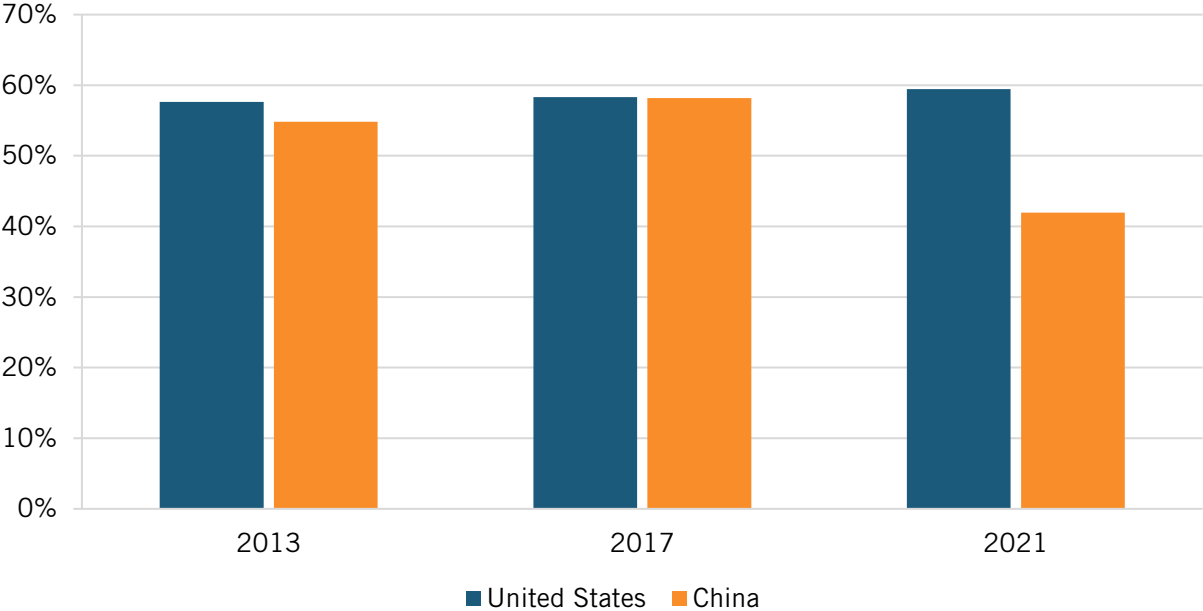
Figure 14: R&D spending by U.S. and Chinese firms in the industrial engineering sector, 2021¹¹⁴



U.S. firms in the industrial engineering sector have not always lagged behind Chinese firms in R&D investments. In 2013, U.S. firms made up 24.8 percent of the global sector’s R&D spending, while Chinese firms only made up 8.9 percent.¹¹⁵ Even in 2017, U.S. firms still exceeded Chinese firms in R&D share of the global sector’s spending. Yet, U.S. firms’ growth started lagging behind the global sector’s growth after that, while Chinese firms’ growth exceeded the global sector’s.¹¹⁶ As a result, in 2021, Chinese firms’ share was 29.2 percent compared with U.S. firms’ 20.3 percent.¹¹⁷

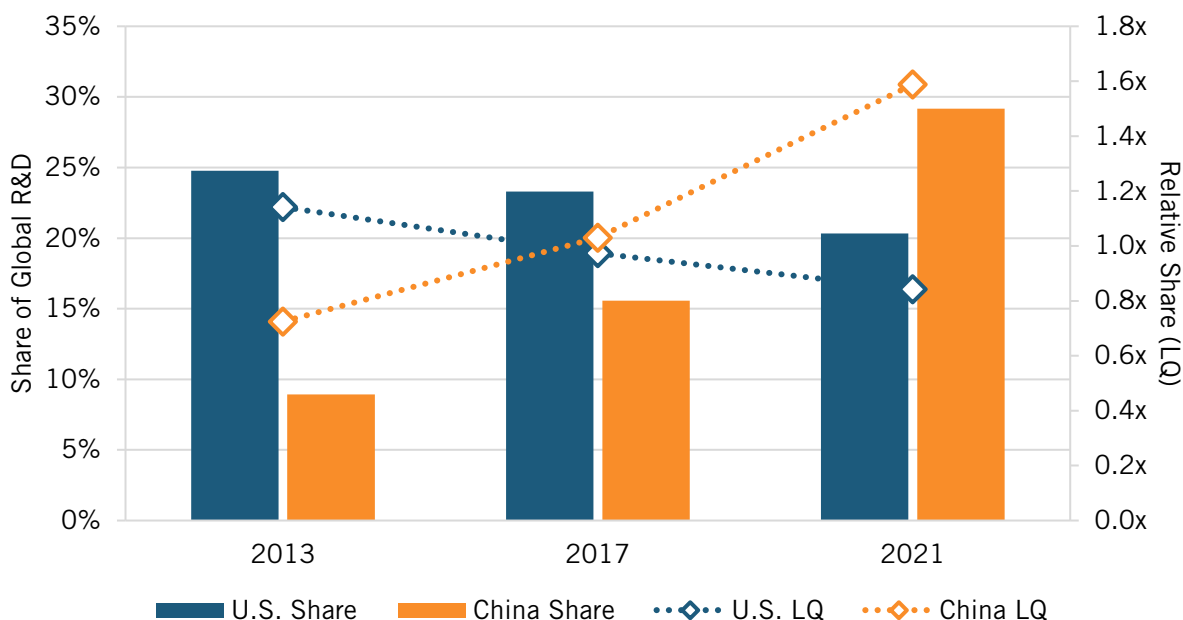
The top four U.S. firms with the highest R&D spending consistently played a key role in driving U.S. firms’ share of global R&D. In 2013, the top four U.S. firms accounted for 58 percent of the domestic sector’s R&D.¹¹⁸ In 2021, they still accounted for 59 percent, meaning these firms made up 12.1 percent of the global sector’s R&D spending.¹¹⁹ U.S. firms’ reliance on the top four firms remained about the same despite the number of U.S. firms declining from 42 to 28 in this period. In comparison, Chinese firms’ share became less dependent on the top four Chinese firms. In 2013, the top four Chinese firms comprised 55 percent of the domestic sector’s R&D spending.¹²⁰ Yet, by 2021, they only accounted for 42 percent.¹²¹ The decreased reliance is partially because the number of Chinese firms increased from 28 to 52 in this period. (See figure 15.) In other words, the United States depends more on its top four firms to maintain current private sector R&D competitiveness levels.

Figure 15: Top four U.S. and Chinese firms’ share of domestic R&D in industrial engineering¹²²



Compared with the global sector’s average, U.S. firms’ size-adjusted investments in R&D have also declined. From 2013 to 2021, U.S. firms’ R&D spending fell from 110 percent to 80 percent of the sector’s global average (1.1x to 0.8x), meaning they now perform below the global average in R&D investments.¹²³ In comparison, Chinese firms’ spending increased from just 70 percent to 160 percent of the sector’s global average (0.7x to 1.6x), meaning Chinese firms are now one of the global leaders in R&D investment.¹²⁴ (See figure 16.) U.S. firms lost their lead in R&D investment share of GDP to Chinese firms, hurting U.S. innovation and competitiveness.

Figure 16: U.S. and Chinese firms' shares of global R&D in industrial engineering¹²⁵



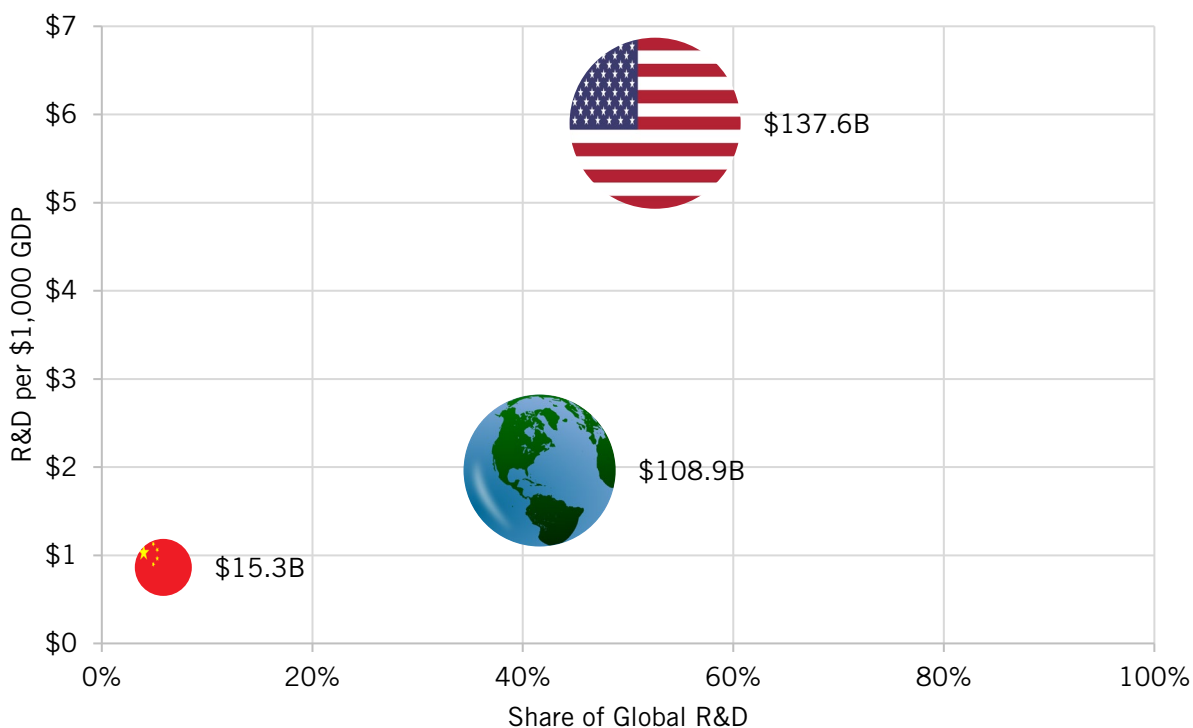
Pharmaceutical and Biotechnology

The pharmaceutical and biotechnology sector includes “companies engaged in research into and development of biological substances for the purposes of drug discovery and diagnostic development, and which derive the majority of their revenue from either the sale or licensing of these drugs and diagnostic tools.”¹²⁶ It also includes manufacturers of prescription and over-the-counter drugs and companies that cultivate and distribute cannabis, or both.¹²⁷

In 2021, 263 U.S. firms made the EU R&D 2,500 list, including Johnson & Johnson, Pfizer, and Bristol-Myers Squibb. Seventy-nine Chinese firms, including Zai Lab, Sino Biopharmaceutical, and CSPC Pharmaceutical, also made the list.¹²⁸ The average U.S. firm spent \$523 million on R&D, a 0.01 standard deviations below the average firm globally. In comparison, the average Chinese firm spent \$194 million, 0.20 standard deviations below the average firm globally.¹²⁹ This is compared with the average firm’s R&D spending of \$548 million globally.¹³⁰ In other words, both the average U.S. and Chinese firm spent less than the average firm on R&D globally.

U.S. firms have spent significantly more than Chinese firms on R&D. In 2021, U.S. firms spent \$138 billion on R&D while Chinese firms only spent \$15.3 billion.¹³¹ As a result, U.S. firms’ R&D share of the global sector was 52.6 percent, almost nine times that of Chinese firms’ 5.8 percent.¹³² Controlling for GDP, U.S. firms still spent more. In 2021, U.S. firms spent \$5.90 for every \$1,000 of GDP.¹³³ In comparison, Chinese firms only spent \$0.86, almost seven times less than U.S. firms.¹³⁴ This is compared with the rest of the world’s R&D share of 41.6 percent and spending of \$1.96 for every \$1,000.¹³⁵ (See figure 17.) Even when adjusting for wages, U.S. firms still spent 4.7 times more than Chinese firms—\$138 billion compared to Chinese firms’ \$29.3 billion.¹³⁶

Figure 17: R&D spending by U.S. and Chinese firms in the pharmaceutical and biotechnology sector, 2021¹³⁷

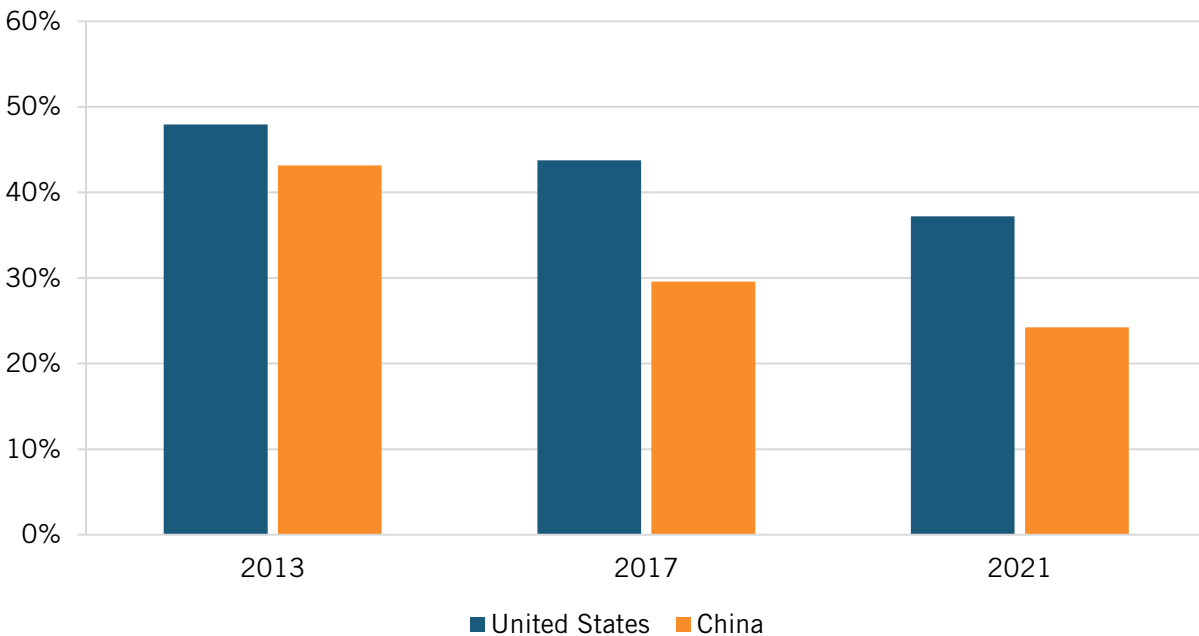


U.S. firms consistently spent more on R&D than did Chinese firms in the last decade. From 2013 to 2021, U.S. firms' R&D share of the global sector rose from 42.8 percent to 52.6 percent, meaning the majority of R&D spending came from U.S. companies.¹³⁸ In comparison, Chinese firms' R&D share started at 0.4 percent in 2013 and rose to only 5.8 percent by 2021.¹³⁹ These figures signal that U.S. firms significantly outperformed Chinese firms in promoting growth and competitiveness with their R&D spending.

Chinese firms in the pharmaceutical and biotechnology sector are not investing as much in R&D in relation to the size of their country's GDP.

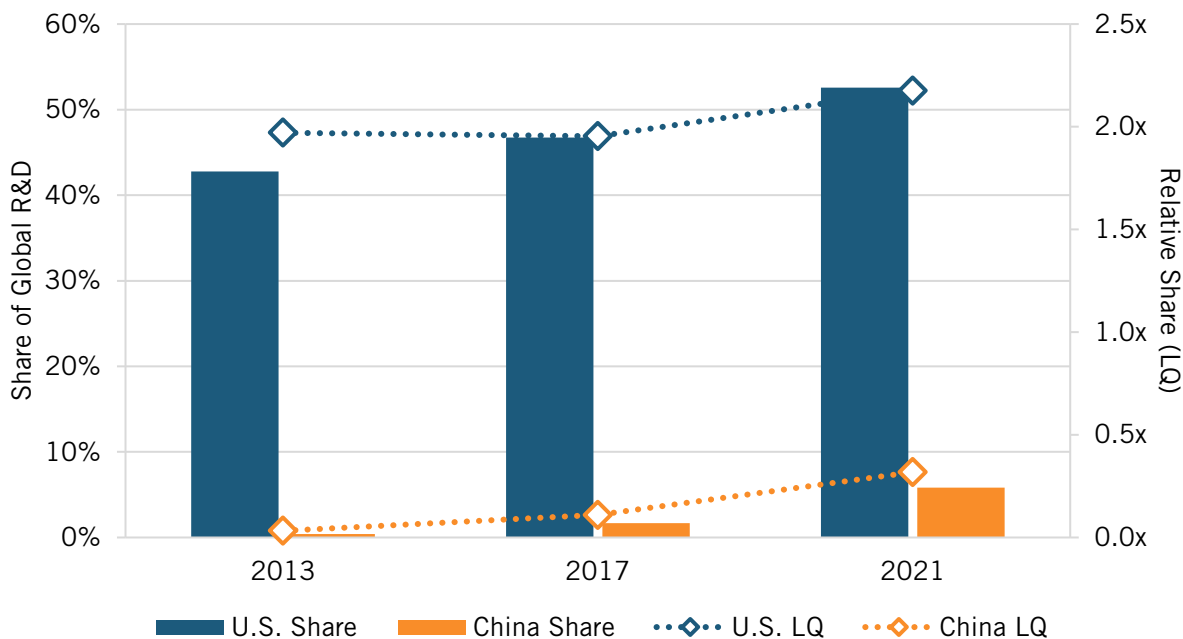
Both the United States and China have become less reliant on their respective top four firms that spend the most on R&D to drive their firms' share of global R&D. In 2013, the top four U.S. firms accounted for 48 percent of the domestic sector's R&D spending.¹⁴⁰ Yet, by 2021, they declined to 37 percent.¹⁴¹ This decreased reliance is partially due to the number of U.S. firms increasing from 144 to 263 in this period. Similarly, in 2013, the top four Chinese firms made up 43 percent of the domestic sector's R&D spending.¹⁴² And by 2021, they only accounted for 24 percent.¹⁴³ This decreased reliance is partially because Chinese firms increased from 14 to 79. (See figure 18.) In other words, the United States depends more on its top four firms to maintain current levels of private sector R&D competitiveness, but both countries are becoming less reliant on the top four firms to drive their firm's share of global R&D.

Figure 18: Top four U.S. and Chinese firms' share of domestic R&D in pharmaceuticals and biotechnology¹⁴⁴



In the last decade, U.S. firms also performed better than the average global R&D share of GDP, while Chinese firms performed poorly. In 2013 and 2017, U.S. firms' size-adjusted R&D spending was 200 percent of the global average (2.0x).¹⁴⁵ And by 2021, that had risen to 220 percent of the global average (2.2x).¹⁴⁶ In comparison, Chinese firms' R&D spending was nonexistent in 2013 and only 10 percent of the global average in 2017 (0.1x).¹⁴⁷ By 2021, that had only risen to 30 percent of the global average (0.3x).¹⁴⁸ (See figure 19.) In other words, Chinese firms are not investing as much in R&D in relation to the size of their economy.

Figure 19: U.S. and Chinese firms' shares of global R&D in pharmaceuticals and biotechnology¹⁴⁹



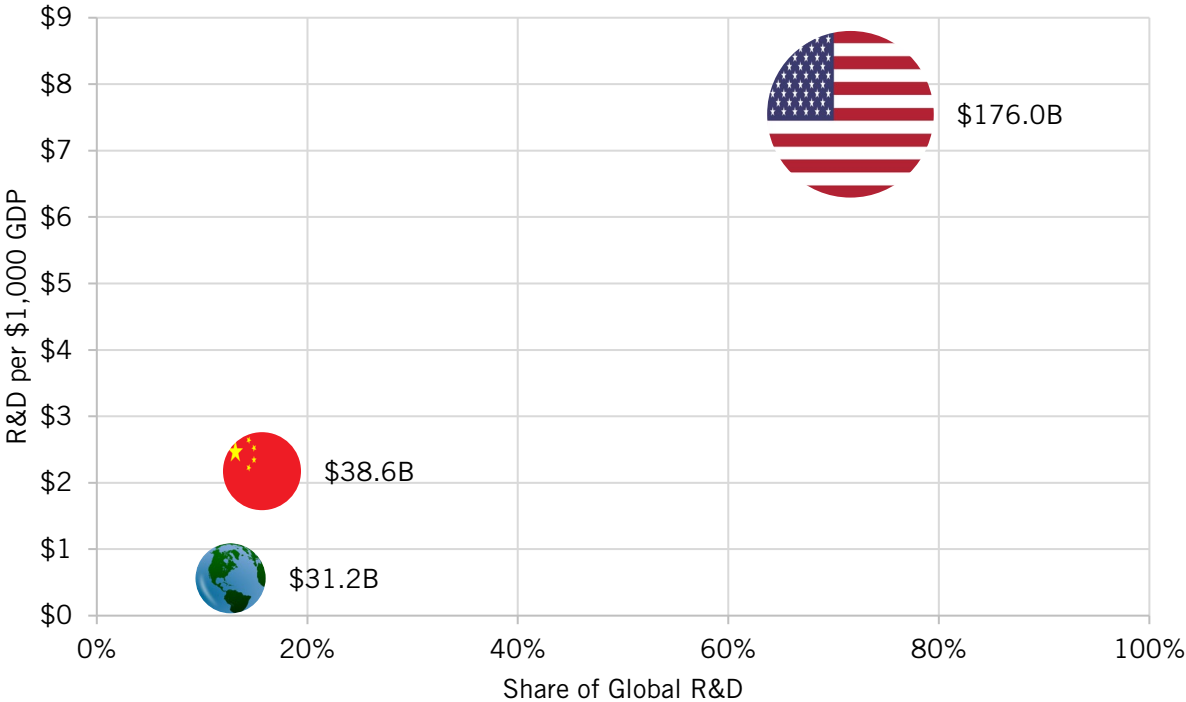
Software and Computer Services

The software and computer services sector includes companies that provide consulting or integration services to other businesses relating to information technology: computer-system designers, systems integrators, network and systems operations, cloud computing service providers, distributed ledger technology (DLT) consultants and integrators, data management and storage providers, repair and technical support services.¹⁵⁰ The sector also includes publishers and distributors of computer software and companies that generate revenue from virtual products using digital platforms.¹⁵¹

In 2021, 197 U.S. firms made the EU R&D 2,500 list, including Alphabet, Meta, and Microsoft. (See appendix 2 for details on the addition of Amazon.) Seventy-three Chinese firms also made the list, including Alibaba Group Holding, Tencent, and Baidu.¹⁵² In 2021, the average U.S. firm spent \$1.1 billion on R&D, a 0.7 standard deviation above the average firm globally.¹⁵³ In comparison, the average Chinese firm spent \$528 million on R&D, 0.9 standard deviations below the average firm globally.¹⁵⁴ This is compared with the average firm’s R&D spending of \$857 million globally.¹⁵⁵

U.S. firms spent more than Chinese firms on R&D. In 2021, U.S. firms spent \$219 billion on R&D, making up 75.8 percent of the sector’s global R&D spending.¹⁵⁶ In comparison, Chinese firms spent \$38.6 billion, making up 13.4 percent of the global R&D spending.¹⁵⁷ When controlling for GDP, U.S. firms spent about four times more than Chinese firms.¹⁵⁸ For every \$1,000 of GDP, U.S. firms spent \$9.39 while Chinese firms spent only \$2.17.¹⁵⁹ This is compared with the rest of the world’s R&D share of 10.8 percent and spending of \$0.56 for every \$1,000.¹⁶⁰ (See figure 20.) Moreover, when adjusting for wages, U.S. firms still spent three times more than Chinese firms—\$219 billion compared to Chinese firms’ \$74 billion.¹⁶¹

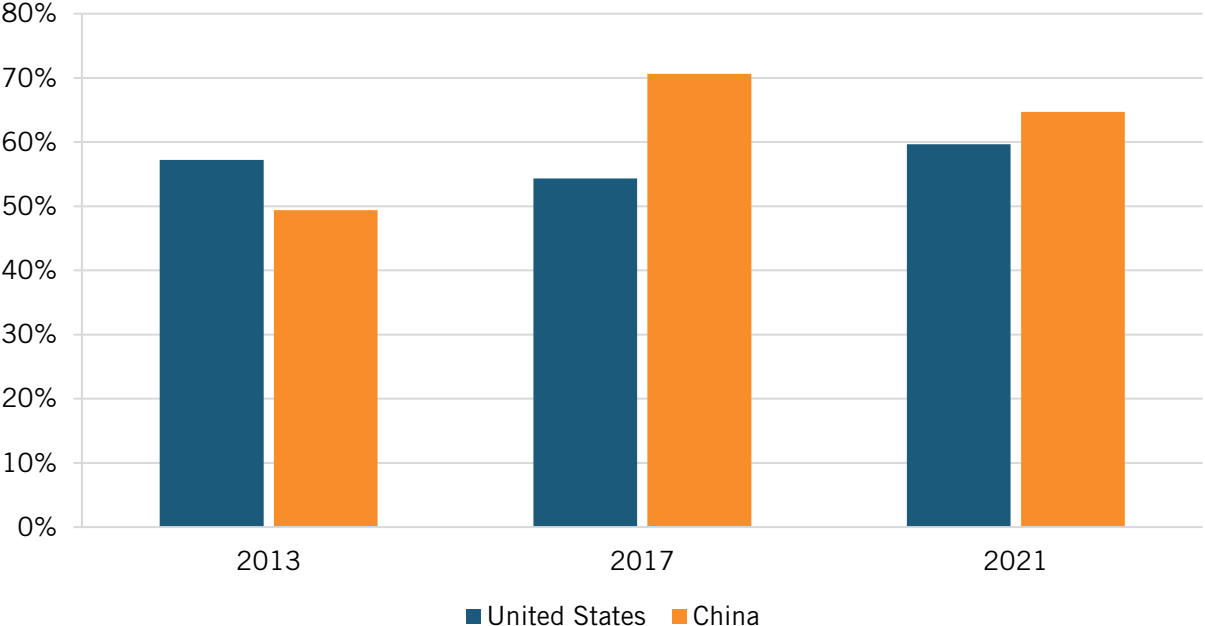
Figure 20: R&D spending by U.S. and Chinese firms in software and computer services, 2021¹⁶²



U.S. firms consistently spend more than Chinese firms on R&D. In 2013, U.S. firms' R&D share of the global sector was 75 percent compared with Chinese firms' 0.6 percent.¹⁶³ And in 2021, that remained about the same (75.8 percent) but was still significantly higher than Chinese firms' 13.4 percent.¹⁶⁴ Although U.S. firms still spend considerably more than Chinese firms, their global sector share has not changed much, while Chinese firms' global share has increased.

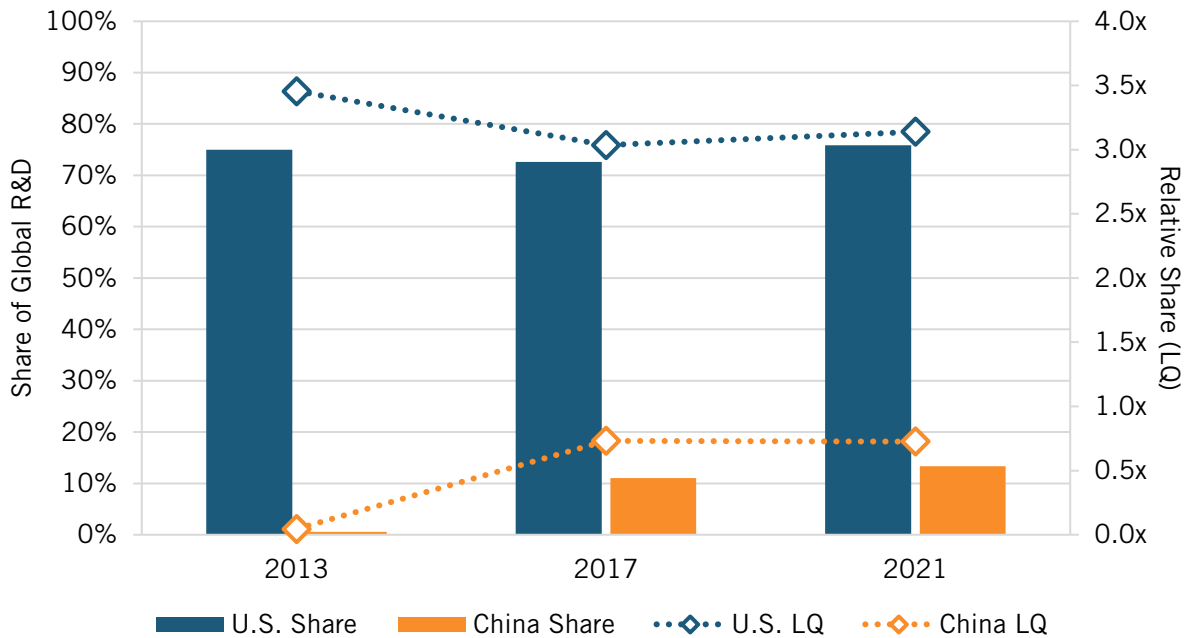
The top four U.S. firms with the highest R&D spending have consistently played a key role in driving U.S. firms' share of global R&D. In 2013, the top four U.S. firms accounted for 57 percent of the domestic sector's R&D.¹⁶⁵ And in 2021, they accounted for 60 percent, meaning these firms made up 45.3 percent of the global sector's R&D spending.¹⁶⁶ This slight increased reliance occurred despite the number of U.S. firms increasing from 152 to 196 in this period. In comparison, Chinese firms' share of global R&D has become more dependent on the top four Chinese firms, which in 2013 made up 49 percent of the domestic sector's R&D spending.¹⁶⁷ Yet, by 2021, they accounted for 65 percent.¹⁶⁸ This increased reliance occurred despite the number of Chinese firms increasing from 11 to 73.¹⁶⁹ (See figure 21.) In other words, China depends slightly more on its top four firms to maintain current private sector R&D competitiveness levels.

Figure 21: Top four U.S. and Chinese firms' share of domestic R&D in software and computer services¹⁷⁰



In the last decade, U.S. firms in the sector also performed better than the average global R&D share of GDP, while Chinese firms performed poorly. In 2013, U.S. firms' size-adjusted R&D spending was 350 percent of the average global (3.5x), while Chinese firms' was nonexistent (0.0x).¹⁷¹ By 2021, U.S. firms' R&D spending had declined to 310 percent of the global average (3.1x), while Chinese firms' rose to 70 percent (0.7x).¹⁷² (See figure 22.) Despite U.S. firms dedicating more spending to R&D than did Chinese firms, U.S. firms' size-adjusted spending compared with the global sector's remained steady, while Chinese firms' was catching up.

Figure 22: U.S. and Chinese firms' shares of global R&D in software and computer services¹⁷³



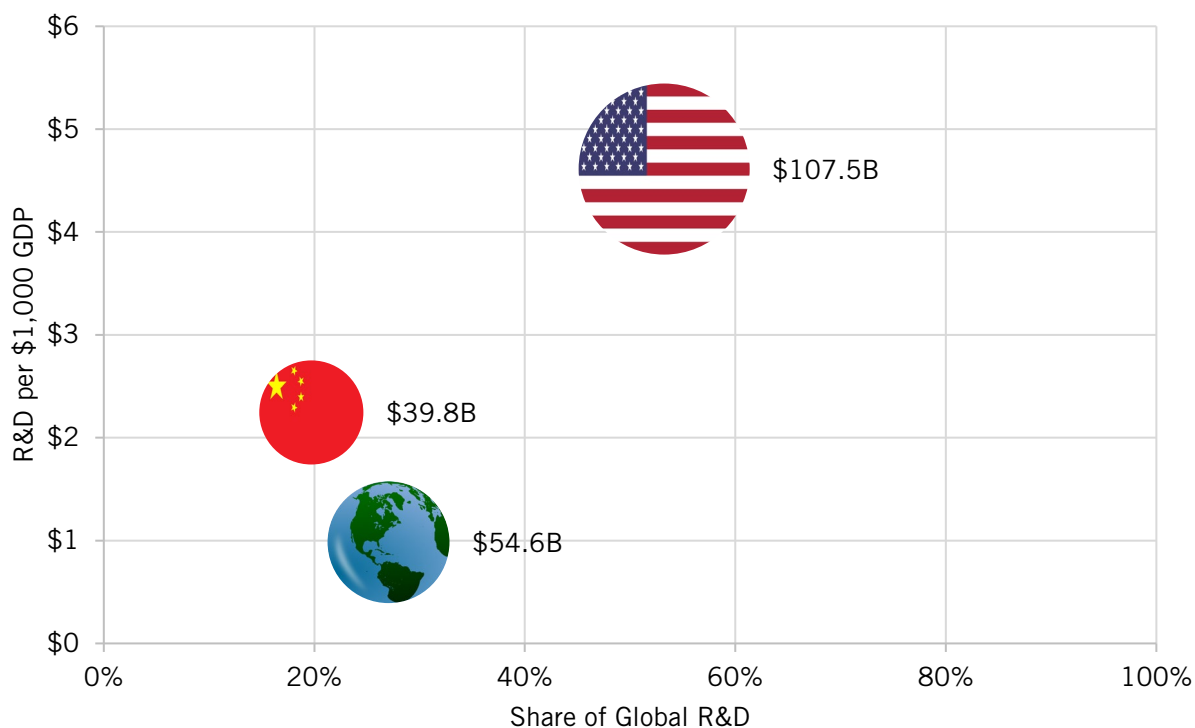
Technology and Hardware Equipment

The technology and hardware equipment sector includes semiconductor and other chip producers and distributors; “companies involved in the application of high technology parts to finished products” (e.g., printed circuit boards); semiconductors, photonics, and wafers creation equipment manufacturers; computer, servers, and other computer hardware manufacturers and distributors; and electronic office equipment manufacturers and distributors.¹⁷⁴

In 2021, 71 U.S. firms made the EU R&D 2,500 list, including Apple, Intel, and Qualcomm. Forty-seven Chinese firms also made the list, including Huawei Investment & Holding, ZTE, and Xiaomi.¹⁷⁵ In 2021, the average U.S. firm spent \$1.5 billion on R&D, a 0.19 standard deviation above the average firm in the sector globally.¹⁷⁶ In comparison, the average Chinese firm in the sector spent \$847 million, a 0.05 standard deviation below the average firm globally.¹⁷⁷ This is compared with the average firm’s R&D spending of \$976 million.¹⁷⁸

U.S. firms spent more than Chinese firms on R&D. In 2021, U.S. firms spent \$107.5 billion while Chinese firms only spent \$39.8 billion.¹⁷⁹ As a result, U.S. firms’ R&D made up 53.2 percent of the global sector compared with Chinese firms’ 19.7 percent.¹⁸⁰ Controlling for GDP, U.S. firms outspent Chinese firms by 2.1 times.¹⁸¹ U.S. firms spent \$4.61 for every \$1,000 of GDP, while Chinese firms spent \$2.25.¹⁸² This is compared with the rest of the world’s R&D share of 27 percent and spending of \$0.98 for every \$1,000.¹⁸³ (See figure 23.) Yet, when adjusting for wages, U.S. firms only spent 1.4 times more than Chinese firms—\$76 billion compared to U.S. firms’ \$108 billion.¹⁸⁴

Figure 23: R&D spending by U.S. and Chinese firms in the technology hardware and equipment sector, 2021 ¹⁸⁵



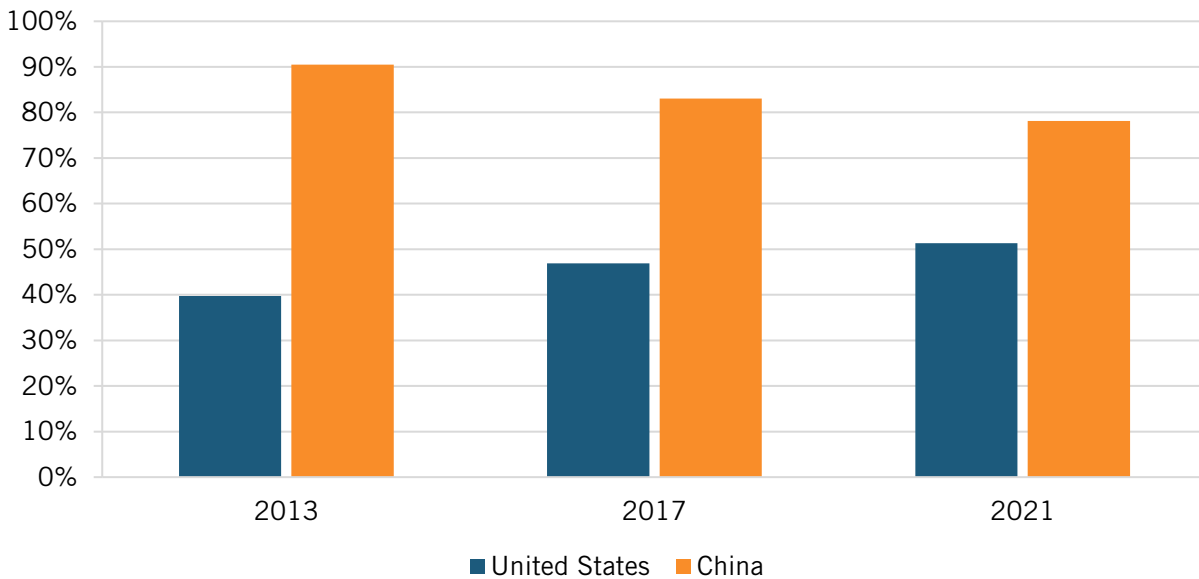
In the last decade, U.S. firms also consistently spent more than Chinese firms on R&D. In 2013, U.S. firms' R&D share of the global industry was 55.6 percent compared with Chinese firms' 6.3 percent.¹⁸⁶ From 2013 to 2017, U.S. firms' R&D spending saw a minor decline to 54.9 percent of the global sector.¹⁸⁷ Yet, in the same period, Chinese firms' grew 8.6 percent, making up 14.9 percent of the global sector.¹⁸⁸ And from 2017 to 2021, U.S. firms' R&D share of the global sector again saw a small decline to 53.2 percent, while Chinese firms' grew to 19.7 percent.¹⁸⁹ (See figure 25.) In other words, Chinese firms' investments are growing, meaning they seek to become a global competitor that rivals U.S. firms in the future.

The rapid increase in R&D investment from Chinese firms in the tech and hardware sector means they will likely become increasingly more competitive, taking market shares from the United States.

The United States is becoming more reliant on its top four firms with the highest R&D spending to drive its share of global R&D spending. In 2013, the top four U.S. firms accounted for 40 percent of the domestic sector's R&D.¹⁹⁰ In 2021, they still accounted for 51 percent, meaning these firms made up 27.3 percent of the global sector's R&D spending.¹⁹¹ This increased reliance is partially because the number of U.S. firms declined from 142 to 71.

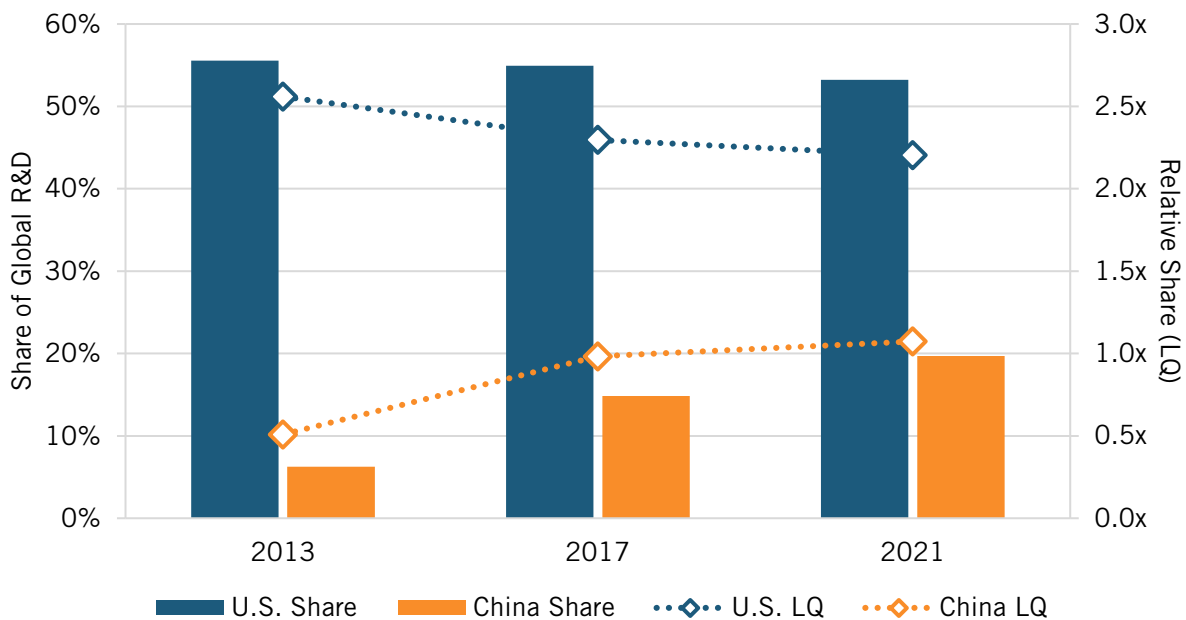
The United States is still much less reliant on its top four firms than is China to maintain its share of global R&D spending. Yet, China is minimizing its reliance on its top four firms. In 2013, the top four Chinese firms made up 90 percent of the domestic sector's R&D spending.¹⁹² Yet, by 2021, they accounted for 78 percent.¹⁹³ This decreased reliance is partially due to the number of Chinese firms increasing from 23 to 47. (See figure 24.)

Figure 24: Top four U.S. and Chinese firms' share of domestic R&D in technology hardware and equipment¹⁹⁴



U.S. firms have also performed better than the average global R&D share of GDP, yet Chinese firms are steadily catching up. In 2013, U.S. firms' size-adjusted R&D spending was 260 percent of the global sector's (2.6x), while Chinese firms' was 50 percent (0.5x).¹⁹⁵ By 2017, U.S. firms' size-adjusted R&D spending had declined to 230 percent of the global sector's (2.3x), while Chinese firms' had risen to 100 percent (1.0x).¹⁹⁶ In 2021, U.S. firms' spending declined to 220 percent of the global sector (2.2x), while Chinese firms' rose to 110 percent (1.1x).¹⁹⁷ (See figure 25.) This is important because the rapid increase in R&D investment from Chinese firms means they will likely become increasingly more competitive, taking market share from the United States.

Figure 25: U.S. and Chinese firms' shares of global R&D in technology hardware and equipment¹⁹⁸



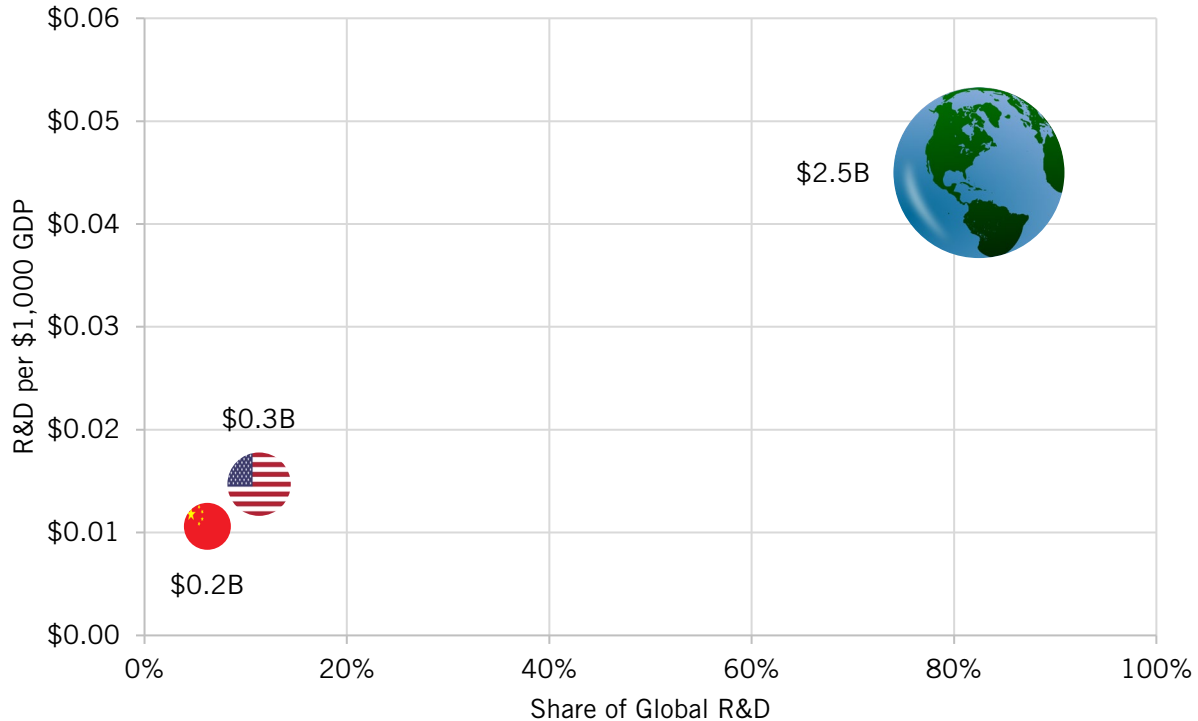
Alternative Energy

The alternative energy sector includes “companies that produce alternative fuels such as ethanol, methanol, hydrogen and bio-fuels that are mainly used to power vehicles, and companies that are involved in the production of vehicle fuel cells and/or the development of alternative fueling infrastructure.”¹⁹⁹ Moreover, the sector also includes “companies that develop or manufacture renewable energy equipment utilizing sources such as solar, wind, tidal, geothermal, hydro and waves.”²⁰⁰

In 2021, two U.S. firms in this sector made the EU R&D 2,500 list: Solaredge Technologies and First Solar.²⁰¹ One Chinese firm, Sungrow Power Supply, also made the list.²⁰² That same year, the average U.S. firm spent \$171 million on R&D, a 0.39 standard deviation below the average firm’s R&D spending of \$378 million in the sector globally.²⁰³ In comparison, the average Chinese firm spent \$188.1 million, a 0.35 standard deviation below the average firm’s.²⁰⁴

Collectively, U.S. firms in the alternative energy sector spent more on R&D than did Chinese firms. In 2021, U.S. firms spent \$343 million, \$155 million more than Chinese firms.²⁰⁵ As a result, U.S. firms’ R&D share of the global sector was 11.3 percent compared with Chinese firms’ 6.2 percent.²⁰⁶ Adjusting for GDP, U.S. and Chinese firms spent the same amount on R&D. For every \$1,000 of GDP, both U.S. and Chinese firms spent \$0.01.²⁰⁷ This is compared with the rest of the world’s R&D share of 82.5 percent and spending of \$0.05 for every \$1,000.²⁰⁸ (See figure 26.) Yet, when adjusting for wages, Chinese firms spent 1.1 times more than U.S. firms—\$361 million compared to U.S. firms’ \$343 million.²⁰⁹

Figure 26: R&D spending by U.S. and Chinese firms in the alternative energy sector, 2021²¹⁰

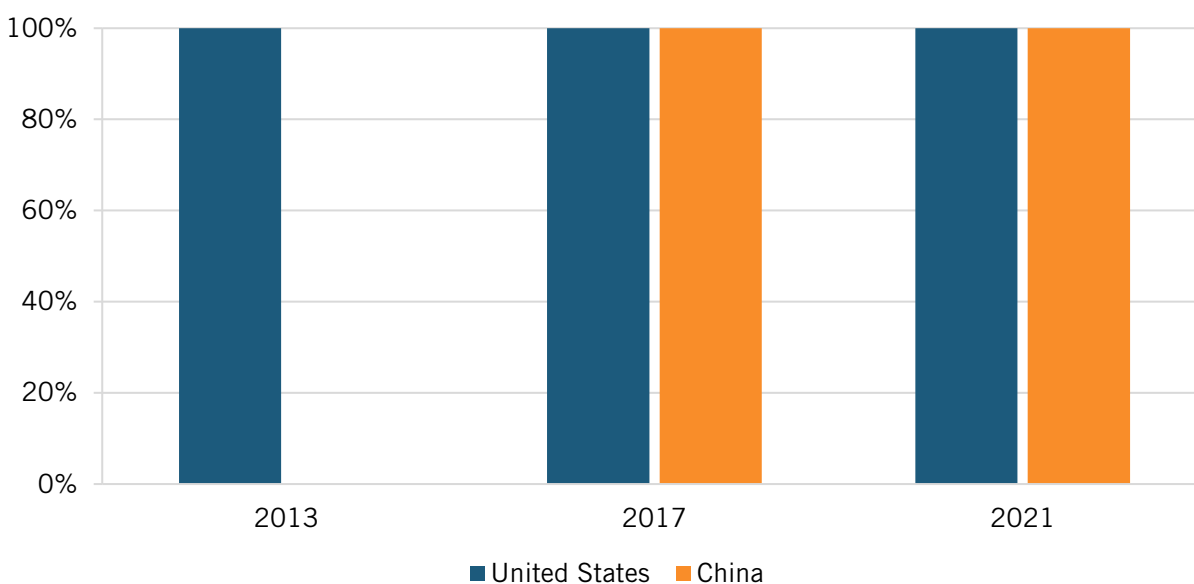


U.S. firms consistently spend more than Chinese firms on R&D. In 2013, U.S. firms’ R&D share of the global sector was 17 percent compared with Chinese firms’ nonexistent share.²¹¹ By 2021,

U.S. firms' share had declined to 11.3 percent but was still about double that of Chinese firms' 6.2 percent.²¹² Despite U.S. firms spending more than Chinese firms, both U.S. and Chinese firms are losing global R&D shares to other nations.

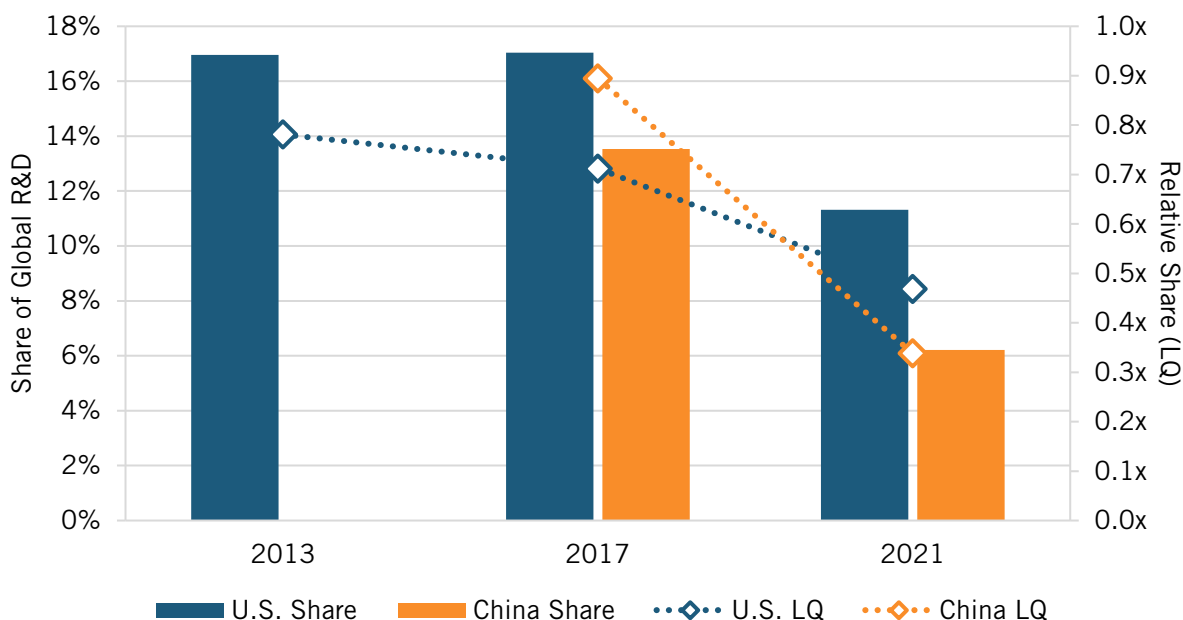
The limited number of U.S. and Chinese firms in the sector means both nations depend on their top four firms to drive their share of global private sector R&D. From 2013 to 2021, the top four U.S. firms accounted for 100 percent of the domestic sector's R&D.²¹³ Similarly, Chinese firms' share of global R&D is dependent on the top four Chinese firms. In 2013, no Chinese firms invested in R&D.²¹⁴ With a few firms entering the sector, the top four Chinese firms then also accounted for 100 percent of the domestic sector's R&D in 2021.²¹⁵ Despite the number of U.S. firms increasing from 1 to 2 and Chinese firms increasing from 0 to 2 in this period, both still rely on the top four firms because of the limited number of firms each country has. (See figure 27.) In other words, both the United States and China depend on their top four firms to maintain current levels of private sector R&D spending competitiveness.

Figure 27: Top four U.S. and Chinese firms' share of domestic R&D in alternative energy²¹⁶



In the last decade, both U.S. and Chinese firms performed worse than the average global R&D share of GDP. In 2013, U.S. firms' size-adjusted R&D spending was 80 percent of the average global spending in the sector (0.8x), while Chinese firms' was nonexistent (0.0x).²¹⁷ By 2021, U.S. firms' spending declined to 50 percent of the global average (0.5x), while Chinese firms' rose to 30 percent (0.3x).²¹⁸ Although U.S. firms dedicated more spending in 2013 and 2021, Chinese firms did outspend U.S. firms in 2017: 90 percent of the global average compared with U.S. firms' 70 percent.²¹⁹ (See figure 28.) In other words, U.S. and Chinese firms have traded off on which spent more on R&D, but both failed to reach the sector's average global size-adjusted R&D spending.

Figure 28: U.S. and Chinese firms' shares of global R&D in alternative energy²²⁰



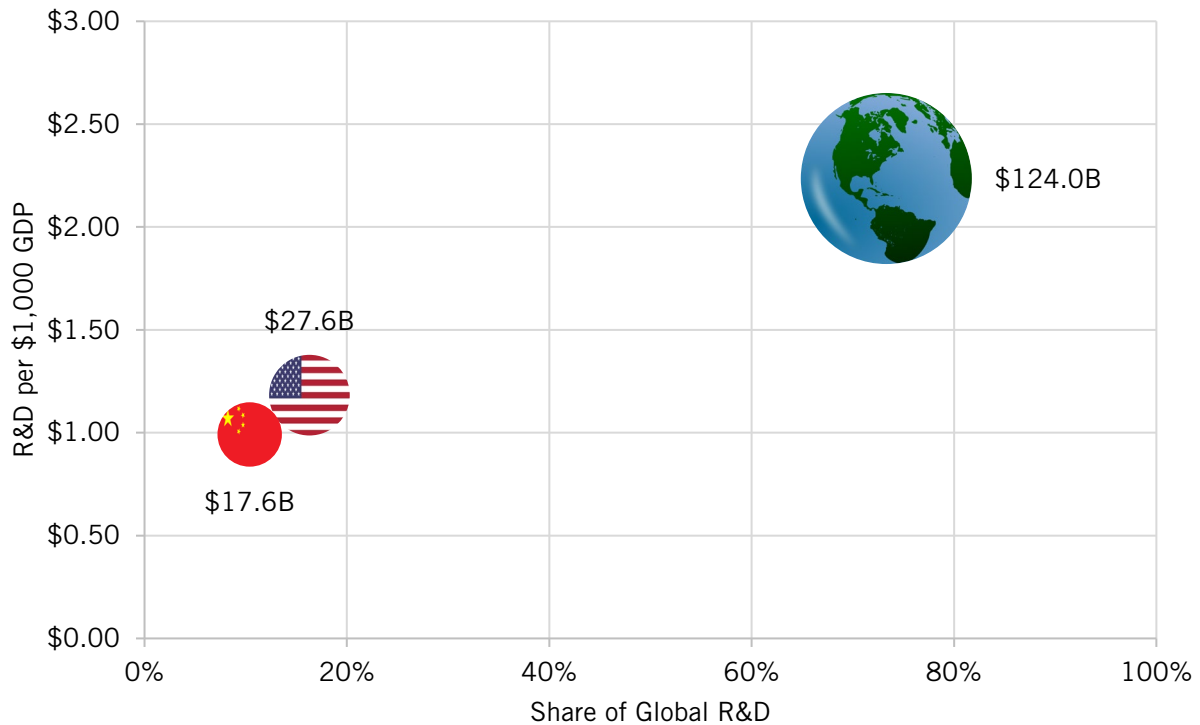
Automobiles and Parts

The automobiles and parts sector includes manufacturers and distributors of automobile, truck, and motorcycle tires; makers of cars, SUVs, and light trucks; and manufacturers and distributors of parts for motorcycles and other automobiles, such as engines.²²¹ The sector also includes “companies that provide assistance to individual vehicle owners.”²²²

In 2021, 28 U.S. firms made the EU R&D 2,500 list, including General Motors, Ford Motor Company, and Tesla.²²³ Forty-five Chinese firms also made the list, including SAIC Motor, Great Wall Motor, and Weichai Power.²²⁴ In 2021, the average U.S. firm spent \$985 million on R&D, a 0.06 standard deviation below the average firm’s R&D spending of \$1.1 billion in the sector globally.²²⁵ In comparison, the average Chinese firm spent \$391 million, a 0.30 standard deviation below the average firm’s.²²⁶

Collectively, U.S. firms have spent more on R&D than did Chinese firms. In 2021, U.S. firms spent \$27.6 billion, \$10 billion more than Chinese firms.²²⁷ As a result, U.S. firms’ R&D share of the global sector was 16.3 percent compared with Chinese firms’ 10.4 percent.²²⁸ Adjusting for GDP, U.S. firms spent more than Chinese firms. For every \$1,000 of GDP, U.S. firms spent \$1.18 compared with Chinese firms’ \$0.99. This is compared with the rest of the world’s R&D share of 73.3 percent and spending of \$2.24 for every \$1,000.²²⁹ (See figure 29.) Yet, when adjusting for wages, Chinese firms spent 1.2 times more than U.S. firms—\$33.7 billion compared to U.S. firms’ \$27.6 billion.²³⁰

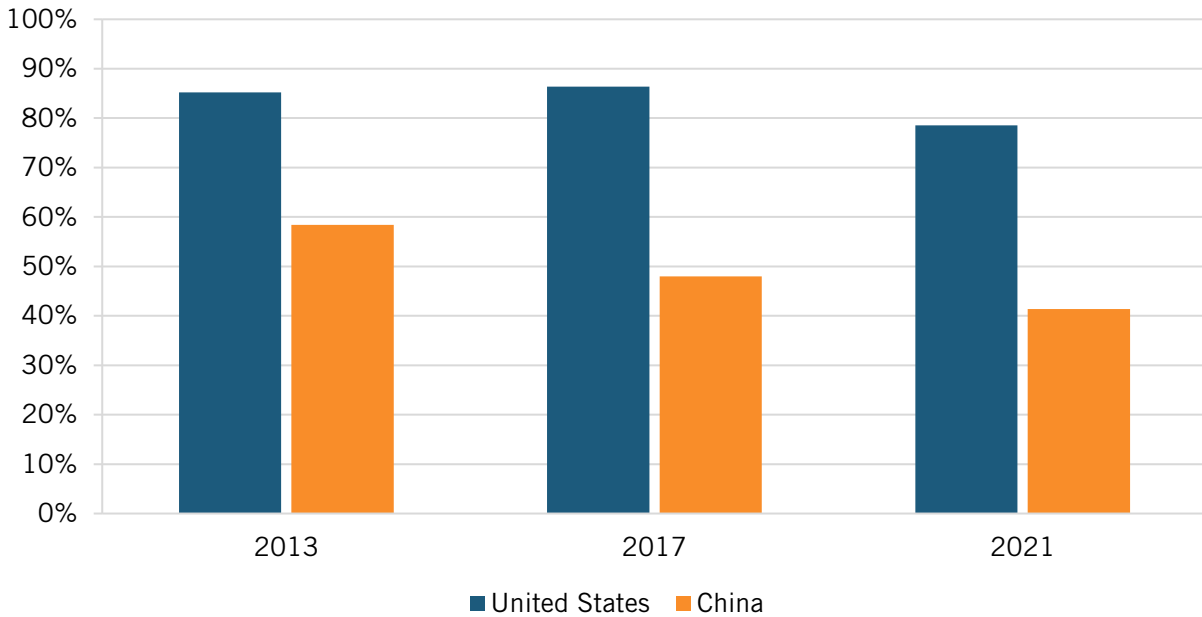
Figure 29: R&D spending by U.S. and Chinese firms in the automobile and parts sector, 2021²³¹



U.S. firms have consistently spent more on R&D than have Chinese firms in the last decade. From 2013 to 2021, U.S. firms' R&D share of the global sector rose slightly from 14.9 percent to 16.3 percent.²³² In comparison, Chinese firms' started at 2.5 percent in 2013 and rose to 10.4 percent in 2021.²³³ In other words, U.S. firms still outperform Chinese firms in R&D investment.

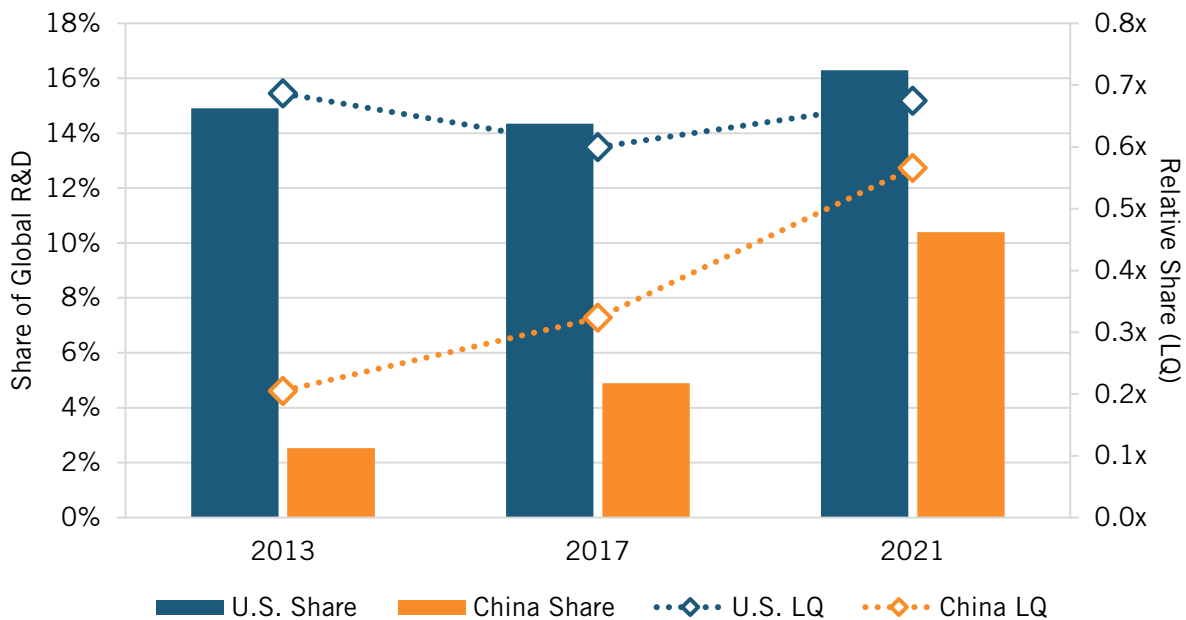
The top four U.S. firms with the highest R&D spending consistently have played a key role in driving U.S. firms' share of global R&D. In 2013, the top four U.S. firms accounted for 85 percent of the domestic sector's R&D.²³⁴ In 2021, they still accounted for 79 percent, meaning these firms made up 12.8 percent of the global sector's R&D spending.²³⁵ The slight decreased reliance is partially because the number of U.S. firms saw a slight increase from 23 to 28 in this period. In comparison, Chinese firms' share of global R&D has become less dependent on the top four Chinese firms. In 2013, the top four Chinese firms made up 58 percent of the domestic sector's R&D spending.²³⁶ Yet, by 2021, they accounted for 41 percent—a 17 percent decline.²³⁷ This decreased reliance is partially because the number of Chinese firms increased from 22 to 45. (See figure 30.) In other words, the United States depends more on its top four firms to maintain current levels of private sector R&D competitiveness, while China is increasingly minimizing its reliance on its top four firms.

Figure 30: Top four U.S. and Chinese firms' share of domestic R&D in the automobile and parts sector²³⁸



In the last decade, both U.S. and Chinese firms performed worse than the average global R&D share of GDP. In 2013, U.S. firms' size-adjusted R&D spending was 70 percent of the average global R&D spending in the sector (0.7x), while Chinese firms' was 20 percent (0.2x).²³⁹ However, while U.S. firms' spending has remained consistent, Chinese firms' has increased. In 2021, U.S. firms' spending remained at 70 percent of the global average (0.7x), while Chinese firms' rose to 60 percent (0.6x).²⁴⁰ (See figure 31.) In other words, Chinese firms are catching up to U.S. firms in R&D investment, but all have yet to reach the sector's average global size-adjusted R&D spending.

Figure 31: U.S. and Chinese firms' shares of global R&D in the automobile and parts sector²⁴¹



ALL OTHER SECTORS

The following sections compare the R&D spending of U.S. and Chinese firms in all nonadvanced traded sectors and nontraded sectors.

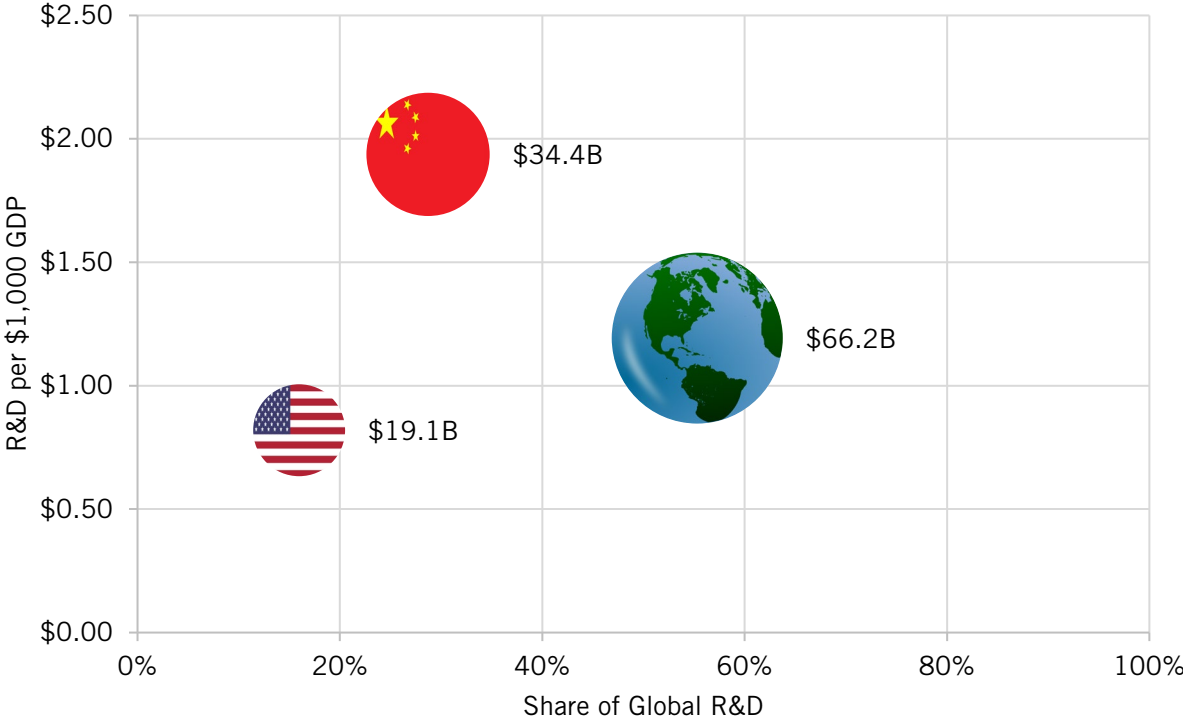
Nonadvanced Traded Sectors

Nonadvanced traded sectors include all traded sectors that are not one of the above advanced sectors (see appendix 1 for a list of sectors). These sectors include producers of leisure goods, chemicals, and food, along with oil and gas producers.

In 2021, 65 U.S. firms and 143 Chinese firms made the EU R&D 2,500 list. The average U.S. firm spent \$294 million on R&D, 0.02 standard deviations below the average firm in the sectors globally. In comparison, the average Chinese firm spent \$240 million, a 0.12 standard deviation below the average firm. This is compared with the average firm’s spending of \$304 million. Both the average U.S. and Chinese firm did not invest as much as the average firm globally.

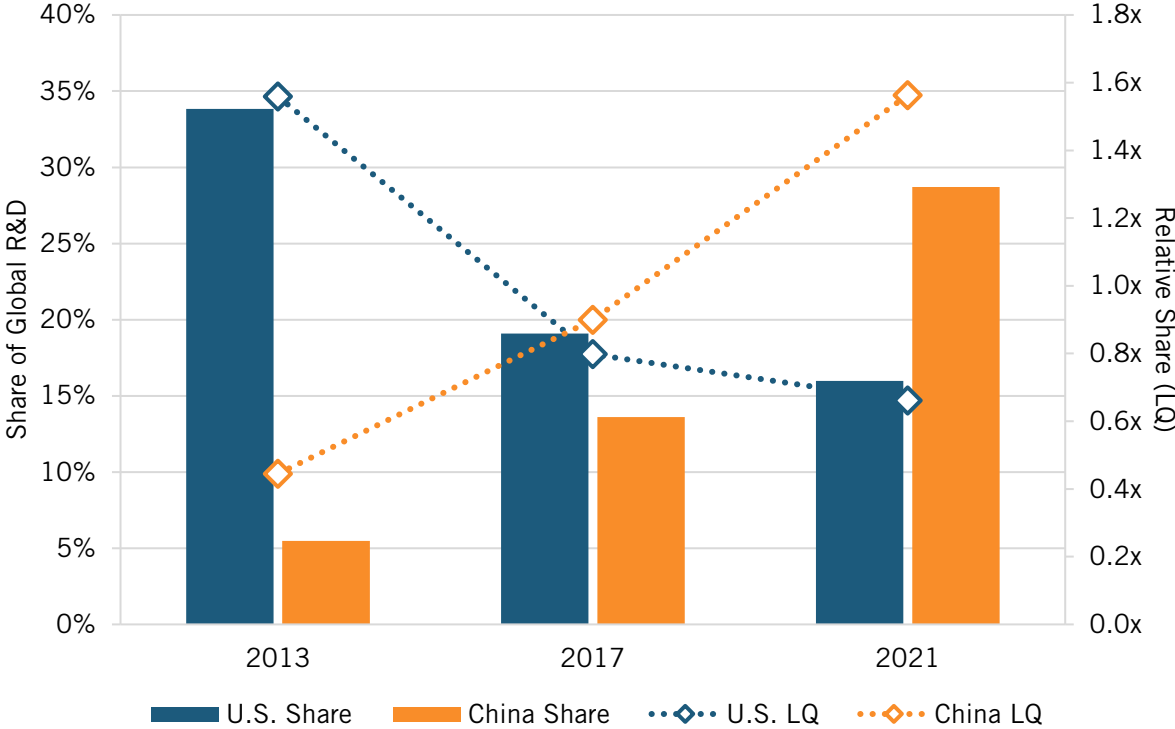
Collectively, Chinese firms invest more in R&D than U.S. firms because of the higher number of Chinese firms. In 2021, Chinese firms invested \$34 billion, while U.S. firms invested \$19 billion.²⁴² As a result, Chinese firms’ share of the global sectors was 28.7 percent, while U.S. firms’ share was 16 percent.²⁴³ Chinese firms still spent more when controlling for GDP. For every \$1,000 of GDP, U.S. firms spent \$0.82, while Chinese firms spent \$1.94.²⁴⁴ This is compared with the rest of the world’s R&D share of 55.3 percent and spending of \$1.19 for every \$1,000.²⁴⁵ (See figure 32.) When adjusting for wages, Chinese firms spent 3.4 times more than U.S. firms—\$66 billion compared to U.S. firms’ \$19.1 billion.²⁴⁶

Figure 32: R&D spending by U.S. and Chinese firms in all non-advanced traded sectors, 2021²⁴⁷



Chinese firms did not always spend more than U.S. firms in R&D to develop the country’s nonadvanced traded sectors. In 2013, U.S. firms’ R&D share of the global nonadvanced traded sectors was 33.8 percent compared with Chinese firms’ 5.5 percent.²⁴⁸ Even when controlling for GDP, U.S. firms’ R&D spending was 160 percent of the global average (1.6x) compared with China’s 40 percent (0.4x).²⁴⁹ Yet, by 2021, U.S. firms’ share of the global sectors declined to 16 percent, while Chinese firms’ rose to 28.7 percent.²⁵⁰ By 2021, U.S. firms’ R&D spending declined to 70 percent of the global average (0.7x), while Chinese firms increased their spending to 160 percent (1.6x).²⁵¹ (See figure 33.) In other words, Chinese firms in nonadvanced traded sectors have caught up and exceeded the United States in R&D investments.

Figure 33: U.S. and Chinese firms’ shares of global R&D in all non-advanced traded sectors²⁵²



Nontraded Sectors

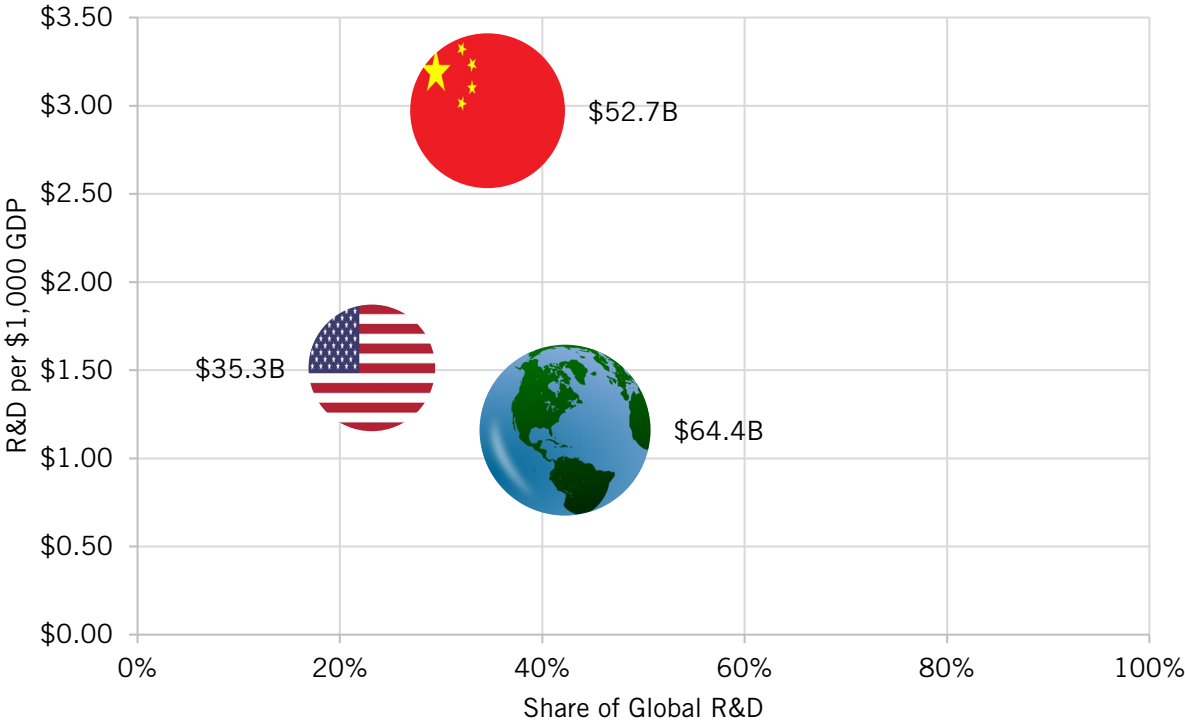
Nontraded sectors include general merchandise stores, life insurance providers, and financial services (see appendix 1 for a list of sectors).

The average Chinese firm spends more on R&D for nontraded sectors. In 2021, 98 U.S. firms and 111 Chinese firms made the EU R&D 2,500 list.²⁵³ The average U.S. firm in nontraded sectors spent \$360 million on R&D, a 0.02 standard deviation below the average firm in the sectors globally.²⁵⁴ In comparison, the average Chinese firm spent \$475 million, a 0.14 standard deviation above the average firm.²⁵⁵ This is compared with the average firm’s R&D spending of \$376 million.²⁵⁶

Chinese firms spend more on R&D than do U.S. firms. In 2021, Chinese firms spent \$52.7 billion on R&D, while U.S. firms spent \$35 billion.²⁵⁷ As a result, Chinese firms’ R&D share of the global sector was 34.6 percent, while U.S. firms’ was 23.2 percent.²⁵⁸ When controlling for GDP, Chinese firms still spent about two times more than U.S. firms.²⁵⁹ For every \$1,000,

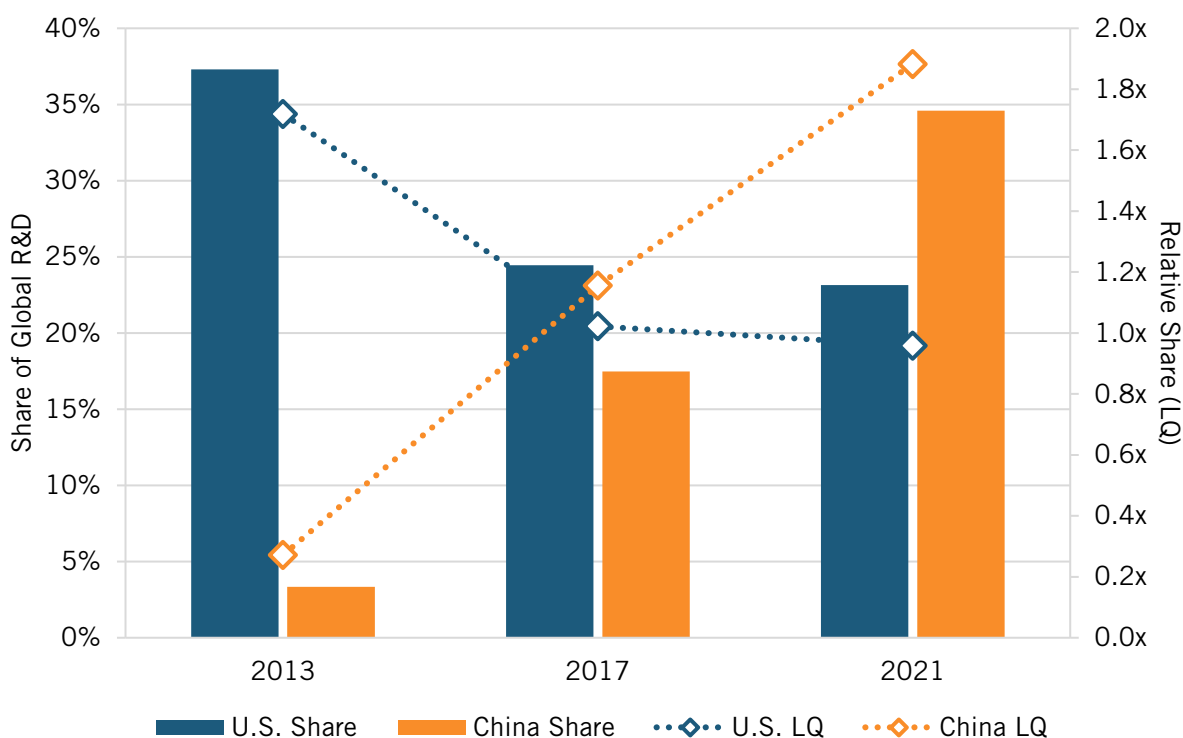
Chinese firms spent \$2.97, while U.S. firms spent \$1.51.²⁶⁰ This is compared with the rest of the world’s R&D share of 42.3 percent and spending of \$1.16 for every \$1,000.²⁶¹ (See figure 34.) Chinese firms’ R&D share exceeds U.S. firms, thereby promoting greater innovation. Moreover, when adjusting for wages, Chinese firms spent 2.9 times more than U.S. firms—\$101 billion compared to U.S. firms’ \$35.3 billion.²⁶² Yet, this is less worrisome since nontraded sectors do not compete globally.

Figure 34: R&D spending by U.S. and Chinese firms in all non-traded sectors, 2021²⁶³



Chinese firms did not always spend more than U.S. firms in R&D. In 2013, U.S. firms’ R&D share of the global sectors was 37.3 percent compared with Chinese firms’ 3.3 percent.²⁶⁴ When controlling for GDP, U.S. firms’ R&D spending was 170 percent of the global average in nontraded sectors (1.7x).²⁶⁵ By 2021, U.S. firms’ share had declined to 23.2 percent, while Chinese firms’ had risen to 34.6 percent.²⁶⁶ When controlling for GDP, U.S. firms spent the same as the global average (1.0x), while Chinese firms increased their spending to 190 percent (1.9x).²⁶⁷ (See figure 35.) Said differently, Chinese firms in the nontraded sectors have caught up and exceeded U.S. firms in R&D investments. However, U.S. firms are not much affected because nontraded sectors do not compete in the global economy.

Figure 35: U.S. and Chinese firms' shares of global R&D in all non-traded sectors²⁶⁸



POLICY RECOMMENDATIONS

Scientific and engineering research is key to innovation success for firms and economies. This generated knowledge is translated into innovation, including novel products and processes. More importantly, business research resulting in knowledge is a crucial driver of global competitiveness for a nation because manufacturing industries and many service industries rely on R&D for competitive success.²⁶⁹

As such, if we want to reverse the process of Chinese firms closing the gap with U.S. firms on R&D investment, Congress needs to boost R&D tax incentivizes. The United States ranked 24th out of 34 Organization for Economic Cooperation and Development (OECD) countries in the generosity of tax support for R&D, while China ranked 8th.²⁷⁰ Congress should double the Alternative Simplified Credit, an R&D tax credit, from 14 percent to 20 percent to restore the United States' R&D competitiveness compared with China and other OECD nations.²⁷¹ Moreover, this change can help increase private spending on R&D as a share of GDP, making the United States more competitive in traded and advanced sectors than China.²⁷²

The United States needs to raise the Alternative Simplified Credit, an R&D tax credit, to 20 percent to restore the United States' R&D competitiveness compared with China and other OECD nations.

Additionally, Congress should restore full expensing of R&D costs. The Accelerate Long-Term Investment Growth Now (ALIGN) Act (S. 1166 and H.R. 2558) and the American Innovation and Jobs Act (S. 749) do this. The ALIGN Act would allow businesses to deduct the cost of new investments in the year they are purchased, thereby incentivizing the private sector to invest in

equipment for R&D.²⁷³ The American Innovation and Job Act would “allow companies investing in R&D ... [to] either deduct their research expenses or claim the R&D tax credit.”²⁷⁴ The option to deduct research expenses or claim R&D tax credits would incentivize both small and large businesses to invest in R&D. Passing both of these bills should be the first step to a national innovation system that promotes global competitiveness in key advanced sectors. Most state governments should also boost their R&D tax credits.²⁷⁵

CONCLUSION

The United States is in fierce geopolitical competition with China, requiring leadership in advanced sectors. Success in these sectors stems in part from R&D investments. Yet, size-adjusted R&D spending of U.S. firms in nine advanced sectors is beginning to fall behind that of Chinese firms, despite U.S. firms being ahead of Chinese firms’ a decade ago. Yet, U.S. firms in two of nine advanced sectors have size-adjusted R&D spending that is now lower than that of Chinese firms. Moreover, Chinese firms are closing the size-adjusted R&D spending gap with U.S. firms in advanced sectors. In seven of the nine sectors, U.S. firms’ size-adjusted R&D spending has either declined or remained stagnant while Chinese spending rose. In other words, Chinese firms will only become more competitive as they increase their R&D investments and develop new products and processes, potentially taking market share from U.S. firms. This will hurt the United States’ economy, national security, and global competitiveness.

APPENDIX 1: INDUSTRY SECTOR GROUPS

Category	Sectors
Advanced Traded Sectors	<ul style="list-style-type: none"> ▪ Software and Computer Services ▪ Technology Hardware and Equipment ▪ Electronic and Electrical Equipment ▪ Pharmaceuticals and Biotechnology ▪ Automobiles and Parts ▪ Aerospace and Defense ▪ General Industrials ▪ Industrial Engineering ▪ Alternative Energy
Nonadvanced Traded Sectors	<ul style="list-style-type: none"> ▪ Personal and Household Goods ▪ Leisure Goods ▪ Chemicals ▪ Oil and Gas Producers ▪ Food Producers ▪ Household Goods and Home Construction ▪ Industrial Metals and Mining ▪ Personal Goods ▪ Beverages ▪ Tobacco ▪ Mining ▪ Forestry and Paper ▪ Toys
Nontraded Sectors	<ul style="list-style-type: none"> ▪ Fixed Line Telecommunications ▪ Construction and Materials ▪ Health Care Equipment and Services ▪ General Retailers ▪ Banks ▪ Media ▪ Financial Services ▪ Support Services ▪ Electricity ▪ Real Estate Investment and Services ▪ Telecommunications ▪ Mobile Telecommunications ▪ Support Services ▪ Oil Equipment, Services, and Distribution ▪ Food and Drug Retailers ▪ Gas, Water, and Multiutilities ▪ Nonlife Insurance ▪ Life Insurance ▪ Nonequity Investment Instruments ▪ Equity Investment Instruments

APPENDIX 2

Key Differences Between EU R&D 2,500 Scoreboard and Business Enterprise R&D Expenditure Estimates

The EU R&D 2,500 Scoreboard differs from business enterprise R&D expenditures due to different methodologies and data sources. The Scoreboard collects data on company-funded R&D expenditures from audited financial records, regardless of where the R&D occurred. In comparison, the business R&D expenditure estimates consider a sample of all large companies and a representative sample of smaller companies to estimate the total business R&D expenditures of a country. Moreover, the business R&D expenditure estimates refer to R&D financed by a business sector in a given territorial unit, whereas the Scoreboard does not. As a result, the EU R&D 2,500 Scoreboard report notes that “the Scoreboard R&D figures are comparable to BES-R&D [or business R&D expenditures] data at only the global level.”²⁷⁶ Even then, the estimates are not a complete match due to the different sources and methodologies of data collection.

Location of R&D Activity

The Scoreboard lists companies based on the location of their headquarters rather than the location of R&D activities or investments. As a result, the aggregate R&D spending of a country reflects the amount that headquartered firms in that country spent globally rather than domestically. For example, the \$5 billion Country A spent on the automobile sector reflects the aggregate amount Country A’s firms spent on R&D globally, and not just the R&D investment that took place in Country A.

Nominal Dollar Figures

The Scoreboard collects R&D spending data from companies’ annual financial records. As a result, companies’ R&D spending is in nominal dollars and not adjusted to control for changes in currency values. If the value of the dollar strengthens compared to other nations, then U.S. aggregate R&D spending will appear larger than if the dollar value remained constant.

Sector Classification

The EU R&D 2,500 Scoreboard classifies each company using the International Classification Benchmark based on the main sector in which it conducts its business. As a result, the Scoreboard is not a comprehensive estimate of R&D spending invested in a sector, but rather an estimate of firms (whose main business activity is in that sector) investments in R&D. The estimates in some sectors may therefore be lower than expected since R&D investments by companies whose main activity is not in the sector are not included. Moreover, it is not guaranteed that the R&D investment by a company within a sector is going to R&D for that sector. For example, a company in the retail sector could invest in R&D for new products and also for software, in which case the R&D investment for both the product and software would be included only in the retail sector.

Addition of Amazon into the 2021 EU R&D Scoreboard

Our report adds Amazon into the 2021 EU R&D 2,500 Scoreboard’s list of firms. Although the 2013 and 2017 EU R&D 2,500 Scoreboard include Amazon in their listing, the 2021 Scoreboard does not include Amazon, despite its significant spending on R&D. One of the reasons may be because Amazon groups its R&D under “technology and content” in its financial

records. As a result, Amazon’s R&D spending for 2021 was estimated using its 2021 SEC 10K filing and Statista’s estimates of Amazon’s video and music content budget. The 10K filing notes that Amazon spent \$56 billion on “technology and content” in 2021, and Statista found that Amazon spent \$13 billion on video and music content.²⁷⁷ As a result, R&D spending is estimated to be \$43 billion, and this figure was added into the 2021 Scoreboard.²⁷⁸

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