January 2022

Chinese and U.S. University Rankings

A Lens into Top Universities and Their Graduates

CSET Data Brief

AUTHORS
Jack Corrigan
Simon Rodriguez

Executive Summary

To succeed in emerging industries like artificial intelligence, synthetic biology, and quantum computing, countries must maintain a robust and well-trained workforce. One of the most reliable ways to cultivate that human capital is through a high-quality university system. Top universities play a critical role in building a country's talent base, providing a valuable education to students at home, and attracting the best and brightest from abroad. The quality of a country's university system can therefore be a useful metric when gauging the strength of its talent pipeline—the more world-class universities a nation has, the more world-class human capital it can develop.

This brief assesses the quality of universities in China and the United States based on their performance in two well-regarded rankings of global universities: the Academic Ranking of World Universities (ARWU) and the QS World University Rankings (QS). We find that:

1. **Chinese universities have made significant gains in the global rankings.** Between 2010 and 2020, the number of Chinese universities in the top 500 on at least one global ranking more than tripled (from 23 to 71), while the number that appeared on both rankings rose from 9 to 26. Chinese universities have also steadily moved up the rankings over time.

2. **Improvements in Chinese university rankings appear to be driven largely by increases in research productivity.** These gains coincide with a series of state-sponsored higher education initiatives that focus primarily on improving the quantity and quality of academic research in China.

3. **The number of ranked U.S. universities fell during the past decade.** Between 2010 and 2020, the number of U.S. universities that appeared in the top 500 on at least one global ranking dropped from 160 to 137, while the number that appeared on both rankings fell from 102 to 82. Other countries and regions have experienced similar, and in some

cases greater, proportional declines in aggregate university rankings during the past decade.

4. **The decrease in the number of ranked U.S. universities does not appear to coincide with other indicators of declining educational quality.** However, available data suggests that universities in other countries (namely China) have significantly improved in metrics such as research productivity relative to their U.S. counterparts.

5. **Ranked U.S. universities produce more PhDs and bachelor's graduates than ranked Chinese universities. Still, more than half of China's PhDs study at ranked universities.** In the United States, ranked universities also play an outsized role in the STEM talent pipeline, accounting for about 80 percent of STEM PhDs and 44 percent of STEM bachelor's graduates. Due to data availability issues, the share of Chinese STEM graduates earning degrees from ranked universities could not be determined.

There remain many unanswered questions regarding the quality of elite universities and their graduates. Additional research into the quality of undergraduate instruction and doctoral research, and the popularity of STEM at China's top universities would shed more light on the strengths and weaknesses of the country's talent pipeline. Furthermore, examining the short- and long-term labor market outcomes of graduates from top universities in the United States and China would provide a better understanding of each country's capacity to use the human capital at its disposal, and promote more nuanced discussions around the international competition for talent.

Ranking Universities in China and the United States

This brief examines the higher education systems in China and the United States through the lens of two global university rankings,

the ARWU and QS.* Each ranking evaluates universities using a different set of criteria: the ARWU generally focuses on research productivity and faculty prestige, while the QS emphasizes reputation among academics. These methodologies are discussed at greater length in the following section. Specifically, we examine the number of universities in each country that appear in the ARWU and QS top 500 between 2010 and 2020 ("ranked universities").

Since 2010, the United States has consistently boasted more ranked universities than any other country. However, U.S. dominance has waned in recent years as the nation's universities have fallen off the rankings. During the same period, the total number of ranked universities in China has nearly tripled.

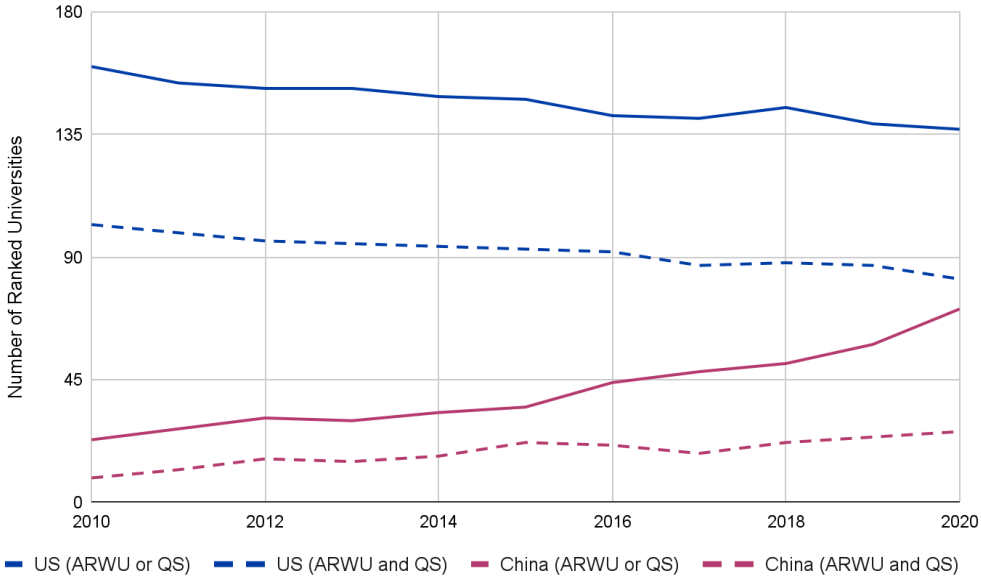
Figure 1 shows the number of Chinese and U.S. universities that appear in the top 500 on **at *least one*** of the global rankings (see Appendix A for more detailed data). In 2010, there were nearly seven times as many ranked universities in the United States as in China, but by 2020, the United States had fewer than twice as many. Over the course of the decade, the number of ranked universities in the United States on either of the two global ranking systems fell from 160 to 137, while the number in China rose from 23 to 71. China added more universities to the rankings than any other country.

A similar, though less extreme, trend emerges when comparing the number of U.S. and Chinese universities that appear in the Top 500 on ***both*** the ARWU and QS. Between 2010 and 2020, the number

* The Academic Ranking of World Universities, also known as the Shanghai Ranking, is published by the Shanghai Ranking Consultancy, a Chinese analysis group that is not publicly affiliated with any government or university. Prior to 2009, the ARWU was published by Shanghai Jiao Tong University. The QS World University Rankings is published by Quacquarelli Symonds, a higher education analysis group based in the United Kingdom.

of ranked U.S. universities in both rankings fell from 102 to 82, and the number in China rose from 9 to 26 (see Appendix A).

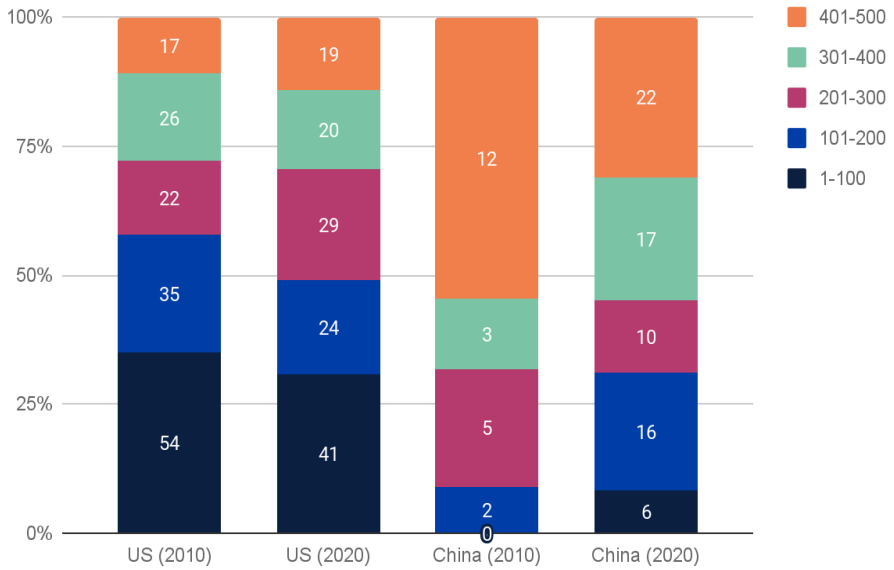
Figure 1. Number of ranked Chinese and U.S. universities, 2010–2020.



Source: Academic Ranking of World Universities and QS World University Rankings, 2010–20.

Not only have more Chinese universities broken into the ARWU and QS top 500 during the past decade, but those universities have also continued to steadily rise in both rankings. In 2010, only two Chinese universities—Peking and Tsinghua—appeared in the QS top 100, and none appeared in the ARWU top 100. By 2020, six Chinese universities—Fudan, Peking, Shanghai Jiao Tong, Tsinghua, Zhejiang, and the University of Science and Technology of China—appeared in the top 100 on both rankings (see Figures 2 and 3). All but one of the 23 ranked Chinese universities in 2010 had improved their ranking by 2020.[1] These findings point to two simultaneous trends at play: the Chinese university system is improving overall, and the country's best universities are getting even better.

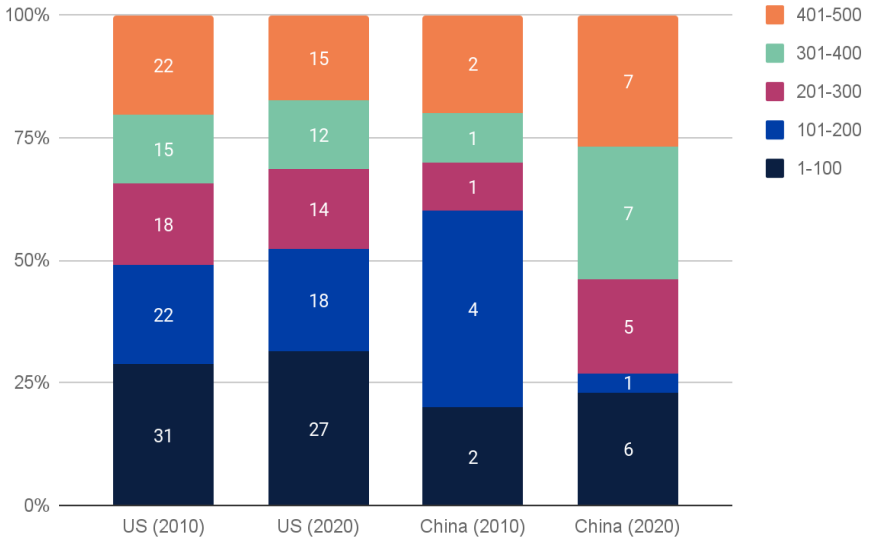
Figure 2. Distribution of U.S. and Chinese universities in the ARWU top 500.



Source: Academic Ranking of World Universities.

Note: The values shown reflect the total number of universities in each ranking bracket (i.e., six Chinese universities were ranked between 1 and 100 in the 2020 ARWU).

Figure 3. Distribution of U.S. and Chinese universities in the QS top 500



Source: QS World University Rankings.

The distribution of ranked universities in the United States has remained fairly consistent during the past decade. The most notable change came in the ARWU, where the share of ranked U.S. universities in the top 200 decreased from 58 to 49 percent, and the share in the 201–300 bracket increased from 14 to 22 percent. There was virtually no change in the distribution of U.S. universities in the QS (see Appendix B for more detailed data).

The stability of these distributions suggests that the decrease in ranked U.S. universities is the result of relative changes in specific ranking metrics (e.g., number of highly cited researchers) rather than overall changes in educational quality at individual institutions. As discussed later in this brief, the United States was not the only country to see universities fall out of the ARWU and QS top 500 during the past decade. In fact, four other countries with a prominent presence in both rankings—Italy, France, Germany, and Japan—saw a *greater* proportional decrease in ranked universities than the United States. If the decrease in the number of ranked U.S. universities did in fact result from a widespread decline in U.S. educational quality, it is unlikely similar patterns would be seen in so many other countries and regions. To understand the factors driving these changes, how universities are ranked in the first place must be examined.

What Rankings Actually Measure

The two rankings used in this analysis evaluate universities using different sets of criteria. In general, the ARWU focuses on research productivity and faculty prestige, and the QS emphasizes reputation among academics (see Appendix C for more on each ranking's methodology).

In the ARWU, 60 percent of a university's score is based on three measurements related to research output: the number of highly cited faculty researchers, the number of papers published in *Nature* and *Science*, and the number of papers listed in two prominent citation indices. Another 30 percent of the score is based on the number of Nobel Prizes and Fields Medals awarded to faculty and alumni; the remaining 10 percent is based on the university's performance in the previous five metrics relative to its size. By

relying on these metrics, the ARWU tends to favor large universities that conduct substantial STEM and social science research. The ARWU methodology also makes it easier for newer, less-well-known universities to climb the rankings by boosting their research output. As discussed in the following section, China's rapid gains in global university rankings have largely been fueled by improvements in its ARWU rankings.

The QS evaluates universities on a wider range of criteria than the ARWU, though the most heavily weighted variable is reputation among academics. Each year, the QS asks tens of thousands of individuals across the world of higher education to rate the instructional and research quality of global universities.[2] These ratings account for 40 percent of universities' QS scores. The remaining 60 percent is divided among a variety of other metrics, including student-to-faculty ratio, citations per faculty member, reputation among employers, and internationality of students and faculty. Though some have criticized the QS for being too subjective, the organization argues that its methodology is designed to be stable, relevant, and resistant to manipulation.[3] The QS also excludes universities that do not offer undergraduate degrees.

There is no perfect way to quantify the quality of a country's higher education system, the universities within it, and the graduates it produces. All analyses emphasize certain variables while downplaying or omitting others. By focusing on universities' performance in the ARWU and QS, this analysis measures "quality" largely in terms of research output and academic reputation. Variables such as instructional quality and students' career outcomes—which are pertinent to talent development—are largely overlooked. However, standardized university rankings are one of the few tools available for comparing higher education across countries, and by taking both the ARWU and QS into account, broad trends can be identified in the U.S. and Chinese higher education systems.

It is worth noting that a university's research output can serve as a proxy for the educational quality of PhD students. Research is a key component of doctoral programs in both the United States and

China, and PhD students who work with respected faculty on high-quality research are more likely to excel in their fields after graduation.[4] Doctoral students also contribute to their institution's research efforts during the course of their studies, which suggests that the quality and quantity of research reflect the caliber of a university's PhD students, at least to some degree.[5]

What Has Changed

This section covers potential factors driving (1) the rapid improvement of Chinese university rankings; and (2) the decline in the number of ranked U.S. universities.

Trends in China

The gains Chinese universities have made in the ARWU and QS during the past decade coincide with improvements in research output that have resulted from a series of recent state-sponsored higher education initiatives.

Since the mid-1990s, the Chinese government has launched multiple programs dedicated to transforming national universities into world-class educational institutions.[6] While each program has been unique, all generally aim to strengthen China's academic R&D ecosystem by standing up new university research organizations, recruiting top scholars to join them, and rewarding top-performing universities with additional investments. Funding for these programs has increased substantially during the past decade. Between 2012 and 2021, the Chinese Ministry of Education nearly doubled its annual spending on higher education, from $24 billion to $47 billion.[7]

Only a small fraction of the 3,000 colleges and universities in China participate in these programs, but many of those that do appear in the global rankings.[8] The most recent state-sponsored initiative—the Double First Class University Plan—directed funding to 137 universities. In 2020, 60 of those universities appeared in either the ARWU or QS top 500, and another 40 were ranked between 501 and 1,000 on at least one of the lists.[9]

These investments have succeeded in strengthening China's research ecosystem. Since 2010, the number of highly cited papers published by Chinese researchers in natural sciences, artificial intelligence, and other STEM fields has increased substantially.[10] A U.S. Department of Energy advisory committee recently announced that Chinese researchers produce most of the world's top research in energy storage and sustainable energy science.[11] A 2020 study by Clarivate found that approximately 12 percent of the most widely cited researchers globally resided in China, up from about 5 percent in 2014 and just 1 percent in 2001.[12]

Improving research capacity and recruiting influential scholars appears to be an effective strategy for boosting university rankings. Between 2010 and 2020, the number of Chinese universities in the ARWU top 500 grew from 22 to 71. In the 2020 ranking, all but three of those universities scored a zero in the categories of alumni and faculty prizes, which account for 30 percent of the overall score.[13] That means virtually all the gains made since 2010 were in the three categories related to research quantity and quality (see Appendix C for more on the ARWU methodology).

The QS also considers research output in its evaluation, but this is given much less weight than the university's global reputation. Though reputation is a more subjective measurement than numbers of papers or citations, it captures intangible aspects of institutional quality that quantitative assessments might miss, and it is also harder for universities to game through citation inflation and other tactics.[14] The fact that the number of Chinese universities in the QS top 500 more than doubled between 2010 and 2020 suggests that improvements in quality may extend beyond the research ecosystem. That said, a university's reputation is still influenced by its research output and performance on other academic rankings. Every Chinese university that has appeared in the QS top 500 since 2018 has also been listed in the more research-oriented ARWU top 500.

Trends in the United States

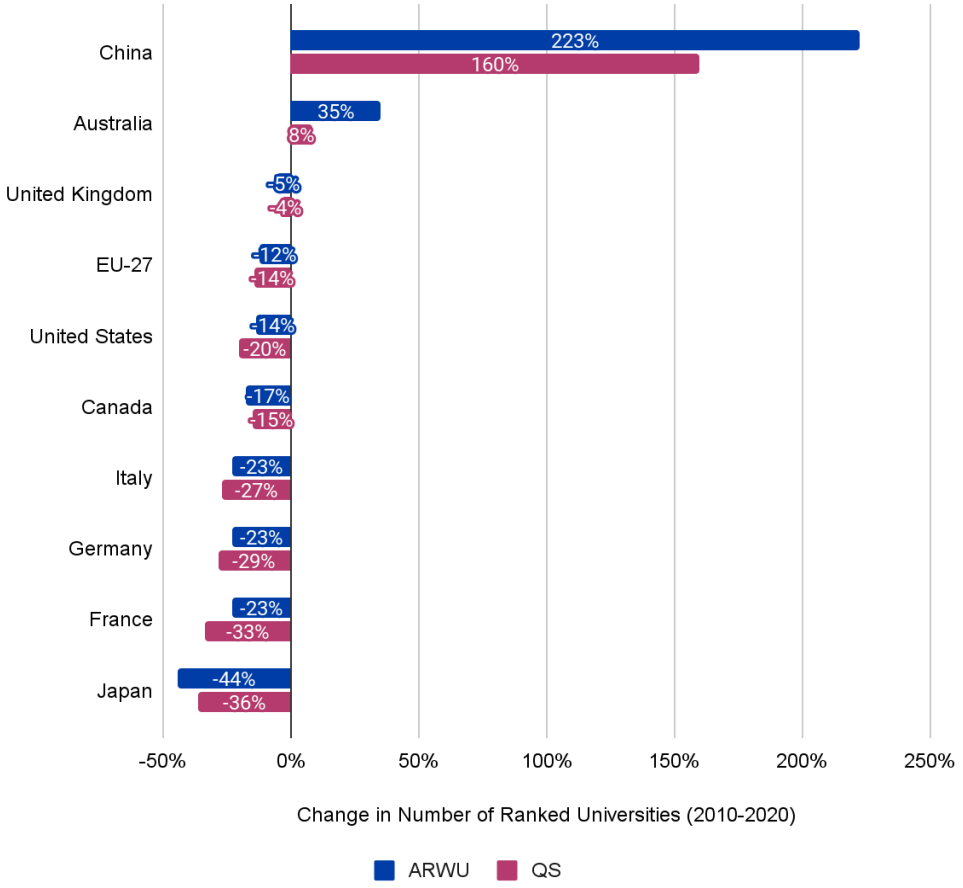
In the United States, the decrease in the number of ranked universities appears to reflect changes in relative metrics rather

than substantive declines in educational quality at individual institutions. Without access to the raw data that the ARWU and QS use to score universities, it is not possible to determine exactly why the ranking of a given university rose or fell. That said, we see no evidence of substantive declines in the absolute number of awards won by U.S. faculty, the internationality of U.S. students and faculty, or the quality and quantity of U.S. academic research during the past decade.[15]

However, available data suggests that the productivity of Chinese researchers has improved significantly compared to their U.S. counterparts, and this would improve the relative performance of Chinese universities in both global rankings.[16] For every new university that appears in the ARWU or QS top 500, one must necessarily fall off the list. The dozens of Chinese universities that were added to the global rankings between 2010 and 2020 displaced dozens of incumbent universities, and no country had more slots to lose than the United States.

The United States was not the only country that saw its universities fall out of the rankings. Other countries with a substantial presence in the ARWU and QS experienced similar, and in some cases greater, proportional declines in their number of ranked universities during the same period. As shown in Figure 4, in four countries—France, Germany, Italy, and Japan—a greater percentage of universities fell out of the ARWU and QS top 500 between 2010 and 2020 than in the United States. The European Union, which in 2010 counted more than 150 universities in both the ARWU and QS top 500, also saw a substantial share of universities fall off the list as more Chinese institutions were added. If the decrease in ranked U.S. universities did in fact result from a widespread decline in educational quality, it is unlikely so many other countries and regions would exhibit the same trend.

Figure 4. Percentage change in the number of ranked universities for select countries and regions, 2010–2020.



Source: Academic Ranking of World Universities and QS World University Rankings, 2010–20.

Counting Graduates from Ranked Universities

Top universities play a critical role in building a country's talent base, providing a valuable education to students at home and attracting the best and brightest from abroad. The quality of a country's university system can therefore be a useful metric when gauging the strength of its talent pipeline—the more world-class universities a country has, the more world-class human capital it can develop.

As shown in Figure 5, in 2019 nearly 47,000 PhD students graduated from ranked universities in the United States, making up 64 percent of the nationwide graduating class that year. The number of PhDs from ranked U.S. universities increased between 2010 and 2020, even as the total number of the country's ranked universities fell. This upward trend is likely linked to rising enrollment numbers at ranked universities.[*]

While the ranked universities in the United States produce more doctoral graduates in both absolute and proportional terms, China also develops most of its PhD-level talent at ranked institutions. In 2019, the 58 Chinese universities that appeared in the ARWU or QS top 500 collectively awarded about 33,500 doctoral degrees, accounting for roughly 54 percent of PhD graduates nationwide. These figures are likely higher today: in 2020 China added 13 new universities to the rankings.[†]

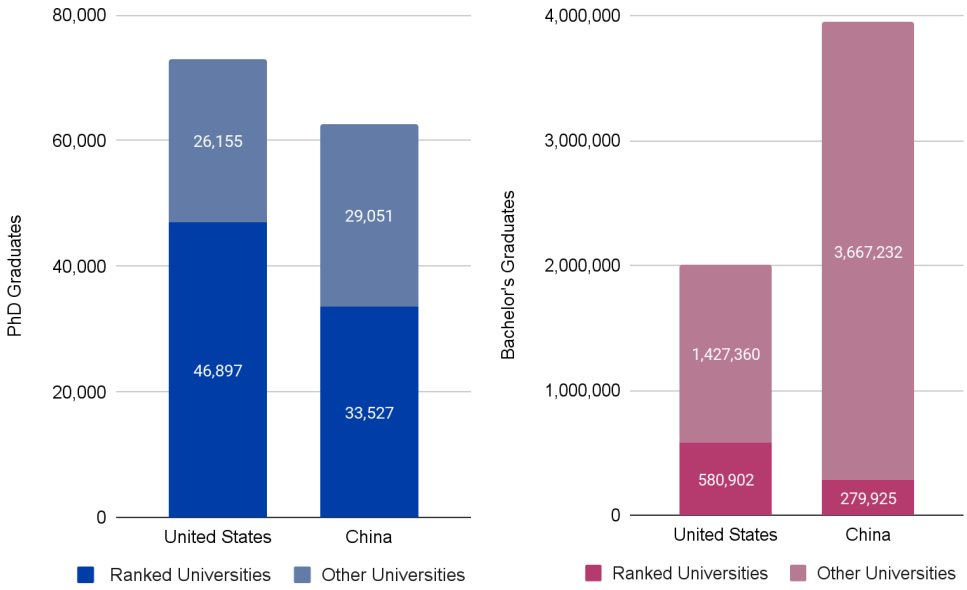
Ranked universities account for a smaller proportion of graduates at the bachelor's level in both the United States and China, but the differences between the two countries are stark. In 2019, the United States produced more than 2 million bachelor's graduates, with about 581,000 (29 percent) coming from ranked universities (see Figure 5). That same year, nearly 4 million students graduated from bachelor's programs at Chinese universities, but only about 280,000 of them (7 percent) had studied at ranked universities. This disparity underscores the stratified nature of the Chinese higher education system: China boasts some of the world's premier universities, but only a small fraction of undergraduates reap their benefits.

---

[*] There were 130 U.S. universities that appeared on the ARWU or QS top 500 in both 2010 and 2019. During that period, 112 universities increased bachelor's enrollments, and 109 increased PhD enrollments. Due to data availability issues, this study does not examine how enrollments at ranked Chinese universities have changed over time.

[†] Complete data on ranked Chinese graduates for 2020 could not be obtained.

Figure 5. PhD and bachelor's graduates from U.S. and Chinese universities, 2019.

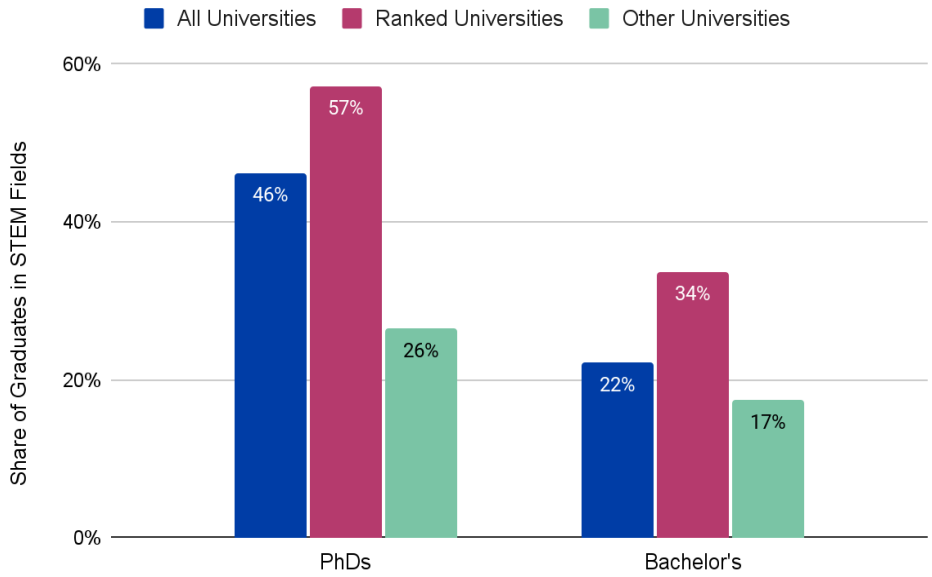


Sources: U.S. data: National Center for Education Statistics' Integrated Postsecondary Education Data System (IPEDS); Chinese data: Ministry of Education Employment Quality Reports.

Graduates who specialize in STEM fields are particularly relevant in the context of national security—countries must maintain a robust and well-trained pool of STEM talent to succeed in emerging industries like artificial intelligence, synthetic biology, and quantum computing.

In the United States, ranked universities play an outsized role in the STEM talent pipeline. Overall, in 2019 they accounted for about 80 percent (26,837) of the STEM doctorates and 44 percent (195,839) of the STEM bachelor's degrees awarded.[17] The share of graduates who earn STEM degrees is also higher at ranked universities than at other institutions (see Figure 7). This trend is likely the result of the ARWU's ranking methodology, which focuses on STEM-oriented awards and publications, and thus favors large research universities that excel in science and technology disciplines (see Appendix C). It stands to reason that such institutions are more likely to attract students interested in STEM.

Figure 6. Share of U.S. PhD and bachelor's graduates in STEM fields by university type, 2019.



Source: National Center for Education Statistics' Integrated Postsecondary Education Data System (IPEDS).

Visibility into the Chinese higher education system is more limited: Chinese universities do not break down graduate data into standardized fields of study. As such, we cannot say for certain how many Chinese STEM graduates are educated at globally ranked universities.

If the share of graduates from ranked universities who specialized in STEM each year was the same as the share nationwide, we estimate that ranked Chinese universities would have awarded about the same number of STEM doctorates in 2019 and about two-thirds as many STEM bachelor's degrees.* These figures should be viewed as conservative estimates. It is likely that students at ranked Chinese universities pursue STEM degrees at higher rates than their peers at other institutions, as is the case in

* According to nationwide graduate data, about 79 percent of PhD graduates and 48 percent of bachelor's graduates in China specialized in STEM fields in 2019.

the United States. Additionally, CSET has previously forecasted that Chinese STEM PhD production will spike more than 50 percent between 2019 and 2025. This suggests that the annual number of STEM PhDs who graduate from ranked universities may already be on the rise.[18]

Still, available data indicates that China has access to a large and well-trained pool of STEM talent, at least at the PhD level, and its capacity to produce high-quality graduates will continue to grow as its university system improves.

Limitations of This Analysis

This analysis of graduates from ranked universities in the United States and China should be interpreted with two caveats in mind.

First, it is unclear to what degree a university's ranking—particularly in the ARWU—reflects the quality of education in non-doctorate programs. While metrics related to research output and faculty prestige are closely linked to PhD education, which centers on research, they are more removed from bachelor's programs, which revolve largely around classroom instruction.*

Second, a country's competitiveness in high-tech industries is not determined solely by the number of STEM graduates it produces. Utilizing that human capital is equally important. While there is little reliable data on the Chinese labor market, anecdotal evidence suggests that university graduates—including those from elite institutions—face persistent unemployment and underemployment.[19] These labor market challenges may grow in the years ahead as the wave of graduates who returned to school amid the COVID-19 pandemic reenters the workforce.[20] Such issues are not unique to China—many U.S. graduates, including

---

* Because of differences in the classification and scope of master's programs across countries, this analysis does not address master's graduates through the lens of ranked universities .

those who hold high-demand degrees in STEM fields, also struggle with underemployment.[21]

Additional research into the quality of undergraduate instruction and doctoral research at U.S. and Chinese universities, and into the popularity of STEM at China's top institutions, would shed more light on the strengths and weaknesses of each country's talent pipeline. Furthermore, examining the short- and long-term labor market outcomes of graduates from top universities in the United States and China would provide a clearer understanding of each country's capacity to use the human capital at its disposal, and would lead to more nuanced discussions around the international competition for talent.

Conclusion

The quality of China's university system has improved during the past decade, and today the country is home to some of the world's top educational institutions. The number of ranked Chinese universities more than tripled between 2010 and 2020, from 23 to 71. In 2020, China counted six universities in the top 100 on both the QS and ARWU, and in general, its universities continue to steadily move up the rankings. Though the United States still boasts more ranked universities than China or any other country, its dominance in the global rankings has waned since 2010.

The gains Chinese universities have made in the global rankings during the past decade appear to be driven largely by improvements in their research output. This expansion in research capacity has coincided with a series of state-sponsored higher education initiatives that generally focused on creating new university research organizations, recruiting top scholars to join them, and directing additional funds into top-performing universities. Improving research capacity and recruiting influential scholars appears to be an effective strategy for boosting Chinese university rankings, particularly in the ARWU, which gives substantial weight to the quality and quality of universities' research. The decrease in the number of ranked U.S. universities does not appear to result from a widespread decline in educational quality. However, available data suggests that universities in other countries (namely China) have improved in ranking metrics such as research productivity relative to their U.S. counterparts.

In both the United States and China, most PhDs earn their degrees from universities ranked in the ARWU and QS top 500. In 2019, ranked universities accounted for approximately 54 percent of the PhD graduates in China and 64 percent in the United States. In both countries, ranked universities play less of a role at the undergraduate level, accounting for 29 percent of bachelor's graduates in the United States and just 7 percent in China.

Ranked institutions also play an outsized role in generating STEM talent, at least in the United States. In 2019, roughly 80 percent of U.S. STEM PhDs and 44 percent of U.S. STEM bachelor's

graduates were educated at ranked universities. Due to limited data, the share of Chinese STEM graduates who earned degrees from ranked universities could not be calculated. However, available data does indicate that China also has access to a large and well-trained pool of STEM graduates, at least at the PhD level, and that the country's capacity to produce high-quality talent will continue to grow as its university system improves.

Authors

Jack Corrigan is a research analyst at CSET, where Simon Rodriguez was formerly a data research assistant.

Acknowledgments

The authors would like to thank Amy Chao, Catherine Aiken, Diana Gehlhaus, Emily Weinstein, Igor Mikolic-Torreira, Remco Zwetsloot, Ryan Fedasiuk, Annie Rehill, Shelton Fitch, Charles Goldman, and Cong Cao for their invaluable feedback, reviews, and editorial support.

Document Identifier: doi: 10.51593/20210047

Appendices

Appendix A. Data Table for Figure 1

Table 1 shows the number of U.S. and Chinese universities that appeared on the ARWU and QS between 2010 and 2020. Overall, both countries consistently counted more universities on the ARWU than on the QS.

Table 1. Number of ranked universities in the United States and China, 2010–2020.

	United States			China		
	ARWU	QS	Both	ARWU	QS	Both
2020	133	86	82	71	26	26
2019	137	89	87	58	24	24
2018	139	94	88	51	22	22
2017	135	93	87	45	21	18
2016	137	97	92	41	24	21
2015	146	95	93	32	25	22
2014	146	97	94	32	18	17
2013	149	98	95	28	17	15
2012	150	98	96	28	19	16
2011	151	102	99	23	16	12
2010	154	108	102	22	10	9

Source: Academic Ranking of World Universities and QS World University Rankings.

Appendix B. University Distribution

Tables 2 and 3 show how ranked universities in the United States and China are distributed across both the ARWU and QS.

In both rankings, the number of Chinese universities ranked in the top 100 increased substantially over the past decade. In 2010, only two of China's universities—Peking and Tsinghua—appeared in the QS top 100, and none in the ARWU top 100. By 2020, six

Chinese universities—Fudan, Peking, Shanghai Jiao Tong, Tsinghua, Zhejiang, and the University of Science and Technology of China—appeared in the top 100 on both rankings. Of the 23 Chinese universities that appeared in the ARWU or QS top 500 in 2010, 22 had improved their ranking by 2020 (Lanzhou University was ranked in the 401–500 bracket in both years). These findings suggest two simultaneous trends at play: the Chinese university system is improving overall, and the country's best universities are getting even better.

The distribution of ranked universities in the United States has remained fairly consistent during the past decade. Between 2010 and 2020, the share of ranked U.S. universities in the ARWU top 200 decreased from 58 percent to 49 percent, while the share in the 201–300 bracket increased from 14 percent to 22 percent. There was virtually no change in the distribution of U.S. universities in the QS.

Table 2. Distribution of ARWU Top 500 universities in the United States and China, 2010–2020.

	#1–100		#101–200		#201–300		#301–400		#401–500	
	United States	China	United States	China	United States	China	United States	China	United States	China
2020	41	6	24	16	29	10	20	17	19	22
2019	45	4	21	13	28	10	22	12	21	19
2018	46	3	23	9	26	11	22	12	22	16
2017	48	2	22	7	29	9	20	15	16	12
2016	50	2	21	7	27	9	21	13	18	10
2015	51	0	27	7	24	6	23	14	21	5
2014	52	0	25	6	27	6	21	13	21	7
2013	52	0	33	5	23	3	23	8	18	12
2012	53	0	32	4	24	3	28	7	13	14
2011	53	0	36	1	21	6	27	5	14	11
2010	54	0	35	2	22	5	26	3	17	12

Source: Academic Ranking of World Universities.

Table 3. Distribution of QS Top 500 universities in the United States and China, 2010–2020.

	#1–100		#101–200		#201–300		#301–400		#401–500	
	United States	China	United States	China	United States	China	United States	China	United States	China
2020	27	6	18	1	14	5	12	7	15	7
2019	29	6	17	1	12	5	17	3	14	9
2018	33	6	15	1	11	5	18	2	17	8
2017	31	6	16	1	12	2	16	5	18	7
2016	32	4	16	3	14	4	16	4	19	9
2015	30	4	19	3	13	4	17	4	16	10
2014	28	3	23	4	14	1	16	5	16	5
2013	30	3	21	4	12	1	21	3	14	6
2012	31	3	23	4	11	1	18	1	15	10
2011	31	3	23	4	16	1	15	1	17	7
2010	31	2	22	4	18	1	15	1	22	2

Source: QS World University Rankings.

Appendix C. Methodology of the ARWU and QS

The Academic Ranking of World Universities (ARWU), also known as the Shanghai Ranking, judges universities primarily on the quality and quantity of their research output and awards won by alumni and faculty. Table 4 breaks down the ARWU's methodology. Given its focus on STEM-oriented awards and publications, the ARWU tends to favor large universities that excel in STEM research.

Table 4. Methodology for the Academic Ranking of World Universities, 2020.

Weight	Criteria
10%	Nobel Prizes and Fields Medals awarded to alumni
20%	Nobel Prizes and Fields Medals awarded to faculty
20%	Number of researchers included in Clarivate Analytics' "Highly Cited Researchers" list the previous year
20%	Number of papers published in *Nature* and *Science* in the previous five years
20%	Number of papers indexed in Science Citation Index–Expanded and Social Science Citation Index in the previous year
10%	Per capita performance of the institution in the prior five indicators

Source: Academic Ranking of World Universities.[22]

The QS World University Ranking evaluates universities on a wider range of criteria than the ARWU does, though the most heavily weighted variable is each university's reputation within the academic community. Table 5 breaks down the QS methodology, which includes reputation among academics and employers, student-faculty ratio, research productivity, and internationality. Though some have criticized the QS for being too subjective, the organization argues that its methodology is designed to be stable, globally relevant, and resistant to manipulation.[23]

Table 5. Methodology for the QS World University Rankings, 2020.

Weight	Criteria
40%	Reputation based on a survey of the academic community
10%	Reputation based on a survey of employers
20%	Student/faculty ratio
20%	Citations per faculty during the previous five years
5%	International faculty ratio
5%	International student ratio

Source: QS World University Rankings.[24]

Appendix D. Change in Rankings by Country

Table 6 shows the change in the number of universities from select countries that appeared in the ARWU and QS top 500 in 2010 and 2020.

Table 6. Number of universities in the ARWU and QS Top 500 by country, 2010 and 2020.

	ARWU			QS		
	2010	2020	Change (%)	2010	2020	Change (%)
Australia	17	23	35%	24	26	8%
Canada	23	19	-17%	20	17	-15%
China	22	71	223%	10	26	160%
EU-27	153	134	-12%	154	132	-14%
France	22	17	-23%	21	14	-33%
Germany	39	30	-23%	42	30	-29%
Italy	22	17	-23%	15	11	-27%
Japan	25	14	-44%	25	16	-36%
United Kingdom	38	36	-5%	51	49	-4%
United States	154	133	-14%	108	86	-20%

Source: Academic Ranking of World Universities and QS World University Rankings, 2010–20.

Appendix E. Counting Graduates from Ranked Universities

Table 7 shows the annual number of PhD and bachelor's students who graduated from ranked U.S. and Chinese universities in 2019.[25] For both countries, the number of graduates was calculated by adding the total number of graduates from each university that appeared in the ARWU or QS top 500 in a given year. For the United States, data is from the National Center for

Education Statistics' Integrated Postsecondary Education Data System (IPEDS). For China, data is from the Employment Quality Reports (EQRs) that each university submits to the Ministry of Education.[26]

Visibility into the Chinese higher education system was more limited for this analysis, because Chinese universities do not break down graduate data into standardized fields of study. Therefore, the number STEM graduates who were educated at globally ranked universities cannot be definitively ascertained.

Table 7. Number of PhD and bachelor's degrees awarded in the United States and China by field and university ranking, 2019.

	PhDs		Bachelor's	
	United States	China	United States	China
All Universities (All Fields)	73,052	62,578	2,008,262	3,947,157
All Universities (STEM)	33,759	49,498	445,238	1,886,091
Ranked Universities (All Fields)	46,897	33,527	580,902	279,925
Ranked Universities (STEM)	26,837	n/a	195,839	n/a

Source: U.S. data: National Center for Education Statistics' Integrated Postsecondary Education Data System (IPEDS); Chinese data: Ministry of Education.

Endnotes

[1] The ARWU ranked Lanzhou University in the 401–500 bracket in both 2010 and 2020.

[2] The 2020–21 QS Global Academic Survey received 103,532 responses. For more information, see "QS World University Rankings: Methodology," QS Quacquarelli Symonds Ltd., September 10, 2021, https://www.topuniversities.com/qs-world-university-rankings/methodology; "2020 Academic Survey Responses," QS Quacquarelli Symonds Ltd., accessed October 2021, http://www.iu.qs.com/academic-survey-responses/.

[3] "Understanding the Methodology: QS World University Rankings," QS Quacquarelli Symonds Ltd., June 8, 2021, https://www.topuniversities.com/university-rankings-articles/world-university-rankings/understanding-methodology-qs-world-university-rankings.

[4] David L. Belavy, Patrick J. Owen, and Patricia M. Livingston, "Do successful PhD outcomes reflect the research environment rather than academic ability?" *PLOS ONE* 15, no. 8 (2020): e0236327, https://doi.org/10.1371/journal.pone.0236327.

[5] Vincent Larivière, "On the shoulders of students? The contribution of PhD students to the advancement of knowledge," *Scientometrics* 90, no. 2 (2012): 463–81, https://doi.org/10.1007/s11192-011-0495-6.

[6] For information on Project 985, Project 211, the C9 League, and the Double First Class University Plan, see Dahlia Peterson, Kayla Goode, and Diana Gehlhaus, "Education in China and the United States: A Comparative System Overview" (Center for Security and Emerging Technology, September 2021), https://cset.georgetown.edu/publication/education-in-china-and-the-united-states/; William C. Hannas and Didi Kirsten Tatlow, *China's Quest for Foreign Technology: Beyond Espionage* (London: Routledge, September 2020).

[7] Ryan Fedasiuk, Alan Omar Loera Martinez, and Anna Puglisi, "China's Support for Universities, Science, and Technology" (Center for Security and Emerging Technology, forthcoming).

[8] Peterson, Goode, and Gehlhaus, "Education in China and the United States: A Comparative System Overview."

[9] Overall, 147 Chinese universities appeared in either the ARWU or QS top 1,000 in 2020.

[10] "China passes US to top output of influential science papers," *Nikkei Asia*, August 10, 2021, https://asia.nikkei.com/Business/Technology/China-passes-US-to-top-output-of-influential-science-papers; Ashwin Acharya and Brian Dunn, "Comparing U.S. and Chinese Contributions to High-Impact AI Research" *Center for Security and Emerging Technology*, January 2022, https://cset.georgetown.edu/publication/comparing-u-s-and-chinese-contributions-to-high-impact-ai-research/.

[11] BESAC International Benchmarking Committee, *Can the U.S. Compete in Basic Energy Sciences?* (Washington, D.C.: Department of Energy, August 2021), https://science.osti.gov/-/media/bes/pdf/reports/2021/International_Benchmarking-Report.pdf.

[12] Lutz Bornmann, Johann Bauer, and Elisabeth Maria Schlagberger, "Highly Cited Researchers 2014 and 2015: An investigation of some of the world's most influential scientific minds on the institutional and country level," *COLLNET Journal of Scientometrics and Information Management* 12, no. 1 (2018): 15–33, 10.1080/09737766.2017.1332610; "Clarivate Identifies Global Scientific Pioneers with Annual Highly Cited Researchers List," Clarivate, November 18, 2020, https://clarivate.com/webofsciencegroup/news/clarivate-identifies-global-scientific-pioneers-with-annual-highly-cited-researchers-list/; John Tianci Li, "On the advancement of highly cited research in China: An analysis of the Highly Cited database," *PLOS ONE* 13, no. 4 (2018): e0196341, https://doi.org/10.1371/journal.pone.0196341.

[13] "Academic Ranking of World Universities 2020," Shanghai Ranking Consultancy, accessed September [add date if available] 2021, http://archive.shanghairanking.com/ARWU2020.html.

[14] Li Tang, Philip Shapira, and Jan Youtie, "Is there a clubbing effect underlying Chinese research citation increases?," *Journal of the Association for Information Science and Technology* 66, no. 9 (2015): 1923–32, https://asistdl.onlinelibrary.wiley.com/doi/10.1002/asi.23302.

[15] "Nobel Prize Winners by Year," *Britannica*, accessed September 2021, https://www.britannica.com/topic/Nobel-Prize-Winners-by-Year-1856946; Autumn Toney and Melissa Flagg, "Comparing the United States' and China's Leading Roles in the Landscape of Science" (Center for Security and Emerging Technology, June 2021), https://cset.georgetown.edu/publication/comparing-the-united-states-and-chinas-leading-roles-in-the-landscape-of-science/; Josh Moody, "Study: International Student Numbers in U.S. Drop," *U.S. News and World Report*, November 16, 2020, https://www.usnews.com/education/best-colleges/articles/annual-study-international-student-numbers-in-us-drop. Researchers in the United States are also more likely than their Chinese

counterparts to collaborate with international scholars. For more, see Autumn Toney and Melissa Flagg, "Research Impact, Research Output, and the Role of International Collaboration" (Center for Security and Emerging Technology, November 2021), https://cset.georgetown.edu/publication/research-impact-research-output-and-the-role-of-international-collaboration/.

[16] "Superpowered science: Charting China's research rise," *Nature*, May 26, 2021, https://www.nature.com/articles/d41586-021-01403-2; "Clarivate Identifies Global Scientific Pioneers with Annual Highly Cited Researchers List," Clarivate; Karen White, "Publications Output: U.S. Trends and International Comparisons," Figure PBS-1, report NSB-2021-4, *Science and Engineering Indicators 2022* (Alexandria, VA: National Science Board, National Science Foundation, October 28, 2021), https://ncses.nsf.gov/pubs/nsb20214/publication-output-by-country-region-or-economy-and-scientific-field.

[17] A previous CSET study estimated that Chinese nationals accounted for approximately 2 percent of STEM undergraduate students and 16 percent of STEM graduate students in the United States in 2019; some return to China after earning their degrees. Due to data limitations, the number of Chinese nationals who graduated with STEM degrees from ranked U.S. universities could not be determined, nor could the share who returned to China after graduating. For more information on Chinese students in the United States, see Jacob Feldgoise and Remco Zwetsloot, "Estimating the Number of Chinese STEM Students in the United States" (Center for Security and Emerging Technology, October 2020), https://cset.georgetown.edu/publication/estimating-the-number-of-chinese-stem-students-in-the-united-states/; and Remco Zwetsloot, Jacob Feldgoise, and James Durham, "Trends in U.S. Intention-to-Stay of International PhD Graduates across Nationality and STEM Fields" (Center for Security and Emerging Technology, April 2020), https://cset.georgetown.edu/publication/trends-in-u-s-intention-to-stay-rates-of-international-ph-d-graduates-across-nationality-and-stem-fields/.

[18] Remco Zwetsloot, Jack Corrigan, Emily Weinstein, Dahlia Peterson, Diana Gehlhaus, and Ryan Fedasiuk, "China Is Fast Outpacing U.S. STEM PhD Growth" (Center for Security and Emerging Technology, August 2021), https://cset.georgetown.edu/publication/china-is-fast-outpacing-u-s-stem-phd-growth/.

[19] These labor market challenges are not unique to China. Survey data suggests that a significant number of recent U.S. university graduates are also struggling to find jobs amid the COVID-19 pandemic: "New grad survey: anxiety, desperation, and salary woes revealed," *Monster.com*, https://hiring.monster.com/employer-resources/blog/labor-statistics/new-grad-

survey/. For more on the labor market dynamics of Chinese university graduates, see 不好为师而人师者, "985毕业卷香烟：是研究生丧失理想？还是," *Weixin*, July 15, 2021, https://mp.weixin.qq.com/s/prkiHN1eMi2ckStLmXMGyg?fbclid=IwAR1ra0k7bxZuKXzcmR3bUsxYSQ9aISAKgcwvmVm8X3GOFiiYuHATVhq9bZw; Mandy Zou, "China's universities produce millions of graduates each year, but many can't get a decent job and end up unemployed or in factories," *South China Morning Post*, July 16, 2021, https://www.scmp.com/news/people-culture/social-welfare/article/3141313/chinas-universities-produce-millions-graduates; Wang Lianzhang and Zeng Chuchu, "China's Tight Job Market Yields Highly Educated Cigarette Makers," *Sixth Tone*, July 17, 2021, https://www.sixthtone.com/news/1008011/chinas-tight-job-market-yields-highly-educated-cigarette-makers; "A drop in China's unemployment rate hides a lack of jobs," *Al Jazeera*, June 21, 2021, https://www.aljazeera.com/economy/2021/6/21/a-drop-in-chinas-unemployment-rate-hides-a-lack-of-jobs.

[20] Vivian Wang, "China's College Graduates Can't Find Jobs. The Solution: Grad School," *The New York Times*, January 18, 2021, https://www.nytimes.com/2021/01/18/business/china-graduate-school-white-collar.html.

[21] "The Permanent Detour: Underemployment's Long-Term Effects on the Careers of College Grads" (Burning Glass Technologies, 2018), 11, https://www.burning-glass.com/wp-content/uploads/permanent_detour_underemployment_report.pdf#page=11.

[22] "Academic Ranking of World Universities 2020," Shanghai Ranking Consultancy.

[23] Understanding the Methodology: QS World University Rankings," QS Quacquarelli Symonds Ltd.

[24] "QS World University Rankings: Methodology," QS Quacquarelli Symonds Ltd.

[25] Due to data availability issues, the following graduate information was used: 2017 for Nanjing University of Technology; 2018 for Soochow University; 2020 for South China Agricultural University and China University of Mining and Technology. The University of Connecticut School of Medicine was excluded from the count of U.S. top 500 graduates, as was the University of Kansas Medical Center. Likewise, Shandong University of Science and Technology was excluded from the count of Chinese top 500 graduates.

[26] In 2019, seven Chinese universities—Capital Medical, Jiangsu, Nanchang, Southwest University, Nanjing University of Technology, Nanjing University of Information Science and Technology, and Southern University of Science and Technology—published aggregated totals of master's and PhD graduates. We disaggregated this figure by calculating the ratio of master's-to-PhD graduates across ranked Chinese universities and applying it to each university's graduating class. For example, Southwest University awarded 3,651 graduate degrees in 2019. The ratio of master's-to-PhD graduates across all ranked Chinese universities in 2019 was approximately 5.63-to-1. Hence, we estimated that Southwest University produced about 551 PhD graduates in 2019.