# Supporting Information

## Xie et al. 10.1073/pnas.1407709111

### SI Text

### 1. China's Economic Growth

We measure China's economic growth with gross domestic product (GDP) data from Penn World Table Version 7.1 (PWT 7.1) (1). We chose to use Chinese data Version 2 for better international comparability (2). The trend from 1978 to 2010 is given in Fig. S1. The unit is the 2005 international dollar [purchasing-power-parity (PPP) adjusted US dollars at 2005 constant prices]. Between 1978 (967 billion) and 2010 (10,303 billion), the annual growth rate is 7.7%.

### 2. Postsecondary Education Attainment in China

We calculated the proportion of the Chinese population aged 25–29 y with college educations from the population censuses in China in 1982, 1990, 2000, and 2010 (3–6). Detailed results are given in Table S1. They show a rapid increase in the attainment of higher education over successive cohorts. Specifically, the share of college-educated Chinese aged 25–29 rose from 0.8% in 1982 to 3.3% in 1990, 6.7% in 2000, and 20.6% in 2010.

### 3. Science and Engineering Labor Force in China and the United States

Science and engineering (S/E) labor force data for both China and the United States came from respective national censuses, with additional data from the American Community Survey (ACS) 2009–2011 3-y sample. For both countries, we used a restricted occupation-based definition for scientist/engineer—an incumbent in an S/E occupation with at least a bachelor's degree. For China, we calculated the size of the S/E labor force based on tabulations from the 1982, 1990, 2000, and 2010 China censuses provided by the National Bureau of Statistics (3–6). For the United States, we calculated comparable figures based on public use 1% microdata from the 1980, 1990, and 2000 US censuses, as well as the 3% 2009–2011 ACS data (7).

In our analysis, S/E occupations include physical scientists, life scientists, mathematical scientists, and engineers but exclude social scientists. We grouped detailed occupational codes into major S/E fields, using a coding system that preserves comparability over time and across the two countries. In Table S2, we give an example of our coding system for the 1990 US census data, using harmonized occupational codes in Integrated Public Use Microdata Series 5.0 (7).

We present our summary results on the S/E labor force in Table S3. Besides giving the total size in both China and the United States, shown in the first row for each section, we break down these statistics into three subcategories: natural scientists, engineers, and computer-related scientists/engineers. In addition, we provide data on the percentage of women in the S/E labor force in both countries. To facilitate the comparison of the growth rate, Fig. S2 presents the United States' and China's S/E labor force sizes on a logged scale (compare with Fig. 1).

It seems surprising that the number of natural scientists in China declined from 1982 to 2000. This decline was likely a result of the Cultural Revolution (1966–1976). Institutions of higher education were closed for much of the Cultural Revolution, and they did not admit regular students in large numbers until the reintroduction of the examination-based admission system in 1977. This caused an interruption in the cohort succession of Chinese scientists. Fig. S3 shows the age structure of scientists in 1982 and 1990. The data are based on 1% census samples in 1982 and 1990. We observe a bulge in the number of scientists aged 40–49 in 1982 and aged 50–59 in 1990, a group who were educated before the Cultural Revolution. This large group of scientists had gradually retired by the year 2000, causing the decline in the number of natural scientists between 1982 and 2000.

### 4. Earnings of Selected Professionals

We computed the earnings ratio of scientists to those of four other high-status professionals—social scientists, medical doctors, lawyers, and engineers—in both China and the United States. Our analysis drew data from the 2005 1% minicensus survey in China and the 2006–2008 ACS. The 2005 minicensus survey in China, conducted by the National Bureau of Statistics of China, collected both demographic and economic information for a very large sample that represented 1% of the Chinese population (8). The ACS is an annual government survey collecting basic demographic and socioeconomic information about the American population. The 2006–2008 ACS is a 3-y pooled sample. Because the data contain only a single code for all academics, we imputed the number of academic scientists based on the share of academics within each field from the 1990 census. We restricted our data analysis to full-time, year-round-employed men (or employed persons working at least 35 h/wk in China) aged 30–55 with at least a bachelor's degree and nonzero income.

We obtained the earnings ratio of a particular profession to that of the scientist by estimating an ordinary linear regression of the logarithm of yearly earnings on a set of profession dummy variables (with scientists as the reference category), controlling for age, a square function of age, degree level of education (having an advanced degree = 1 and having a bachelor's degree = 0), and two dummy variables of hours of work per week (divided into 41–50 h and 51 h and above, with 35–40 h as the reference category). The following equation describes the relationship:

$$\begin{aligned}\log \mathrm{Inc} = {} & \beta_0 + \beta_1 \mathrm{soc} + \beta_2 \mathrm{eng} + \beta_3 \mathrm{doc} + \beta_4 \mathrm{law} + \lambda_1 \mathrm{age} \\ & + \lambda_2 \mathrm{age}^2 + \lambda_3 41\text{–}50\mathrm{h} + \lambda_4 51\mathrm{h} + \lambda_5 \mathrm{advanced\ degree} + \lambda.\end{aligned}$$

The exponentiated coefficients for the other professions in the regression ($\beta_1$ to $\beta_4$) yielded the earnings ratios.

We present our regression results in Table S4: Column "b" gives the regression coefficient for each variable and column "Exp(b)" gives the exponential coefficient for each profession, representing the earnings ratio. Table S4 shows that scientists in China earn more than social scientists, doctors, and lawyers, but less than engineers. Engineers in China earn a 25% premium over scientists. The earnings of Chinese scientists are 25% higher than those of social scientists, 13% higher than those of medical doctors, and 5% higher than those of lawyers. By contrast, as Table S4 shows, American scientists earn less than the other high-status professional groups being compared. Their earnings are only 93% (= 100·[1/1.08]) of social scientists' earnings, 83% of engineers', 50% of medical doctors', and 66% of lawyers'.

### 5. The Number of Higher Education Institutions in China

Historical counts of higher education institutions (HEIs) in China came from the Web site of the Ministry of Education of the People's Republic of China, which releases educational statistics for the years 1998–2010 (9). The term "higher education institution" refers to regular institutions of higher education, including universities and colleges providing degree-level programs, junior colleges (or short-cycle colleges), and vocational colleges. Table S5 summarizes the trends in the number of HEIs over the years.

## 6. Postsecondary S/E Education in China and the United States

We constructed China's degree production trends from two sources. Numbers of doctorates from 1993 to 1996 were retrieved from *Science and Engineering Indicators* (*SEI*) 2010 (10), and all others were based on various issues of *Educational Statistics Yearbook of China* (11). The yearbooks, however, do not provide information about bachelor's degrees between 1989 and 1997. To connect the series, we extrapolated the numbers of degrees for these years with constant annual growth rates between 1988 and 1998.

The US degree series came from the WebCASPAR Integrated Science and Engineering Resource Data System (12). We combined degrees across disciplinary categories to derive the numbers of S/E degrees. China degrees included those in natural sciences (*li ke*) and agricultural sciences (*nong ke*). For both countries, medical degrees were excluded.

In Table S6, we present trends in the bachelor's and doctoral S/E degree production in China and the United States. One obvious difference between China and the United States lies in the proportions of degrees in S/E. The difference is particularly pronounced at the bachelor's level. Over the period, the proportion of bachelor's degrees in S/E ranged from 15.1% to 18.5% in the United States but from 43.6% to 59% in China. For example, in 2010, China graduated a much higher percentage (43.6%) of S/E students than the United States (16%) at the undergraduate level. The disparity is also present, albeit less pronounced, at the doctoral level, again indicating China's greater concentration of higher educational resources in S/E.

Table S6 also shows the rapid expansion of Chinese S/E education. In absolute terms, China's S/E baccalaureate production caught up with that of the United States in 1991 and grew to more than four times that of the United States in two decades. In 2010, China graduated 1.13 million students with bachelor's degrees in S/E, whereas the United States graduated 0.26 million. China's population, however, was also much larger (1.34 billion) than that of the United States (0.31 billion). Divided by the total population size, the crude rate of scientific baccalaureate attainment happens to be the same for the United States (0.00084) and China (0.00085). To compare the growth rates of China and the United States, we plot out the degree trends on a log scale in Fig. S4 (compare with Fig. 3).

## 7. Chinese Students Studying S/E and Attaining S/E Doctoral Degrees in US Universities

The number of Chinese graduate students studying S/E in US universities between 1987 and 2010 came from *SEI* 2004, 2008, 2010, and 2012 (10, 13–15). The appendix table of *SEI* contains tabulations of foreign graduate student enrollment by field and selected place of origin. We constructed a series for Chinese students by field of study in US universities that is shown in Tables S7 and S8.

Data on S/E doctoral degrees awarded by US universities to Chinese citizens were provided by the National Science Foundation in a research report (16). We present the series in Table S9. We were unable to exclude social science from this series. However, given that relatively few Chinese study social science in US universities, the upward bias due to the inclusion of social science degrees should be small.

## 8. Government Policies for Scientific/Technological Development in China

**The Guiding Principle of Scientific/Technological Development (1982).** "Economic development should rely on science and technology; science and technology should be oriented to serving economic development" has become the guiding principle for the development of science and technology in China since the early 1980s (17). This principle was first declared and explicated by former Premier Zhao Ziyang in his speech entitled, "A Strategic Question on Invigorating the Economy" at the National Science and Technology Award Conference on October 24, 1982. During the speech, Premier Zhao emphasized the close relationship between science/technology and economic development. He argued that backward science and technology was China's major barrier to reaching the economic goal of doubling agricultural and industrial production by 2000. Zhao called for management improvements to promote the development of science and technology.

**The Funding of Project 985 (1998).** Project 985 originated from the speech of former President Jiang Zemin at the 100th Anniversary of Peking University on May 4, 1998. In this speech, President Jiang proposed that "several world-class universities and a number of universities with worldwide reputations" be established in China. To achieve this goal, the Ministry of Education first selected Peking University and Tsinghua University as target universities and planned to invest ¥180 million (or US$300 million) in each of them from 1999 to 2001 (18). The project later expanded to fund a total of 39 universities.

**The Recruitment Program of Global Experts (2008).** The Recruitment Program of Global Experts (also known as the Thousand Talent Program) was launched in 2008, with the goal of recruiting up to 2,000 overseas experts during the next 5–10 y. The awardees would receive ¥1 million (US$160,449) tax-free relocation allowances from the central government (19). Moreover, the awardees and their families would be given the right of permanent residency in China if they hold foreign citizenships or household registration in any city where they work if they are Chinese citizens. The awardees also enjoy enhanced medical insurance, generous pensions, and other privileged social services (20). The salary and research funding depend on negotiations with one's employer. The package is usually generous (21).

## 9. Media Reports of Returning Scientists

The names of prominent returning scientists such as Yi Rao, Yigong Shi, and Xiaodong Wang have frequently appeared on international and domestic media (21–29). They are examples of overseas experts who have returned to China to develop their careers. Their opinions reflect both the opportunities and the difficulties that returning scientists encounter in China. Below, we summarize briefly several reports from domestic and overseas media about these three returning scientists.

The *China Economic Herald* on August 5, 2004 reported the founding of the National Institute of Biological Sciences (NIBS) in Beijing and interviewed its first director, Xiaodong Wang, a biochemist and a Howard Hughes Medical Institute investigator at the University of Texas Southwestern Medical Center in Dallas. According to the report, the NIBS was founded to support outstanding experts producing world-class scientific research. Wang's main task was to help the institute to recruit overseas talent. During the interview, Wang showed confidence in the future research staff of the NIBS by saying that "those who can get positions in the United States may not get hired at the NIBS, while those who work in the NIBS must be good enough to get positions in the US" (22). At the time of the interview, Wang worked only part time at the NIBS. Later, according to a report in *Science* magazine on July 31, 2009, Wang closed his laboratory in the United States and returned to China full time for his second term at the NIBS under the Recruitment Program of Global Experts. The report quoted Wang as saying that "there is no turning back" to show his determination (23). On November 24, 2010, the *People's Daily* reported that Wang was received by Li Yuanchao, then a member of the Politburo and minister of the Party's Organization Department, who used the occasion to express his general support for returning scientists (24).

Yigong Shi, a molecular biologist who left Princeton University to assume a position at Tsinghua University in Beijing in 2008, is another figure who has received repeated media attention. He is cited as an example of a Thousand Talent funds recipient in articles appearing in *Science* (23) and *Nature* (21). A *New York Times* article, published on January 7, 2010, "Fighting trend, China is luring scientists home," reported that Shi's decision to return to China shocked his American colleagues. Using Shi's case as an example, the article revealed China's generous packages to attract overseas top scientists home. The article also discussed problems in China's scientific system that may discourage top overseas Chinese scientists from going back. However, according to the article, some returning scientists such as Shi are optimistic about the future of Chinese science, as they see themselves as having opportunities to influence the government's new initiatives and to improve China's science-related institutions and practices (25).

Yi Rao, a neuroscientist, left Northwestern University for Peking University in Beijing in 2007. He was selected as "The Most Influential Figure Between 1999 to 2009" by *China Newsweek* (26), in large part because of his sharp criticisms of the current scientific research system in China. His criticisms regarding institutional barriers to China's scientific development have been cited by *Nature* (27) and the *New York Times* (25). In an article entitled "Time to turn attention to science & technology," published in *China Daily* on September 3, 2008, Rao and Shi argued that China's scientific and technological development has lagged behind relative to the country's great achievements in sports, the economy, and other fields. To advance science, they called for good policies and reforms that would ensure fair competition based on scientific merit, unaffected by the interests of different groups. They also predicted that more top-tier overseas scientists would return to China if a favorable environment were created (28). In an article published in *Science* magazine on September 3, 2010, Shi and Rao further criticized unhealthy research practices in China, particularly the control of funding decisions by a small group of government bureaucrats (29).

## 10. Funding Figures from the Organisation for Economic Co-operation and Development

The Organisation for Economic Co-operation and Development (OECD)'s Main Science and Technology Indicators database (30) provides data related to research and development (R&D) in the OECD and some selective nonmember countries, including China. In Table S10, we present the OECD data that compare China and the United States in gross expenditure on R&D (GERD) and GERD's share of the country's gross domestic product (GDP) between 1991 and 2010. The GERDs are purchase-power adjusted and converted to 2005 constant US dollars. Data were extracted online on February 2, 2013 (30).

Two patterns emerge from Table S10. First, the GERD in both countries has increased over time, but the increase in China's GERD outpaced that of the United States. Between 1991 and 2010, the China:US ratio rose steadily from 5% to 44%. Second, in terms of percent GERD of GDP, whereas the United States has remained at the level of around 2.65% over the past 20 y, China's share of GDP spent on R&D has more than doubled, rising from a mere 0.73% in 1991 to 1.76% in 2010.

## 11. China's Scientific Output and Impact

Our analysis of scientific output and impact draws on special tabulations from Thomson Reuters' InCites (http://researchanalytics.thomsonreuters.com/incites/) and Essential Science Indicators (ESI; http://thomsonreuters.com/essential-science-indicators/) databases. InCites counts documents indexed by the Web of Science and the times they are cited. ESI tracks the highly cited Thomson Scientific indexed journal articles over a rolling 10-y period. Based on total citations received by field and year, articles meeting the threshold of the top 1% are regarded as highly cited. Thomson Reuters provided the data upon our request, separately by country/region [i.e., China, United States, European Union (EU-15), United Kingdom, Germany, Japan, India], year (InCites 1990–2011; ESI 2001–2011), and 22 disciplinary fields.

From the data, we constructed three series to track changes in scientific output and impact by country/region. For scientific output, we used the total number of Web of Science articles in S/E. We measure impact by the average number of citations and the number of highly cited articles. All analyses were restricted to fields in the natural sciences and engineering, excluding the medical and social sciences. Data are summarized in Table S11. Historical trends in total number of articles and number of highly cited articles were plotted out in Fig. S5 *A* and *B* on log scales. In the main text, we present country-specific raw counts (i.e., number of articles, number of highly cited articles) in Fig. 5 *A* and *C*. In Fig. S6, we provide an adjusted version of those two series with a ratio-of-ratio measure: The ratio in relative productivity adjusting for economy size (i.e., the raw counts divided by each country's real GDP in 2005 constant PPP-adjusted US dollars) between a country and the United States. The GDP data were retrieved from the PWT (1). Fig. S6 *A* and *B* show that China's research productivity increased substantially even after we control for its fast increase in GDP (Fig. S1). In addition, China, along with India, has still lagged behind the other countries in relative productivity, in terms of both total number of publications (Fig. S6*A*) and most-cited publications (Fig. S6*B*), the latter gap being more pronounced.

We also calculated statistics that compare China and the United States in research productivity in specific fields and subfields. We note that the observed increase in publications by Chinese scientists may have overestimated the growth of China's real research productivity because our analysis is restricted to English publications to the exclusion of Chinese scientists' work in their native language. In the 1990s, in an effort to join the international community, Chinese scientists were shifting from Chinese publications to publications in English. Many English language journals based in China became included in the index systems of international citation agencies in this period.

Besides indicators based on scientific publications, we also traced historical data pertaining to patent applications initiated from China, the United States, and other leading countries/regions. The data came from the World Intellectual Property Organization statistics database (31). Similar to the publication trends, Fig. S7 shows a dramatic increase in China's patent applications since the late 1990s, in both absolute and comparative terms.

## 12. Scientific Misconduct in China

**Significant Cases of Scientific Misconduct Exposed on New Threads.** New Threads (www.xys.org) is a Web site where a well-known Chinese blogger, Fang Shimin, exposes scientific misconduct. For each case, the Web site posts the evidence that Fang has either uncovered himself or forwarded from others, as well as debates and criticisms about allegations of scientific misconduct. We examined the Web site and provide a summary of significant cases posted there from 2000 to 2009 (see below table). Our focus is on "scientific misconduct," which is defined broadly as plagiarism; fabrication of data and scientific findings; and fraudulent authorship, publications, and curriculum vitae. The cases summarized below all involved Chinese scholars in natural science. For most of the cases, we confirmed the validity of allegations with independent media reports or announcements of disciplinary actions taken by relevant institutions. Allegations that have not been confirmed are not listed here.

**The Count of Scientific Misconduct Using Google News.** The data of Fig. 6 are the search results from Google News. On the

| Year | Event |
|---|---|
| 2009 | The editors at *Acta Crystallographica* Section E retracted 70 published structures, which were submitted by two researchers at Jinggangshan University, because these structures were found to be falsified. |
| | An academician candidate at the Chinese Academy of Science and a vice president of Wuhan University of Technology, Zhou Zude, was found to have submitted a plagiarized paper with his PhD student to the second National Conference of Intelligent Manufacturing. |
| | Zhejiang University dismissed He Haibo, an associate professor in the College of Pharmaceutical Sciences, because nine of his papers were charged with problems of plagiarism, multiple submission, fabricating funding source, and listing coauthors without consent. |
| 2007 | Two retired researchers revealed that a newly elected member of the Chinese Academy of Science, Xie Huaan, published a paper and a book that were plagiarized. The authenticity of Xie's educational credential, a technical secondary school diploma, was also questioned. |
| | Huang Linglin, a female PhD degree recipient from the Shanghai Institute of Organic Chemistry, Chinese Academy of Sciences, was deprived of her PhD degree. Her supervisor reported that Huang fabricated data in her dissertation, which had been published in the *Journal of the American Chemical Society.* |
| | The Chinese Academy of Engineering circulated a notice of criticism regarding three papers by the academician Fan Weideng and his students and colleagues in which they plagiarized the work of Japanese researchers. |
| 2006 | Tongji University dismissed its recently recruited professor and dean at the School of Life Sciences and Technology, Yang Jie, because he fabricated key items in his resume when applying for the position. |
| | Liu Hui, assistant dean and professor at the Tsinghua University Medical School, was dismissed for fabricating key items in his resume when applying for the job. |
| 2005 | The vice president of Anhui Normal University, Liu Dengyi, resigned because he was accused of having fabricated the record of a publication in the *American Journal of Botany* and *Ecology*. |
| 2003 | Li Shifeng, a PhD student at the School of Computer Science and Engineering, Southeast University, was found to have published a paper, which was translated and plagiarized from *Proceedings of IEEE Conference on Computer Communications* (*IEEE INFOCOM*). |
| 2001 | Yang Jingan, professor at the School of Computer and Information, Hefei University of Technology, was reported to have published six plagiarized papers and fabricated overseas research experiences and publications. Yang also received a warning letter from the Institute of Electrical and Electronics Engineers (IEEE) Publication Services and Products Board. |
| 2000 | Four researchers at Beijing University of Aeronautics and Astronautics were reported to have published a paper in the *Journal of Beijing University of Aeronautics and Astronautics* that was plagiarized from the IEEE journal *Transactions on Signal Processing*. One of the alleged plagiarizers was the president of the university, Shen Shituan. |

Google News Web site (https://news.google.com.hk), we used "advanced search" feature and set "China" as the searching location. We specified the date of the news from January 1 to December 31 of each year from 2000 to 2010. We searched pages containing each of three key words (in Chinese) that are most commonly used to describe academic misconduct in China: scientific fabrication (*ke xue zao jia*), plagiarism (*lun wen chao xi*), and scholarly corruption (*xue shu fu bai*). In addition to Fig. 6 in the main text, we also include a Fig. S8 with the $y$ axis on log scale.

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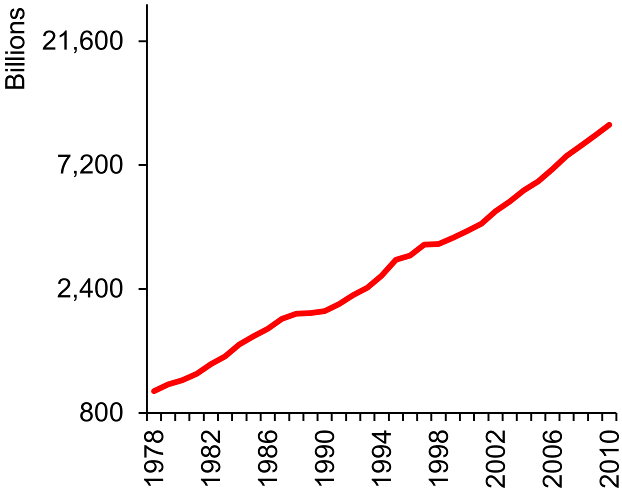

**Fig. S1.** China's GDP (2005 PPP-adjusted US dollars on a log scale), 1978–2010.

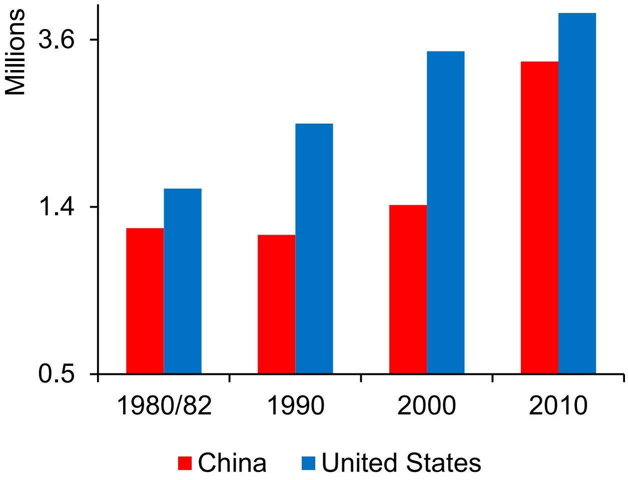

**Fig. S2.** Labor force (on a log scale) in S/E, 1980/1982–2010. In the 1980/82 category, 1980 represents the United States, and 1982 represents China.

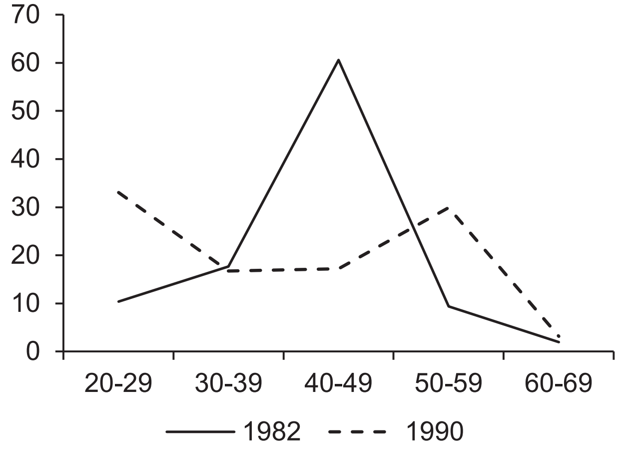

**Fig. S3.** Age structure of scientists (y) in China (%).

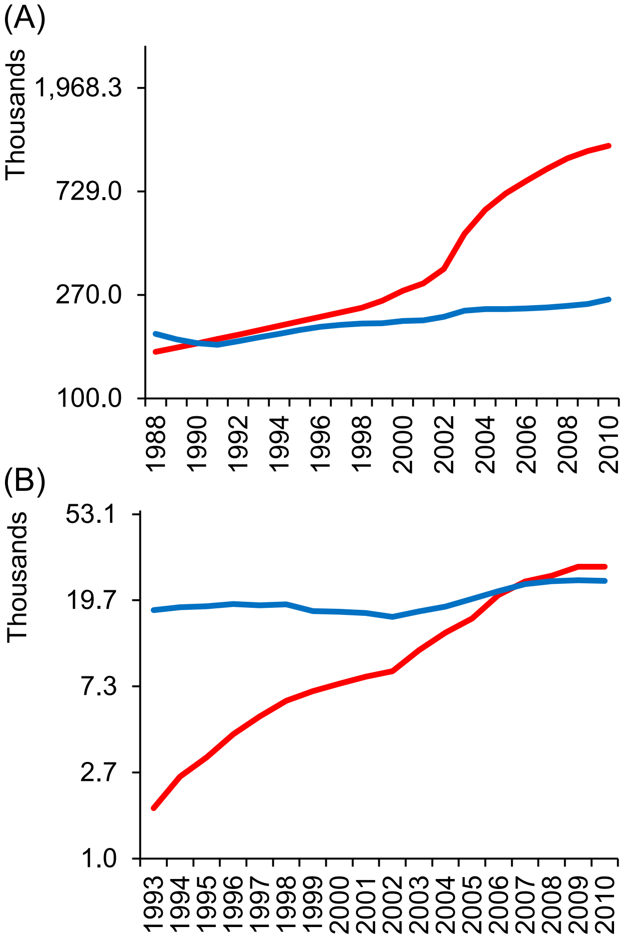

**Fig. S4.** (*A*) Bachelor's degrees (on a log scale) awarded, 1988–2010. (*B*) Doctoral degrees (on a log scale) awarded, 1993–2010. The red line is for China, and the blue line is for the United States.

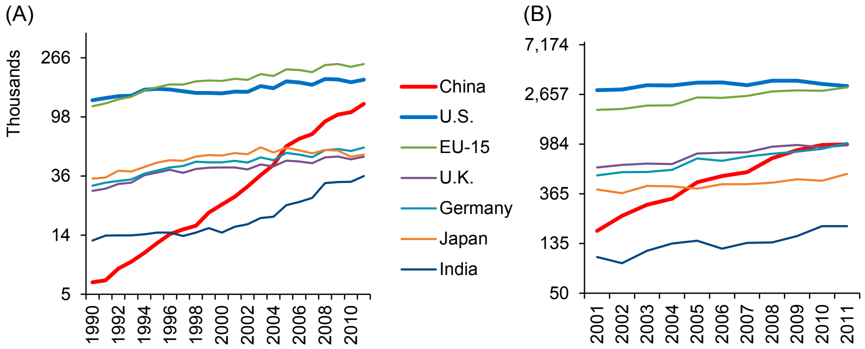

**Fig. S5.** (*A*) Total number of articles in S/E (on a log scale), 1990–2011. (*B*) Number of highly cited articles in S/E (on a log scale), 2001–2011.

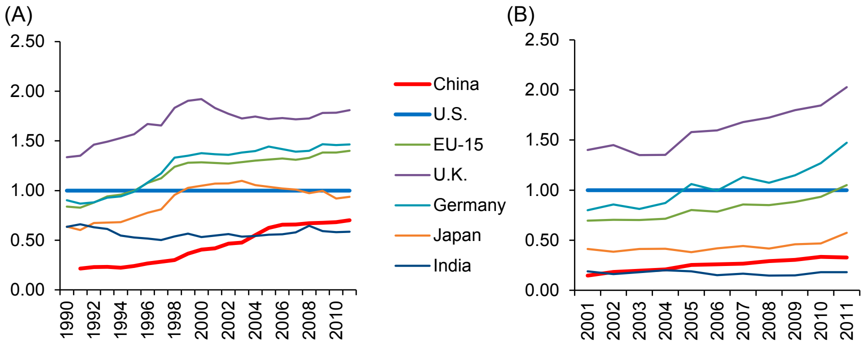

**Fig. S6.** (*A*) GDP-adjusted total number of articles in S/E compared with the United States, 1990–2011. (*B*) GDP-adjusted number of highly cited articles in S/E compared with the United States, 2001–2011.

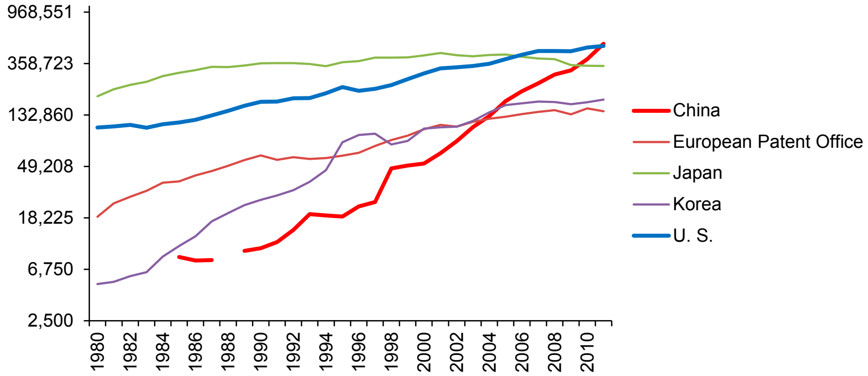

**Fig. S7.** Total patent applications (on a log scale), 1980–2011.

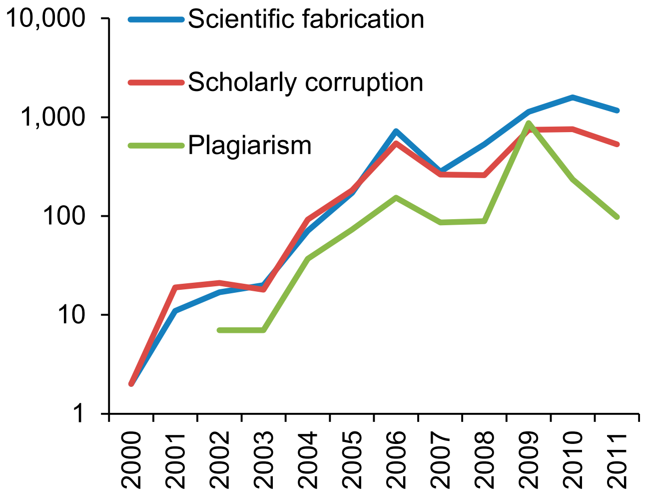

**Fig. S8.** Number of results in Google News search (on log scale).

**Table S1. Chinese population aged 25–29, 1982–2010**

| Year | With postsecondary education | Total population | Percent with postsecondary education |
|---|---|---|---|
| 1982 | 748,326 | 92,563,882 | 0.8 |
| 1990 | 3,199,995 | 96,982,769 | 3.3 |
| 2000 | 7,867,235 | 117,602,265 | 6.7 |
| 2010 | 20,783,912 | 101,013,852 | 20.6 |

**Table S2. US S/E occupation coding scheme, 1980–2010**

| S/E occupations | Code, 1990 |
|---|---|
| Natural sciences | |
| Physical sciences | |
| Physicists and astronomers | 69 |
| Chemists, except biochemists | 73 |
| Atmospheric and space scientists | 74 |
| Geologists and geodesists | 75 |
| Physical scientists, n.e.c. | 76 |
| Chemistry instructors | 115 |
| Physics instructors | 116 |
| Biological sciences | |
| Agricultural and food scientists | 77 |
| Biological scientists | 78 |
| Forestry and conservation scientists | 79 |
| Medical scientists | 83 |
| Earth, environmental and marine science instructors | 113 |
| Biological science instructors | 114 |
| Mathematical sciences | |
| Actuaries | 66 |
| Statisticians | 67 |
| Mathematical scientists, n.e.c. | 68 |
| Mathematical science instructors | 128 |
| Engineering | |
| Aerospace engineers | 44 |
| Metallurgical and materials engineers | 45 |
| Petroleum engineers | 47 |
| Chemical engineers | 48 |
| Civil engineers | 53 |
| Electrical and electronic engineers | 55 |
| Industrial engineers | 56 |
| Mechanical engineers | 57 |
| Engineers, n.e.c. | 59 |
| Engineering instructors | 127 |
| Sales engineers | 258 |
| Computer-related occupations | |
| Computer systems analysts and scientists | 64 |
| Operations and systems researchers and analysts | 65 |
| Computer programmers | 229 |

Note: Occupational classifications vary across years. The results are based on harmonized data with standard 1990 occupational codes (7). n.e.c., not elsewhere classified.

**Table S3.** **Labor force in S/E in China and the United States, 1980 (US)/1982 (China)–2010**

| Labor force | 1980 (US)/1982 (China) | 1990 | 2000 | 2010 |
|---|---|---|---|---|
| | China | | | |
| S/E total | 1,190,144 | 1,142,166 | 1,366,000 | 3,200,082 |
| Natural sciences | 101,698 | 98,139 | 79,923 | 155,980 |
| Engineering | 1,088,446 | 1,044,027 | 1,111,641 | 2,404,481 |
| Computer-related occupations | — | — | 174,436 | 639,622 |
| Female in S/E, % | 21.0 | 22.9 | 20.0 | 25.0 |
| Natural sciences | 28.3 | 27.9 | 30.3 | 36.1 |
| Engineering | 20.3 | 22.4 | 18.4 | 24.5 |
| Computer-related occupations | — | — | 25.9 | 24.1 |
| Total labor force, % S/E | 0.2 | 0.2 | 0.2 | 0.4 |
| | United States | | | |
| S/E total | 1,504,500 | 2,214,900 | 3,403,500 | 4,272,100 |
| Natural sciences | 308,400 | 370,500 | 551,800 | 687,800 |
| Engineering | 889,300 | 1,106,100 | 1,177,700 | 1,397,067 |
| Computer-related occupations | 306,800 | 738,300 | 1,674,000 | 2,187,233 |
| Female in S/E, % | 11.2 | 19.3 | 23.2 | 24.3 |
| Natural sciences | 19.8 | 26.8 | 33.7 | 39.8 |
| Engineering | 3.4 | 9.0 | 10.6 | 12.8 |
| Computer-related occupations | 25.3 | 30.9 | 28.7 | 26.8 |
| Total labor force, % S/E | 1.5 | 1.9 | 2.6 | 3.1 |

**Table S4.** **Regression estimates of logged earnings in China and the United States**

| Variables | b | SE | *P* | Exp(b) |
|---|---|---|---|---|
| | China, 2005 | | | |
| Occupation, scientists = 0 | | | | |
| Social scientists | −0.286 | 0.084 | 0.001 | 0.75 |
| Engineers | 0.227 | 0.054 | 0.000 | 1.25 |
| Doctors | −0.134 | 0.058 | 0.020 | 0.87 |
| Lawyers | −0.056 | 0.063 | 0.374 | 0.95 |
| Age | −0.065 | 0.021 | 0.002 | |
| Age square | 0.001 | 0 | 0.003 | |
| Working hours, 35–40 h = 0 | | | | |
| 41–50 h | 0.027 | 0.039 | 0.491 | |
| 51+ h | −0.039 | 0.045 | 0.385 | |
| Education, bachelor's degree = 0 | | | | |
| Advanced degree | 0.52 | 0.034 | 0 | |
| Intercept | 8.85 | 0.422 | 0 | |
| $R^2$ | 0.152 | | | |
| *N* | 2,715 | | | |
| | United States, 2006–2008 | | | |
| Occupation, scientists = 0 | | | | |
| Social scientists | 0.074 | 0.014 | 0.000 | 1.08 |
| Engineers | 0.183 | 0.008 | 0.000 | 1.20 |
| Doctors | 0.705 | 0.010 | 0.000 | 2.02 |
| Lawyers | 0.419 | 0.009 | 0.000 | 1.52 |
| Age | 0.158 | 0.004 | 0.000 | |
| Age square | −0.002 | 0.000 | 0.000 | |
| Working hours, 35–40 h = 0 | | | | |
| 41–50 h | 0.182 | 0.006 | 0.000 | |
| 51+ h | 0.305 | 0.007 | 0.000 | |
| Education, bachelor's degree = 0 | | | | |
| Advanced degree | 0.147 | 0.007 | 0.000 | |
| Intercept | 7.366 | 0.092 | 0.000 | |
| $R^2$ | 0.3014 | | | |
| *N* | 50,363 | | | |

**Table S5. Trends in number of HEIs**

| Year | No. of HEIs |
|---|---|
| 1998 | 1,022 |
| 1999 | 1,071 |
| 2000 | 1,041 |
| 2001 | 1,225 |
| 2002 | 1,396 |
| 2003 | 1,552 |
| 2004 | 1,731 |
| 2005 | 1,792 |
| 2006 | 1,867 |
| 2007 | 1,908 |
| 2008 | 2,263 |
| 2009 | 2,305 |
| 2010 | 2,358 |

**Table S6. Degrees awarded in S/E in China and the United States, 1988 (Bachelor's degree)/1993 (Doctoral degree)–2010**

| | China | | | | United States | | | |
|---|---|---|---|---|---|---|---|---|
| Year | Engineering | Sciences | S/E | % S/E | Engineering | Sciences | S/E | % S/E |
| Doctoral degrees | | | | | | | | |
| 1993 | 1,069 | 723 | 1,792 | 84.8 | 5,823 | 11,783 | 17,606 | 41.7 |
| 1994 | 1,389 | 1,182 | 2,571 | 71.6 | 5,964 | 12,220 | 18,184 | 42.0 |
| 1995 | 1,659 | 1,560 | 3,219 | 73.8 | 6,112 | 12,288 | 18,400 | 41.3 |
| 1996 | 2,195 | 1,999 | 4,194 | 84.7 | 6,371 | 12,469 | 18,840 | 42.1 |
| 1997 | 2,964 | 2,185 | 5,149 | 70.4 | 6,202 | 12,373 | 18,575 | 40.7 |
| 1998 | 3,427 | 2,752 | 6,179 | 69.0 | 6,013 | 12,757 | 18,770 | 40.6 |
| 1999 | 4,039 | 2,871 | 6,910 | 67.0 | 5,427 | 11,951 | 17,378 | 39.2 |
| 2000 | 4,611 | 2,907 | 7,518 | 68.3 | 5,384 | 11,859 | 17,243 | 38.5 |
| 2001 | 5,009 | 3,148 | 8,157 | 63.4 | 5,561 | 11,440 | 17,001 | 37.8 |
| 2002 | 5,252 | 3,434 | 8,686 | 59.3 | 5,192 | 11,076 | 16,268 | 36.5 |
| 2003 | 6,573 | 4,461 | 11,034 | 58.7 | 5,287 | 12,010 | 17,297 | 37.3 |
| 2004 | 8,054 | 5,495 | 13,549 | 57.8 | 5,928 | 12,368 | 18,296 | 37.6 |
| 2005 | 9,427 | 6,551 | 15,978 | 57.7 | 6,551 | 13,430 | 19,981 | 38.0 |
| 2006 | 12,130 | 8,785 | 20,915 | 57.7 | 7,423 | 14,484 | 21,907 | 39.2 |
| 2007 | 14,479 | 9,954 | 24,433 | 58.9 | 8,083 | 15,665 | 23,748 | 39.5 |
| 2008 | 15,276 | 10,889 | 26,165 | 59.8 | 8,137 | 16,356 | 24,493 | 40.4 |
| 2009 | 17,386 | 11,576 | 28,962 | 59.5 | 7,944 | 16,860 | 24,804 | 41.0 |
| 2010 | 17,428 | 11,611 | 29,039 | 59.3 | 7,840 | 16,760 | 24,600 | 43.7 |
| Bachelor's degrees | | | | | | | | |
| 1988 | 115,397 | 40,802 | 156,199 | 55.8 | 70,154 | 115,611 | 185,765 | 18.5 |
| 1989 | 120,769 | 41,906 | 162,675 | 56.0 | 66,947 | 109,137 | 176,084 | 17.1 |
| 1990 | 126,391 | 43,102 | 169,493 | 56.3 | 64,705 | 105,021 | 169,726 | 16.0 |
| 1991 | 132,275 | 44,395 | 176,671 | 56.5 | 62,187 | 105,383 | 167,570 | 15.1 |
| 1992 | 138,433 | 45,793 | 184,226 | 56.8 | 61,941 | 111,158 | 173,099 | 15.1 |
| 1993 | 144,878 | 47,300 | 192,178 | 57.1 | 62,705 | 116,745 | 179,450 | 15.2 |
| 1994 | 151,622 | 48,924 | 200,547 | 57.4 | 63,012 | 122,976 | 185,988 | 15.7 |
| 1995 | 158,681 | 50,672 | 209,353 | 57.8 | 63,371 | 129,465 | 192,836 | 16.4 |
| 1996 | 166,068 | 52,552 | 218,620 | 58.2 | 63,114 | 135,943 | 199,057 | 16.9 |
| 1997 | 173,799 | 54,571 | 228,370 | 58.6 | 62,352 | 140,346 | 202,698 | 17.1 |
| 1998 | 181,890 | 56,738 | 238,628 | 59.0 | 60,914 | 144,441 | 205,355 | 17.1 |
| 1999 | 195,354 | 59,804 | 255,158 | 57.9 | 59,275 | 146,354 | 205,629 | 16.8 |
| 2000 | 212,905 | 68,368 | 281,273 | 56.8 | 59,536 | 150,898 | 210,434 | 16.8 |
| 2001 | 219,563 | 82,522 | 302,085 | 53.2 | 59,258 | 152,326 | 211,584 | 16.8 |
| 2002 | 252,024 | 94,988 | 347,012 | 52.9 | 60,639 | 158,536 | 219,175 | 16.8 |
| 2003 | 351,537 | 133,167 | 484,704 | 52.1 | 63,773 | 168,557 | 232,330 | 17.1 |
| 2004 | 442,463 | 168,242 | 610,705 | 51.0 | 64,675 | 171,106 | 235,781 | 16.8 |
| 2005 | 517,225 | 198,495 | 715,720 | 48.8 | 66,133 | 169,486 | 235,619 | 16.4 |
| 2006 | 575,634 | 231,547 | 807,181 | 46.7 | 68,121 | 169,229 | 237,350 | 16.1 |
| 2007 | 633,744 | 271,360 | 905,104 | 45.3 | 68,229 | 171,411 | 239,640 | 15.9 |
| 2008 | 704,604 | 297,259 | 1,001,863 | 44.4 | 69,870 | 172,857 | 242,727 | 15.7 |
| 2009 | 763,635 | 311,341 | 1,074,976 | 43.8 | 70,447 | 176,770 | 247,217 | 15.7 |
| 2010 | 813,218 | 317,495 | 1,130,713 | 43.6 | 74,109 | 184,332 | 258,441 | 16.0 |

**Table S7.** **Chinese graduate student enrollment in US universities, 1987–1997**

| | Subfield | | | | | |
|---|---|---|---|---|---|---|
| Year | Agricultural sciences | Physical/ life sciences | Mathematics/ computer sciences | Engineering | Other sciences | S/E total |
| 1987 | 591 | 6,341 | 2,630 | 4,343 | 775 | 14,679 |
| 1989 | 773 | 9,113 | 3,728 | 5,799 | 911 | 20,324 |
| 1991 | 1,045 | 11,562 | 4,179 | 7,870 | 1,045 | 25,700 |
| 1993 | 1,018 | 11,457 | 4,364 | 8,692 | 1,164 | 26,696 |
| 1995 | 1,398 | 9,201 | 4,259 | 8,095 | 1,040 | 23,994 |
| 1997 | 1,215 | 9,683 | 6,312 | 10,036 | 1,372 | 28,619 |

**Table S8.** **Chinese graduate student enrollment in US universities, 2006–2010**

| | Subfield | | | | | | |
|---|---|---|---|---|---|---|---|
| Year | Agricultural sciences | Physical sciences | Biological sciences | Computer sciences | Mathematics | Engineering | S/E total |
| 2006 | 272 | 6,100 | 4,063 | 3,733 | 2,959 | 10,727 | 27,854 |
| 2007 | 289 | 6,209 | 4,131 | 3,783 | 3,240 | 11,141 | 28,793 |
| 2008 | 690 | 5,880 | 5,160 | 3,480 | 3,290 | 11,220 | 29,720 |
| 2009 | 830 | 6,070 | 5,290 | 3,970 | 3,840 | 13,110 | 33,110 |
| 2010 | 1,090 | 6,970 | 5,550 | 5,470 | 5,000 | 18,220 | 42,300 |

**Table S9.** **Chinese temporary visa holders earning doctorates at US colleges and universities**

| Year | No. of US doctorates awarded by Chinese citizens in S/E |
|---|---|
| 2000 | 2,074 |
| 2001 | 2,196 |
| 2002 | 2,170 |
| 2003 | 2,323 |
| 2004 | 2,769 |
| 2005 | 3,346 |
| 2006 | 4,121 |
| 2007 | 4,308 |
| 2008 | 4,141 |
| 2009 | 3,744 |
| 2010 | 3,449 |

**Table S10. GERDs, total and as share of GDP: 1991–2010 (PPP, 2005 US dollars in millions)**

| | China | | United States | |
|---|---|---|---|---|
| Year | GERD | Percentage of GDP | GERD | Percentage of GDP |
| 1991 | 9,978 | 0.73 | 215,660 | 2.72 |
| 1992 | 11,452 | 0.74 | 216,462 | 2.64 |
| 1993 | 12,455 | 0.70 | 212,210 | 2.51 |
| 1994 | 12,750 | 0.64 | 212,198 | 2.41 |
| 1995 | 12,766 | 0.57 | 225,613 | 2.50 |
| 1996 | 13,915 | 0.57 | 237,877 | 2.54 |
| 1997 | 17,254 | 0.64 | 251,359 | 2.57 |
| 1998 | 18,844 | 0.65 | 265,171 | 2.60 |
| 1999 | 23,512 | 0.76 | 282,775 | 2.64 |
| 2000 | 30,401 | 0.90 | 302,231 | 2.71 |
| 2001 | 34,673 | 0.95 | 306,683 | 2.72 |
| 2002 | 42,570 | 1.07 | 300,510 | 2.62 |
| 2003 | 49,618 | 1.13 | 307,769 | 2.61 |
| 2004 | 59,264 | 1.23 | 310,261 | 2.55 |
| 2005 | 71,055 | 1.32 | 325,936 | 2.59 |
| 2006 | 83,902 | 1.39 | 342,286 | 2.65 |
| 2007 | 96,304 | 1.40 | 357,836 | 2.72 |
| 2008 | 111,183 | 1.47 | 374,199 | 2.86 |
| 2009 | 140,603 | 1.70 | 369,856 | 2.91 |
| 2010 | 160,494 | 1.76 | 368,203 | 2.83 |

**Table S11. Publication trends by country, 1990–2011**

| Year | China | United States | EU-15 | United Kingdom | Germany | Japan | India |
|---|---|---|---|---|---|---|---|
| Total no. of articles | | | | | | | |
| 1990 | 6,104 | 130,559 | 117,940 | 28,484 | 30,988 | 34,948 | 12,346 |
| 1991 | 6,306 | 135,382 | 123,618 | 29,534 | 32,595 | 35,525 | 13,397 |
| 1992 | 7,699 | 139,512 | 132,217 | 31,897 | 33,579 | 39,873 | 13,447 |
| 1993 | 8,631 | 140,742 | 138,209 | 32,611 | 34,361 | 39,328 | 13,468 |
| 1994 | 10,010 | 155,473 | 153,661 | 36,959 | 37,866 | 42,463 | 13,676 |
| 1995 | 11,827 | 157,713 | 162,127 | 38,632 | 39,975 | 45,747 | 14,090 |
| 1996 | 13,731 | 156,185 | 170,011 | 40,408 | 42,100 | 47,629 | 14,118 |
| 1997 | 14,897 | 151,776 | 169,486 | 38,501 | 43,225 | 47,082 | 13,308 |
| 1998 | 15,816 | 147,438 | 179,167 | 41,078 | 46,474 | 50,584 | 14,094 |
| 1999 | 19,700 | 147,646 | 181,860 | 42,001 | 45,827 | 51,823 | 15,178 |
| 2000 | 22,611 | 146,476 | 180,577 | 42,079 | 45,885 | 51,457 | 14,105 |
| 2001 | 25,730 | 150,817 | 186,819 | 42,041 | 47,058 | 53,655 | 15,522 |
| 2002 | 30,548 | 150,008 | 183,772 | 40,727 | 45,776 | 52,677 | 16,208 |
| 2003 | 36,931 | 165,368 | 202,510 | 44,232 | 49,824 | 59,021 | 17,993 |
| 2004 | 43,954 | 159,711 | 195,748 | 42,937 | 47,571 | 54,136 | 18,381 |
| 2005 | 60,216 | 178,956 | 218,653 | 47,266 | 53,761 | 58,630 | 22,348 |
| 2006 | 68,270 | 175,578 | 217,003 | 46,655 | 52,296 | 56,124 | 23,593 |
| 2007 | 73,745 | 168,867 | 209,115 | 45,319 | 50,024 | 53,456 | 25,229 |
| 2008 | 91,257 | 186,283 | 235,294 | 49,887 | 56,383 | 56,485 | 32,379 |
| 2009 | 102,605 | 184,765 | 239,301 | 50,656 | 57,319 | 55,937 | 32,942 |
| 2010 | 106,694 | 176,747 | 228,520 | 48,217 | 55,460 | 50,333 | 33,122 |
| 2011 | 122,672 | 184,253 | 240,056 | 50,495 | 58,774 | 52,229 | 36,456 |
| Average times cited tier article | | | | | | | |
| 1990 | 8.6 | 32.7 | 22.2 | 26.9 | 21.8 | 18.2 | 7.1 |
| 1991 | 8.7 | 32.5 | 22.2 | 25.1 | 20.9 | 18.3 | 7.1 |
| 1992 | 8.7 | 32.7 | 22.6 | 26.5 | 22.2 | 18.1 | 7.7 |
| 1993 | 8.5 | 32.7 | 23.0 | 26.9 | 23.4 | 18.3 | 7.7 |
| 1994 | 8.0 | 29.8 | 21.9 | 24.8 | 23.2 | 17.4 | 7.8 |
| 1995 | 8.1 | 30.3 | 21.9 | 25.6 | 22.4 | 17.3 | 8.1 |
| 1996 | 8.1 | 30.4 | 21.7 | 24.6 | 23.3 | 16.7 | 8.6 |
| 1997 | 9.2 | 31.1 | 22.7 | 27.4 | 22.9 | 18.0 | 9.2 |
| 1998 | 9.8 | 33.2 | 23.0 | 27.5 | 24.4 | 18.3 | 9.9 |
| 1999 | 9.9 | 32.0 | 22.8 | 26.9 | 24.1 | 18.1 | 9.6 |
| 2000 | 10.2 | 32.0 | 23.0 | 27.8 | 24.0 | 18.4 | 11.3 |
| 2001 | 11.0 | 30.4 | 21.7 | 26.4 | 23.3 | 17.8 | 10.7 |
| 2002 | 10.8 | 28.5 | 21.1 | 26.3 | 22.8 | 16.5 | 10.8 |
| 2003 | 11.1 | 26.0 | 19.1 | 23.5 | 20.3 | 15.0 | 10.7 |
| 2004 | 10.5 | 24.1 | 17.7 | 21.7 | 19.3 | 14.8 | 10.1 |
| 2005 | 9.4 | 20.6 | 15.8 | 19.6 | 17.7 | 12.6 | 9.0 |
| 2006 | 8.3 | 17.1 | 13.2 | 16.5 | 14.8 | 10.8 | 8.0 |
| 2007 | 7.5 | 14.6 | 11.7 | 14.6 | 13.3 | 9.4 | 6.6 |
| 2008 | 6.0 | 11.1 | 8.9 | 11.1 | 10.5 | 7.3 | 4.8 |
| 2009 | 4.1 | 7.5 | 6.0 | 7.6 | 7.0 | 4.9 | 3.4 |
| 2010 | 2.0 | 3.7 | 3.0 | 3.9 | 3.7 | 2.5 | 1.6 |
| 2011 | 0.4 | 0.7 | 0.6 | 0.8 | 0.8 | 0.5 | 0.3 |
| No. of highly cited articles | | | | | | | |
| 2001 | 174 | 2,894 | 1,951 | 617 | 528 | 398 | 103 |
| 2002 | 235 | 2,931 | 1,988 | 650 | 563 | 369 | 91 |
| 2003 | 293 | 3,187 | 2,128 | 667 | 564 | 427 | 117 |
| 2004 | 331 | 3,174 | 2,137 | 661 | 589 | 424 | 135 |
| 2005 | 460 | 3,354 | 2,503 | 814 | 740 | 404 | 143 |
| 2006 | 520 | 3,376 | 2,477 | 828 | 706 | 443 | 122 |
| 2007 | 563 | 3,186 | 2,580 | 835 | 768 | 443 | 137 |
| 2008 | 742 | 3,495 | 2,823 | 935 | 811 | 455 | 138 |
| 2009 | 872 | 3,493 | 2,886 | 966 | 849 | 487 | 157 |
| 2010 | 968 | 3,275 | 2,856 | 924 | 895 | 474 | 191 |
| 2011 | 980 | 3,137 | 3,064 | 963 | 1,006 | 544 | 191 |

Source: Special tabulations by Thomson Reuters. Our data were purchased from Thomson Reuters as customized tabulations based on InCites (http://researchanalytics.thomsonreuters.com/incites/) and ESI (http://thomsonreuters.com/essential-science-indicators/).