

## A call for effective science policies in an era where Japan has the third-highest GDP in the world

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### Correlation between the amount of Grants-in-Aid for Scientific Research and the number of main papers published

In the so-called “the scrutinizing of public projects,” which was carried out by the government led by the Democratic Party of Japan (DPJ) at the end of last year, the science and technology budget was seriously affected by the budget cuts as if to say that the science and technology budget is not a sanctuary any more. The journal *Nature* quickly reported this situation by saying that science in Japan is facing a crisis. 14 academic societies including the Chemical Society of Japan (CSJ) submitted a written request to the Minister of Education, Culture, Sports, Science and Technology which addressed the importance of strengthening science and technology research in Japan. Since the establishment of the Science and Technology Basic Act in 1995, the budget for scientific research has continued to grow steadily in Japan. The increase has almost stopped in the past few years, but how did this affect scientific research in Japan? There is a public view with a cold eye that scientists oppose “the scrutinizing of public projects” only because they want to secure the budget. However, while the budget cuts are making headlines, it is said that China’s GDP will eventually exceed Japanese GDP, making Japan the third largest economy in the world. Already on November 2 last year, Thomson Reuters released the news that the number of papers published by Chinese scientists finally exceeded that of Japanese scientists and came second in the world after the US. What is happening in the chemistry field? In order to obtain the latest statistics, one needs to find the relevant data by himself/herself. The results of chemical research are normally published as papers. It is easy to find the data nowadays if needed since a database has been developed. I looked up the changes in the number of main chemical papers over the years by country, on the Web of Science. **Figure 1** shows the changes over time in the number of papers published in the leading chemical academic journal “*Journal of the American Chemical Society (JACS)*” by country, together with the increase in the amount of Grants-in-Aid for Scientific Research in Japan.

This shows many interesting facts. The number of papers written by Japanese scientists, published in the *JACS*, was second to the US for many years. A particularly notable change was that the number of papers increased 2.2-fold over the period from 1997 (207 papers) to 2005 (458 papers). When looking at the European leading chemical journal “*Angewandte Chemie-International Edition (ACIE)*,” the number also increased three-fold over the period from 1998 (71 papers) to 2005 (220 papers). In the field of physics, the number of papers written by Japanese scientists which were published in the leading international journal “*Physical Review Letters (PRL)*” increased 2.5-fold over the period from

1996 (188 papers) to 2005 (464 papers). Therefore, there is a surprising correlation between these numbers and the number published in the *JACS*. It is thought that these increases are due to changes in the science and technology policies in Japan. The 1st Science and Technology Basic Plan was implemented from 1996, which is a year after the Science and Technology Basic Act was established. The Core Research for Evolutional Science and Technology (CREST) was also launched in 1995. It can be said that the increase in the number of papers published is the result of the striking effects of these policies. The amount of Grants-in-Aid for Scientific Research increased 1.7-fold from 112.2 billion yen to 188 billion yen during this period. The increase in the amount of Grants-in-Aid stopped in 2005 and so did the increase in the number of papers published in the *JACS*. The number of papers published in the *PRL* also peaked in 2005 and declined to 420 papers in 2009. The number of papers published in the *ACIE* also declined to 201 papers in 2009.

### Rapid growth of China and South Korea

China and South Korea are showing even more remarkable results from changes in science policies. In 1999, only 22 papers were published in the *JACS* by China and South Korea combined. This was less than 1% of the total number of papers published. However, the number had increased to 344 papers a decade later (2009), reaching the same level as Germany. This is a 16-fold increase over 10 years. In particular, the rapid growth in the number of papers written by Chinese scientists since 2000 is astonishing. In May 1998, China announced at the convention marking the 100th anniversary of the foundation of Peking University that the country would need some world-class universities in order to achieve modernization, and announced a policy called “Project 985” which indicates the launch year and month of the project. Based on this policy, the country started intensively investing its budget for scientific research in specific universities and research institutes. This was the start of a new revolution in science policy in China. The second phase of the “Project 985” was launched in 2004 and the total amount of input reached 42.6 billion yuan. In 1999, South Korea announced the BK21 (Brain Korea 21) project and intensively invested a huge sum (1,300 billion won) in the science sector of leading universities over seven years up to 2005.

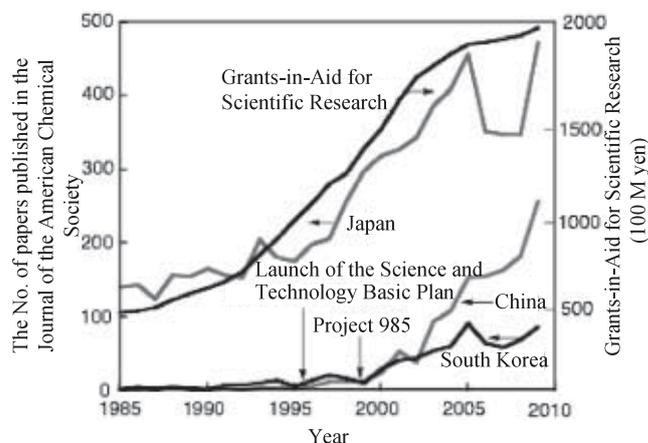
This project started two years earlier than the Japanese 21st Century COE (Center of Excellence) Program. The BK21 project was a notable political decision given that South Korea was in the middle of a national crisis at the time due to economic problems involving the International Monetary Fund (IMF). Under such conditions, the government made a political decision which aimed to develop inventive human resources that are capable of

creating and utilizing new knowledge and technologies, because such resources are the core driving force for social development and economic growth. The public has extremely high expectations of universities. It is a country where police cars are mobilized when students might be late for the nationwide university entrance examination. The second phase of the BK21 project was implemented in 2006 and will continue until 2012. The plan is for another 2,030 billion won to be provided during the seven-year period. The World Class University (WCU) Program was also launched in 2009, which further promotes the introduction of the principle of competition. As a result, two universities from South Korea were included for the first time in the top 50 universities for natural sciences in the Times World University Rankings for 2008.

### The present and future of chemical research in Japan in East Asia

In Japan, the Global COE Program (which corresponds to the second phase of the 21st Century COE Program) became subject to the scrutinizing of public projects. It was right after the program received a good review overall in its mid-term evaluation for its vigorous activities. The representatives of 140 centers subject to the Global COE Program immediately released a joint statement which addressed the importance of the continuation of the program. This resulted in a slightly smaller budget cut, but the fiscal year 2010 budget for the program was significantly reduced to 26.5 billion yen. This is only 70% of the sum allocated for the BK21 project in South Korea. Other than the Grants-in-Aid for Scientific Research, the Japanese government launched the Funding Program for World-Leading Innovative R&D on Science and Technology (FIRST Program) in 2009 with a huge budget of 270 billion yen. We will need to assess the effect of this policy closely, although the budget was significantly reduced after the change of government. From a cost-effectiveness standpoint, the 1st Science and Technology Basic Plan had a dramatic effect as shown in **Fig. 1**. The growth in the amount of Grants-in-Aid for Scientific Research led to a steady increase in the number of papers published in top chemical journals. This effect was enhanced by the COE Program started in 2001. As a result, Japan has steadily increased its influence in the chemical field worldwide. When looking into the number of papers published by each university in the JACS in 2009, three Japanese universities are included in the top 10 although the JACS is an American journal (the University of Tokyo comes first, Kyoto University fifth and Osaka University eighth). Nine Japanese universities are included in the top 100. The great efforts by major Japanese universities are noticeable, considering that Harvard University comes ninth. Setting aside whether or not ranking universities is a good idea, the ranking of universities is progressing worldwide, for example, with the Times World University Rankings. The media also started to report how many Japanese universities have made to the top 100 list. These rankings are for graduate schools rather than for universities because research is an important part of evaluation.

Although no Japanese university is found in the top 10 of the



**Fig. 1** Changes in the Number of Papers Published in the Journal of the American Chemical Society by Country over Time and the Increase in the Amount of Grants-in-Aid for Scientific Research

Times World University Rankings 2009 for the entire sector and only six Japanese universities made to the top 100, Japanese major universities are of the highest quality in the world when looking only at the chemical sector. This fact is not widely known by the public. However, the Chinese Academy of Sciences (CAS) has already come sixth. Since it gained 83rd place in 2002, the CAS has rapidly progressed towards the top. The number of papers written by Chinese scientists published in the ACIE in 1999 was 12. The number increased to 182 in 2009, close to the level of the numbers written by Japanese scientists. If the slow growth in the amount of Grants-in-Aid for Scientific Research (which has been seen over the past several years) continues, it is inevitable that China will beat Japan sooner or later in terms of the number of papers published in top chemical journals.

After the storm of "the scrutinizing of public projects," the amount of Grants-in-Aid for Scientific Research for 2010 slightly increased, reaching 200 billion yen. On the other hand, 393.3 billion yen was newly included in the government budget for eliminating high school fees. This is no doubt good news for Japanese high school education. However, it is probably not just I who think that, if this amount of money was newly allocated for Grants-in-Aid for Scientific Research, then Japan would not be overtaken by China for the time being regarding top-level research, in light of the results shown in **Fig. 1**. I hope that the Japanese science policy for the 2010s, when Japan becomes a country with the third largest GDP in the world, will be more effective than the science policies in China and South Korea.

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