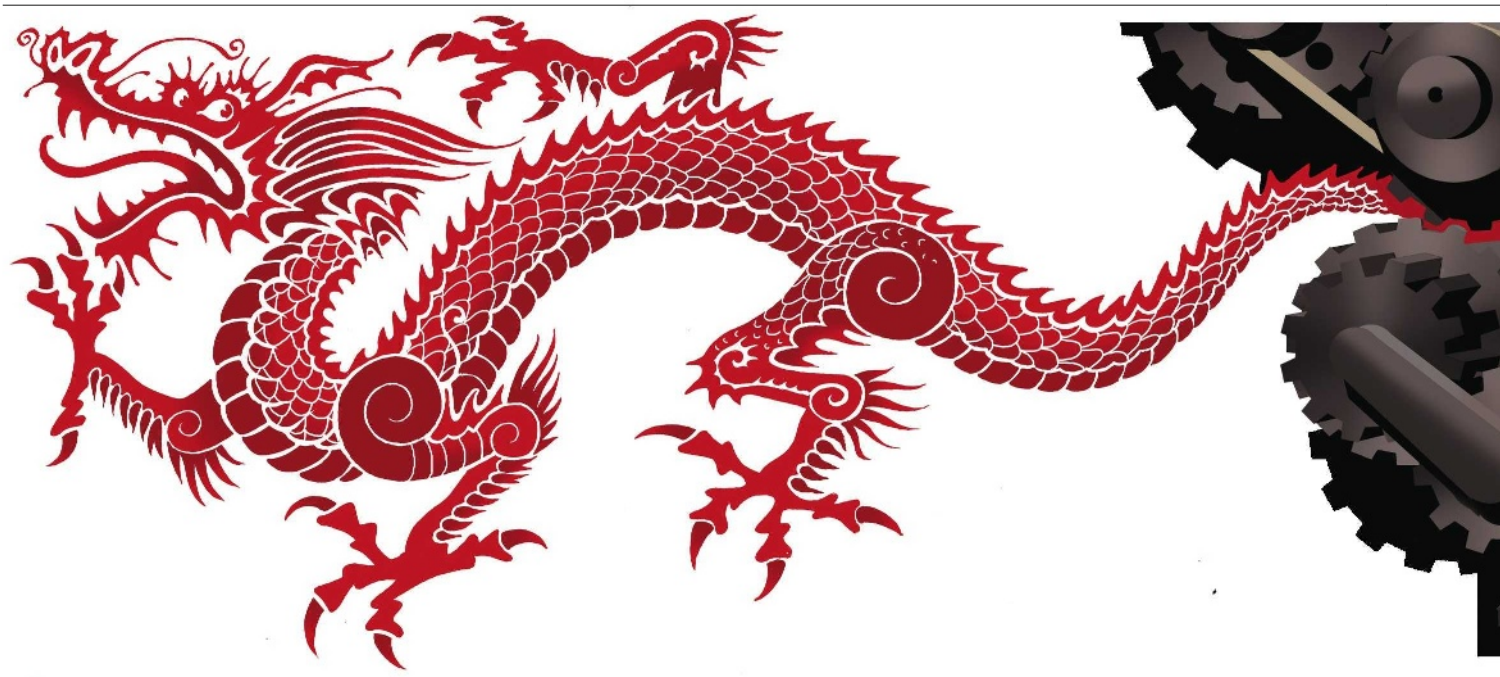
COMMENTARY



The prizes and pitfalls of progress

Pushes to globalize science must not threaten local innovations in developing countries argues **Lan Xue**.

Developing countries such as China and India have emerged both as significant players in the production of high-tech products, and as important contributors to the production of ideas and global knowledge. China's rapid ascent as a broker rather than simply a consumer of ideas and innovation has made those in the 'developed' world anxious. A 2007 report by UK think tank Demos says that "US and European pre-eminence in science-based innovation cannot be taken for granted. The centre of gravity for innovation is starting to shift from west to east"[1].

But the rapid increase in research and development spending in China — of the order of 20% per year since 1999 — does not guarantee a place as an innovation leader. Participation in global science in developing countries such as China is certainly good news for the global scientific community. It offers new opportunities for collaboration, fresh perspectives and a new market for ideas. It also presents serious challenges for the management of innovation in those countries. A major discovery in the lab does not guarantee a star product in the market. And for a country in development, the application of knowledge in productive activities and the related social transformations are probably more important than the production of the knowledge itself. By gumming the works in information dissemination, by misplacing priorities, and by disavowing research that, although valuable, doesn't fit the tenets of modern Western science, developing countries may falter in their efforts to become innovation leaders.

Vicious circle

China's scientific publications (measured by articles recorded in the Web of Science) in 1994 were around 10,000, accounting for a little more than 1% of the world total. By 2006, the publications from China rose to more than 70,000, increasing sevenfold in 12 years and accounting for almost 6% of the world total (see graph, page 400). In certain technical areas, the growth has been more dramatic. China has been among the leading countries in nanotechnology research, for example, producing a volume of publications second only to that of the United States.

The publish-or-perish mentality that has arisen in China, with its focus on Western journals, has unintended implications that threaten to obviate the roughly 8,000 national scientific journals published in Chinese. Scientists in developing countries such as China and India pride themselves on publishing articles in journals listed in the Science Citation Index (SCI) and the Social Science Citation Index (SSCI) lists. In some top-tier research institutions in China, SCI journals have become the required outlet for research.

A biologist who recently returned to China from the United States was told by her colleague at the research institute in the prestigious Chinese Academy of Sciences (CAS) that publications in Chinese journals don't really count toward tenure or promotion. Moreover, the institute values only those SCI journals with high impact factors. Unfortunately, the overwhelming majority of the journals in SCI and SSCI lists are published in developed countries in English or other European languages. The language requirement and the high costs of these journals mean that few researchers in China will have regular access to the content. Thus as China spends more and publishes more, the results will become harder to find for Chinese users. This trend could have a devastating impact on the local scientific publications and hurt China's ability to apply newly developed knowledge in an economically useful way.

Several members of the CAS expressed their concerns on this issue recently at the 14th CAS conference in Beijing. According to Molin Ge,

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a theoretical physicist at the Chern Institute of Mathematics, Nankai University, Tianjin, as more high-quality submissions are sent to overseas journals, the quality of submissions to local Chinese journals declines, which lowers the impact of the local Chinese journals. This becomes a vicious circle because the lower the impact, the less likely these local journals are to get high-quality submissions[2].

Setting agendas

Research priorities in developing countries may be very different from those in developed nations, but as science becomes more globalized, so too do priorities. At the national level, developing countries' research priorities increasingly resemble those of the developed nations, partly as a result of international competitive pressures. For example, after the United States announced its National Nanotechnology Initiative (NNI) in 2001, Japan and nations in Europe followed suit, as did South Korea, China, India and Singapore. According to a 2004 report by the European Union[3], public investment in nanotechnology had increased from €400 million (US$630 million) in 1997 to more than €3 billion in 2004.

In their words

Researchers and businesspeople in China, expatriates and 'returnees' give their views of what it will take to make China a research and innovation powerhouse.

CHINA

Ling-An Wu
Professor, Institute of Physics, Chinese Academy of Sciences, Beijing

Fix the gender ratio

When I returned to China in 1962 I was impressed by the equality of men and women in society. Even during the 'Cultural Revolution' there was no prejudice against women, although political discrimination was routine. The reforms of the 1980s opened a new era for science, yet contrary to expectation female scientists have not fared so well. In physics the situation is particularly discouraging. Formerly, 25% of the research staff at our institute were female, but that has dropped to 14%, while the percentage of women full professors has fallen from 17% to 7%. In the physics department of Tsinghua University in Beijing, the percentage of retired female full professors is 19% whereas that of those currently employed is 8%.

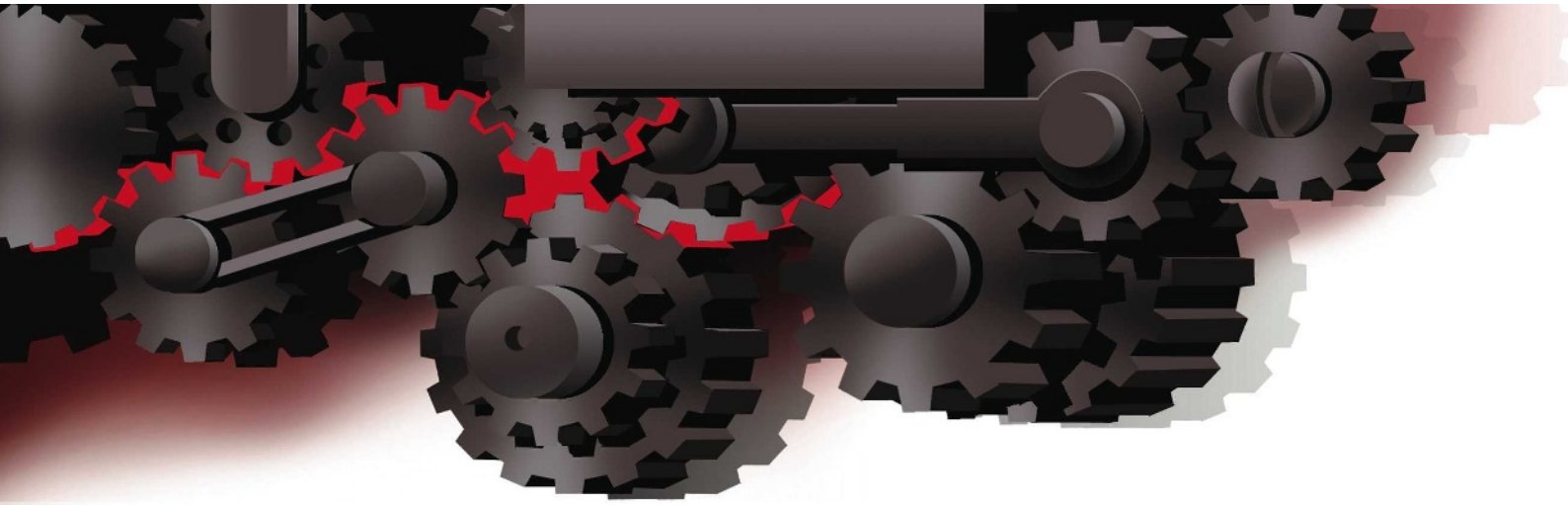
Discrimination now menaces both younger and older women: some employers openly declare that only male applicants need apply, while many institutions force women of associate professor status to retire at age 55; their male counterparts can retire at 60. The current (predominantly male) leadership is not concerned with the statistics. It is true that the number of female postgraduate students has risen, but the chief reason is that job discrimination everywhere is pushing them to seek higher degrees. Will this new generation be able to find their way to the top in China, or will they pursue better opportunities abroad, or just be wasted along the leaky pipeline?

Wolfgang Hennig
CAS-MPG Partner Institute for Computational Biology, Shanghai, China and Johannes Gutenberg-University Mainz, Germany

Overhaul education

My first experience of China was in 1985 and since then I've taught in the Chinese Academy of Sciences in Shanghai and elsewhere on behalf of the Max Planck Society, the German Academic Exchange Service and the Chinese Academy of Sciences to improve biological sciences training for Chinese students and to create contacts with European students. So, it's a good time to ask what has changed in China in two decades. The obvious answer is everything — from the thousands of bikes now replaced by air-choking cars to the boost in funding and the focus on science and technology.

Still, what has not changed during the past 20 years is the educational approach in China. It is based on memorizing and reproducing knowledge rather than on developing one's own initiative, critical thinking and originality. Postdocs trained in China rarely show the ability to work independently or demonstrate creativity in the selection of and approach to research subjects. While I had excellent Chinese students in the past, educated in my lab in the Netherlands, today many of the highly qualified students move into commercial fields through business schools and management courses. Making money has become the major attraction in China and this has severe consequences at the university level: basic research is not considered as important and attractive as it had been. Considering the living conditions of most students — dormitories still house four to six students to a room without heating or air conditioning — one can understand this desire.

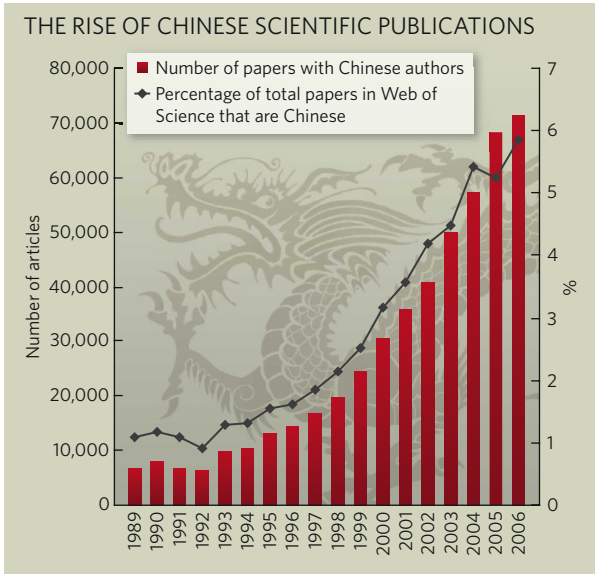


Part of the pressure to jump on the international bandwagon comes from researchers themselves. Scientists in the developing world maintain communications with those elsewhere. It is only natural that they want to share the attention that their colleagues in the developed Western world and Japan are receiving by pursuing the same hot topics. The research is exciting, fast-moving and often easier to publish. At the same time, there are many other crucial challenges to be met in developing countries. For example, public health, water and food security, and environmental protection all beg for attention and resources. If people perceive these research areas as less intellectually challenging and rewarding, the issues will fail to receive the resources, support and recognition they require. Without better agenda-setting practices, the scientific community will continue to face stinging criticism. It can send a satellite to Mars but not solve the most basic problems that threaten millions of lives in the developing world.

The introduction of Western scientific ideals to the developing world can generate an environment that is hostile to the indigenous research that prima facie does not fit those ideals. The confrontation between Western medicine and traditional Chinese medicine dates back to the early days of the twentieth century when Western medicine was first introduced in China. The debate reached a peak last year when a famous actress, Xiaoxu Chen, died from breast cancer. She allegedly insisted on treatment by Chinese traditional medicine, raising the hackles of some who claimed it to be worthless. Many Chinese still support traditional medicine and say that the dominance of Western medicine risks endangering China's scientific and cultural legacy.

A similar row erupted around earthquake prediction. In the 1960s and 1970s, China set up a network of popular earthquake-prediction stations, using simple instruments and local knowledge. For the most part, the network was decommissioned as China built the modern earthquake-monitoring system run by the China Earthquake Administration. When the system failed to predict the recent Sichuan earthquake, several people claimed that non-mainstream approaches had predicted its imminence. Scientists in the agency have tended to brush off such unofficial and individual predictions. To many this seems arrogant and bureaucratic.

It would be foolish and impossible to stop the globalization of science. There are tremendous benefits to science enterprises in different countries being integrated into a global whole. One should never think of turning back the clock. At the same time, it is possible to take some practical steps to minimize the harmful effects of this trend on local innovation.



Prioritizing for the people

First of all, there is a need to re-examine the governance of global science in recognition of the changing international geography of science. Many international norms and standards should be more open and accommodating to the changing environment in developing countries. For example, there is a need to re-evaluate the SCI and SSCI list of journals to include quality journals in the developing countries. In the long run, the relevant scientific community could also think about establishing an international panel to make decisions on the selection of journals for these indices, given their important influence. The recent move by Thomson Reuters, the parent company of ISI, to expand its coverage of the SCI list by adding 700 regional academic journals, is a step in the right direction[4].

English has become the de facto global language of science. Developing countries should invest in public institutions to provide translation services so that global scientific progress can be disseminated quickly. Developing countries can learn from Japan, a world leader in collecting scientific information and making it available to the public in the local language. At the same time, there should also be international institutions to provide similar services to the global

science community so that "results and the knowledge generated through research should be freely accessible to all", as advocated by Nobel Laureates John Sulston and Joseph Stiglitz[5].

When setting agendas, governments in developing countries must be careful in allocating their resources for science to achieve a balance between following the science frontier globally and addressing crucial domestic needs. A balance should also be struck between generating knowledge and disseminating and using knowledge. In addition, the global science community has a responsibility to help those developing countries that do not have adequate resources to solve problems themselves.

Finally, special efforts should be made to differentiate between pseudoscience and genuine scientific research. For the latter, one should tolerate or even encourage such indigenous research efforts in developing countries even if they do not fit the recognized international science paradigm. After all, the real advantage of a globalized scienctific enterprise is not just doing the same research at a global scale, but doing new and exciting research in an enriched fashion. ■

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See Editorial, page 367, and News Feature, page 382.
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Li Gong

Chief executive, Mozilla Online, Beijing

Liberate funding

Research funding in China has increased manyfold in the past two decades. The National Natural Science Foundation awards alone went from 80 million renminbi (US$12 million) in 1986 to 4.33 billion renminbi in 2007. These programmes have succeeded in nurturing researchers and yielding research papers, books and patents. However, regulations governing how research funds can be spent, established in part to prevent misuse and abuse, are handicapping researchers and institutions, distorting research activities, and resulting in significant waste.

Chinese research programmes operate much like those in the rest of the industrial world, with a major difference that China has strict national guidelines on project spending. The most flawed rule dictates that researchers are already paid salaries and thus only a small portion of funding (usually 10–20%, sometimes less) can be spent on personnel. In reality, academic research salaries are uncompetitive. The average overall income per faculty member at top computer science departments is comparable to a fresh graduate's starting salary at IBM or Microsoft. These government guidelines make it much more profitable to stay outside the academic institutions, and drive researchers towards more commercial projects to earn more income. The rules can also result in spending on equipment that is unnecessary and in the worst cases resold, and in wasteful conferences and trips, meals and entertaining, and other excesses. The spending regulations are a significant drag on research performance, fund efficiency, and personal advancement, and need urgent reform.

Cong Cao

Sociologist, Neil D. Levin Graduate Institute of International Relations and Commerce, State University of New York

Encourage returnees

Of the some 1.2 million Chinese who have gone abroad as students and scholars, only a quarter have returned, thereby constituting an unequivocal 'brain drain' for China. Indeed, non-returnees, especially academics, are most likely to be the best and the brightest, who are most needed in China's innovation push.

Besides taking several years to set up a laboratory, form a team, recruit students, apply and get grants, and start the research, returned academics have to adapt and adjust to a 'different' research environment and be involved in various activities unimaginable to those abroad. They risk not being able to survive because they do not know the rules of the game played in China, and without *guanxi* — personalized networks of influence — and social and political connections, they have no one to turn to for help.

The costs of working in China are high. Some productive scientists have expressed the wish to return permanently and demonstrate that it is possible to do first-rate science in China. But this depends on whether China can provide the kind of research environment that will help them thrive.

Jianguo Liu

Director, Center for Systems Integration and Sustainability, Michigan State University, East Lansing; guest professor, Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences (CAS)

Integrate disciplines

China's unprecedented economic boom and societal changes have created unexpected environmental challenges. Divorce, for example, usually splitting one household into two smaller ones, is increasingly common in China and traditional multi-generation families are also fragmenting. More households require more land and construction material for housing. Smaller households are often inefficient and produce relatively more wastes and pollutants. To tackle environmental problems, there is an urgent need to integrate natural sciences with socioeconomics, demography, human behavior and policy, addressing seemingly unrelated trends. Enhancing international partnerships for systems integration is a win-win strategy for China and other nations.