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China's funding system and research innovation

By Jane Qiu

In the past decade, China's total expenditure on research and development (R&D) has been increasing by about 20% per year. And the total output of scientific research from China has not failed to impress: a 2011 study by Britain's Royal Society found that, in 2004–08, the country produced 10% of the world's published scientific articles, putting it second after the United States.

But a study conducted by the World Bank and China's State Council concluded in the year 2012 that Chinese research quality falls short. It noted that the country produces relatively few high-impact articles, and that the majority of Chinese patents constitute minor novelties rather than genuine innovations.

So what has gone wrong? And what needs to be changed to spur innovation in China significantly? In a forum organized by *National Science Review*, its executive associate editor Mu-ming Poo asked four leading scientists in China.

Yadong Li
Chemist of Tsinghua University in Beijing
(Courtesy of Yadong Li)

Yi Rao
Biologist of Peking University in Beijing
(Courtesy of Yi Rao)

Dingsheng Wang
Physicist of Institute of Physics, Chinese Academy of Sciences in Beijing
(Courtesy of Dingsheng Wang)

Pinxian Wang
Geologist of Tongji University in Shanghai
(Courtesy of Pinxian Wang)

Mu-ming Poo (Chair)
Neuroscientist of Institute of Neuroscience, Chinese Academy of Sciences in Shanghai
(Courtesy of Mu-ming Poo)

TOP-DOWN CONTROL IS NOT CONDUCIVE TO CREATIVITY

P. Wang: In 1988, Deng Xiaopin famously said that science is the primary force of production. This is partly why science has enjoyed a great status in China in the past few decades. Unfortunately, this has also led to the science-management style in China: it is featured by strong top-down administrative control, and science is managed like a business or industry. This is not conducive to creativity or genuine innovation. Science, especially basic research, is driven by curiosity and can only flourish in an environment that allows diversity.

D. Wang: Indeed, creative ideas, unlike engineering, cannot be planned. They are based on knowledge as well as intellectual exchange. But when original thoughts surface, often when individual scientists are working independently and alone, it is not totally accidental.

Li: The great leap forward-type of science, done by a mass work force, is useful for capacity building, but will not lead to genuine innovation. The key to remedying the situation is to have greater support for bottom-up ideas proposed by individual scientists, and to instigate more talent-based, as opposed to project-based, programmes. This would allow scientists plenty of room and time to pursue blue-sky research—free from bureaucratic interference.

Poo: I certainly agree that original and creative research often cannot be planned. But I do not think there is really any top-down control of how scientists pursue their work in the laboratory—as long as they show some productivity. The problem is that most scientists are not encouraged to try risky studies, because the evaluation system for funding does not allow people to do so—it only counts immediate short-term achievements.

Rao: In developed countries, there are independent research institutes, such as the Max Planck Institutes in Germany, and the Howard Hughes Medical Institutes in the USA—which allow scientists to test risky ideas and pursue long-term projects. They also have non-governmental or charity funding agencies, such as the Sloan Foundation in the USA, to support scientific research. Such independent institutions could stimulate competition, diversifies priorities, and complement government-funded projects.

DECISIONS REGARDING MAJOR PROJECTS ARE OFTEN MISGUIDED

Li: This is especially important when top-down control is often inadequate. For instance, there are some problems with decisions regarding major national projects, such as those in the 15-year plan for science and technology, which was announced in 2006. More often than not, the chosen fields had passed their prime time when the projects were launched. This means we are often a step behind. This is okay for capacity building and training a large number of scientists in a particular field, but is not good enough strategically if China aspires to be a world leader in science.

Rao: This is a big problem. A lot of the major projects are rather misguided and there are a lot of overlaps between different ministries, causing substantial redundancy and waste.

D. Wang: As China has a relatively low starting point, it is probably unavoidable that—with some exceptions—it will follow the trend of scientific development in the West for some time. The question is how the situation can be improved and how China can be the one who sets the trend.

P. Wang: I was involved in deliberating the 15-year plan, and was rather disappointed with the process. It mobilized thousands of scientists but bowed to only judgements of a small number of authoritative figures. The whole exercise was quite superficial and lacked genuine debates.

Li: The ultimate goal of Chinese scientists is to find their own path, rather than always following what is hot and trendy in the West. But it is often tricky to get cutting-edge Chinese research accepted in high-impact international journals.

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Poo: Indeed, China needs to establish its own research directions and priorities that are catered towards a set of scientific questions unique to the country and its needs and interest. But we cannot ignore mainstream science. If we deviate from the mainstream, it would be very difficult to publish in key journals—which can be subjective and depend on the editors' interest. That is the dilemma.

D. Wang: Perhaps innovative, non-mainstream research could be published in Chinese journals. The Japanese scientist Toshihide Maskawa had published all his work in Japanese journals before he won the Nobel Prize in physics in 2008. Therefore, publishing in high-impact English-language journals is not the only way. If the work is good and original, it does not really matter where it is published.

P. Wang: It is difficult to drastically change the 'macroclimate'—that is, the political institutions and procedures—of major decision making. But there is a lot we can do about the 'microclimate'—by education, capacity building and international collaboration. It has already improved significantly compared to 30 years ago. It takes time to build up a critical mass of creative and independent-minded scientists and we need to keep up the momentum.

Rao: One way to improve major decision making could be to establish a high-level scientific advisory committee, consisting of top scientists from all research fields as well as from both academia and industry. It would be within the State Council and independent of ministerial interests—similar to the US National Science and Technology Council.

DECISIONS OF GRANT ALLOCATION ARE PLAGUED BY *guanxi* AND THE LACK OF CONFIDENTIALITY AND TRANSPARENCY

D. Wang: A problem at the next level of science governance is how research funding is allocated. There can be a lot of bureaucratic interference in such decisions in some funding agencies and expert opinions often do not have a key role—though China is by no means the only country to have this problem.

Rao: Although the National Science Foundation of China is not without problems, it is so far the best agency in terms of the evaluation of grant proposals. In other agencies and ministries, there is a lot of political interference, and *guanxi* (personal connection) is often important for successful application. Most of the officials have little research experience but are very powerful. Many experts are afraid of offending them and do not dare to contradict their views. Those who voice independent opinions are often not welcome.

Poo: The problem is that key decisions rest upon administrators rather than scientists. In some cases, the funding agency does not reveal the scores submitted by the review team, preventing the transparency of the final decision.

P. Wang: This encourages researchers not to devote their time on research but on schmoozing with those in power—influential researchers and government officials. In some cases, bribery and corruption also take place.

Rao: In the past, we had much less funds, but the situation was not this bad. Now, with lots of money, the problem gets much worse and causes a huge amount of waste.

Li: Most of the major projects involve hundreds of scientists from tens of institutes. Even committees sometimes suggest scientists who do not really have the expertise. The influence of *guanxi* is more difficult to discern when a large number of people are involved. A solution could be to largely reduce the number of participating institutes and to make sure that they really account for what is going on.

Rao: Confidentiality is another major concern. In a number of occasions, grant applicants got in touch with me ahead of the evaluation meeting. How did they know that I was a member of the committee? This is supposed to be confidential. And what takes place at internal committee meetings could also be easily leaked to those who have *guanxi*.

Poo: Everyone is complaining about the lack of confidentiality, but the majority of scientists I knew in China do not abide by the rule of confidentiality. You just have

to attend one dinner party of scientists to find cases of people talking about the grant he had reviewed and who is saying this and that on someone's application. The problem is that no one is enforcing the rule of confidentiality and most scientists are not showing self-discipline.

PERFORMANCE EVALUATION ENCOURAGES *jigong jinli*

D. Wang: Another key problem is the over-emphasis on the journal impact factor when evaluating the quality of a research paper or the performance of scientists, institutions and research programmes.

P. Wang: This should definitely be changed. I am fervently against the formula of using the impact factor times the number of publications. It is also ridiculous to offer monetary awards for papers published in high-impact journals. We are trying to quantify something that is not quantifiable.

Poo: Performance evaluation at the moment is all about short-term output. This has encouraged a culture of *jigong jinli*—seeking quick success and a short-term gain. Scientists are just pre-occupied with everyday survival or getting as many grants as they can—by publishing a large number of easy, but insignificant, papers. It is all about today and now. Few have a long-term perspective or are willing to take risks to test original ideas. In a way, the current situation does not allow research that addresses difficult problems in science.

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P. Wang: You need money to do science, but having a lot of money does not guarantee quality research. Everybody is busy getting grants and publishing. But most people are just replicating and duplicating research that has been done elsewhere. They may just as well not do anything, because tons of money is being wasted in this way.

Li: One way to correct *jigong jinli* could be to support more long-term projects. At the moments, most projects span 3–5 years and often rather short-sighted. To be able to demonstrate their productivity in such a short time, scientists are forced to seek quick return. It takes much longer to build up original, quality research—probably 3–5 years just to establish the foundation.

Rao: The poor performance evaluation in China is also related to the fact that the overall standard of science in the country is still quite low. And the number of independently minded scientists with sufficient expertise is limited.

Li: If a particular project is original and successful, scientists should be able to summarize it in one sentence about what they have achieved and why it is important. When it is mediocre, or researchers are not clear which scientific problems they are trying to solve, then they tend to focus on the quantity of their papers.

P. Wang: I am not against Science Citation Index (SCI) per se, but we have seriously overdone it. In many cases, it has become the only criteria. SCI reflects the average impact of a journal, which not necessarily correlates with the significance of its papers.

D. Wang: A more useful index might be the number of citations of individual papers, especially if they have already been published for a few years. This could be used to evaluate the importance of a project—a quick initial screening mechanism, especially when the pool of expertise is limited. But, similar to SCI, this should by no means be the only criteria, and must be complemented by qualitative assessment by experts.

THE FUTURE OF CHINESE SCIENCE?

Li: I do not think we need to worry too much. There are weeds in the scientific ecosystem in China, but the country has achieved a lot in the past few decades. The majority of scientists in China are honest, talented and hard-working. The seeds have been sown. We are experiencing growing pains at the moment, but I am confident that the plants will develop into a full blossom one day.

Rao: As optimistic as my personality is, I am increasingly worried that perhaps Chinese science cannot go as far as we are hoping for. There is a possibility that China will never become a global science leader. A possible outcome is that it will be satisfied with small achievements and stop going forward—because of its unwillingness or inability to instigate major institutional reforms that are necessary to reach the next level. Judging by the way things are, science will not have major impact on economic development in China.

P. Wang: I am also extremely concern where Chinese science is going. We have invested so much in science, but how much will we get out of it? If China cannot do good science, it will never be a global leader.

Poo: Science is intimately linked to culture. It will take time, probably several generations, to establish a science culture that is conducive to creative research. Unless this happens, the future of basic science in China is looking dim. As established scientists, we have the responsibility to cultivate scientific interests among the younger generations and to help building an environment and a funding system that truly promotes innovative science.

D. Wang: I do not share your pessimism. I do not think China lacks certain 'cultural DNA' that will prevent it from being a global leader in science. By contrast, the science culture in the country can be self-correcting and will improve with time. China used to lead the world in ancient times, both culturally and scientifically. I do not see why this will not happen again.

Jane Qiu writes for NSR from Beijing.