



## RESEARCH IMPACT

# A tale of two systems

*Tensions between the old communist regime and modern market forces are hindering efforts to turn China's scientific discoveries into commercial advances.*

BY PENG TIAN

It is definitely 'the worst of times' for Chu Jian. At the end of 2013, the engineer and former vice-president of the prestigious Zhejiang University in Hangzhou was arrested on suspicion of embezzling state-owned assets, and was formally charged in February 2015, just before Chinese new year. Chu was co-founder and director of Supcon Group, an engineering company based in Hangzhou in Zhejiang province. A major part of Supcon Group was Haina Software, a former subsidiary of Zhejiang Haina Science and Technology Company, a spin-off company from the state-owned university. Haina Software was sold to Supcon Group by 2003, and one of Chu's alleged crimes is transferring the better performing assets from Zhejiang Haina to Supcon, leaving poor-performing ones behind.

Chu's story is not unusual. Dozens of university officials and entrepreneurs are being swept up in China's ongoing anti-corruption efforts. But getting a clear picture of the extent of the corruption is hampered by difficulties in

penetrating the murky rules surrounding the commercialization of state-funded research. Even as China is pushing to translate more basic research into societal benefits, this lack of transparency is preventing many would-be entrepreneurs from taking the plunge.

## WESTERN INFLUENCE

Chinese universities and research institutes are reforming their research processes and evaluation systems to meet the higher standards of the international academic community and become more like Western research systems — particularly that of the United States. And to a certain extent these reforms are working: with better training and more resources, an increasing number of Chinese scientists are getting published in higher quality publications such as those covered by the *Nature Index* ([www.natureindex.com](http://www.natureindex.com)).

The reform process is being fuelled by investment from local and central governments. China spent more than 1 trillion yuan (US\$165 billion) on research and development (R&D) across all sectors in 2013 — second

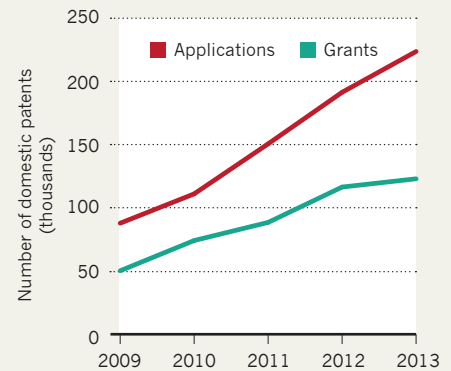
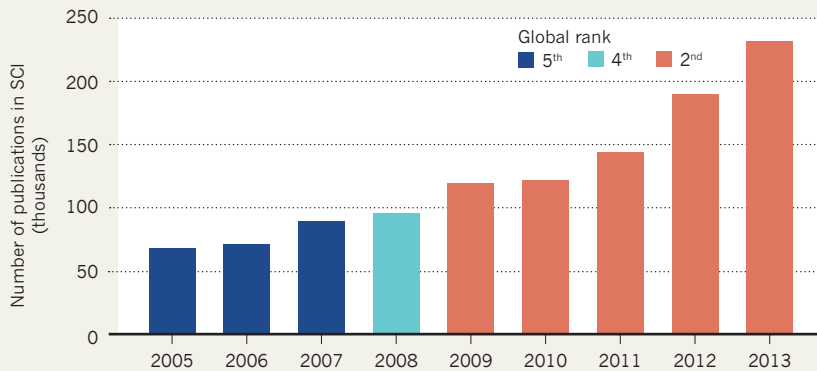
only to the United States (see page S8) — and has the second largest output for academic publications and patents (see 'Rising output'). The hope is that basic research will feed into inventions and improvements for industry, and eventually boost the economy.

But when it comes to turning scientific discoveries into technological innovation, the results are disappointing. In the biomedical industry, for instance, most domestic drug companies produce either generic versions of existing drugs or drugs based on Chinese traditional medicines, which struggle to get into the regulated markets of developed countries. Even Xinhua, the official press agency of China, has criticized the technology transfer capabilities of the country's research system.

As the reforms of publicly owned research institutions continue, they throw up more uncertainty. "The atmosphere is changing in both universities and Chinese Academy of Sciences institutes — people can feel that things are coming," says Wang Liming, a 32-year-old neurobiologist at Zhejiang University. Wang, like many researchers of his

## RISING OUTPUT

China's science and technology output continues to rise steadily, in terms of both numbers of publications in the science citation index (SCI) and of patent applications and grants. Yet there is no clear path for translating this technology to improve industry.



generation, has entrepreneurial aims. But he acknowledges that in these unsettled times, many researchers will cling even more tightly to the old system. “Getting a publication in journals with a high impact factor becomes the priority for scientists when they feel unsafe,” he says, “because they know it will probably help them survive any kind of top-down evaluation led by the administration.”

### OBSTACLE COURSE

In response to criticisms of China's inability to commercialize its research, the government green-lit a 1-billion-yuan National Centre for Translational Medicine in October 2014. This centre is to be in Ruijin Hospital, which is affiliated with Shanghai Jiaotong University, and is expected to complete construction in 2017.

The Shanghai centre is the first in a series of projects for translational medicine from the government's National Science and Technology Infrastructure programme. There are four sister institutions planned, to be built in influential hospitals or medical colleges: two in Beijing, and one each in Xian in Shaanxi province and Chengdu in Sichuan province.

The main goal of the translational medicine centres is to more efficiently transform basic biomedical research into clinical applications, including new diagnostics, treatments and drugs. But many obstacles stand in the way. First is that although reform of China's scientific research system is under way, reform of its public hospital system is lagging behind. Around 90% of China's health care is provided in public hospitals. In theory, most public hospitals are wholly owned and financed by local and central governments, which strictly control staff numbers and salaries. But many hospitals have said that they do not receive enough funding and need to find additional resources. There have been reports of hospital staff allegedly accepting bribes from drug or device firms; one high-profile case involving British pharmaceutical giant GlaxoSmith-Kline, based in London, was exposed in 2013.

Recruitment is another issue. “Public

hospitals are still in the old system, where there is less mobility of personnel,” says Chen Zhiguo, a young neuroscientist at Xuanwu Hospital in Beijing. Hospitals such as the new Shanghai translational centre, which are affiliated with universities or medical colleges, may be able to get around this barrier by recruiting staff through their affiliates. But even these institutions often retain ties to the old system — and its policy and culture. Researchers at Xuanwu Hospital, including Chen Zhiguo, are obliged to publish a certain number of papers each year in journals covered by the Science Citation Index. This requirement takes up valuable research time and can stifle commercialization efforts. The result is a chicken-and-egg situation. “If a researcher successfully transfers her or his research to the market and gets economic benefits, the administration will loosen the requirement of publishing papers,” Chen Zhiguo says. “But before that, you have to cope with it.”

*“Chinese scientists want to be rich and famous.”*

Then there are questions over financing. Because there is no Chinese equivalent of the United States National Institutes of Health (NIH), which funds clinical trials, researchers wishing to develop drugs must look elsewhere. “More than one-half of China's clinical trials are supported by drug companies,” says Li Mengfeng, vice-president and dean of Zhongshan School of Medicine at Sun Yat-sen University in Guangdong. Some local governments and universities are trying to encourage clinical research that is initiated instead by independent investigators. One example is the 5010 Clinical Research Foundation, established in 2008 at Sun Yat-sen University. But there is nothing yet on the national level, says Li.

One attempt to bridge the funding gap is the Shanghai Guangci Translational Medical Research Development Foundation, which was established in September 2014 by Chen Saijuan, director of the translational

centre, and her husband Chen Zhu, China's former health minister. The main goal of the foundation is to finance clinical research. The two have successfully worked together before, when they led a translational medical research project in China that resulted in a new treatment for leukaemia.

Even if all the obstacles could be overcome, these new translational centres are only one link in the ‘bench to bedside’ chain. “Every link of the chain has problems in policy and culture,” says Li, who adds that China is still weaker than other developed countries in basic research, and that the administrative side of the scientific community hampers creativity. “Basic research is not driven by the realistic needs of clinical practice, it's about getting more impact factors.” And, even if a scientist has a strong talent for innovation, the environment is not supportive, he contends. “Governments and institutes in China do not give scientists enough incentives to bring their research to application.”

Successful translational research depends on many factors, says Xiao Ruiping, a physiologist and director of the Institute of Molecular Medicine at Peking University in Beijing. As well as providing incentives for researchers, other important elements to ensuring success are improving laws and regulations concerning research commercialization, and ensuring there is availability of capital and appropriate industry infrastructures. “The problems inherent in China's translational medicine process cannot be resolved by a few scientists and projects,” says Xiao. “How can these systematic defects be overcome?”

### STATE OWNERSHIP CONUNDRUM

Other countries have been through the process of promoting commercialization of the fruits of publicly funded research. The key piece of legislation in the United States is the Bayh-Dole Act of 1980. Prior to this law, any inventions derived from federally funded research belonged to the government. Bayh-Dole gave those universities, institutes and companies



who received federal grants the right to profit commercially from their inventions.

China has introduced similar policies, and has solidified them into formal rules in the Science and Technology Progress Law of 2007, but has had less success than the United States at fostering the commercialization of university invention. The reason lies in the different ways the two countries treat their universities and research institutes — in the United States these organizations have more independence from the government than their Chinese equivalents, and also have autonomy as market participants. China's universities and institutes, are all controlled by the government. Any economic activities must be approved by the administration of state-owned assets, which can hinder attempts by would-be entrepreneurs to commercialize their research.

Such a situation is facing Chen Zhiguo, who was hoping to transform his neural-stem-cell research into a clinical treatment when he returned to China in 2012 having completed a postdoc at Stanford University in California. Two years on, the results from Chen Zhiguo's animal experiments are promising, but because his research is funded by the government the project will need additional capital to move into clinical trials. Securing capital means transferring intellectual property, which is controlled by the hospital, which in turn is controlled by the state. "There are many difficulties," Chen Zhiguo laments. "How can we balance the interests of the hospital, the start-up and the researchers?"

The biggest problems are that current regulations concerning technology transfer are unclear and authority oversight is unpredictable. A young university researcher, who wishes to remain anonymous for fear of repercussion from his university administration, explains: "If I want to transfer my research achievements to the pharmaceutical industry, my only choice is to cross a 'grey zone' when it comes to intellectual property regulations. There is no clear legal track, so infractions are inevitable." It is impossible, he continues, for a scientist-entrepreneur to avoid these traps forever, as Supcon's Chu found out. "Faults could be investigated by the government or prosecutors in the future, particularly if a company becomes big and successful." Consequently, many inventors simply avoid the maze of policies and regulations. If they are unwilling to transfer their innovations through 'grey zone' agreements, their only choice is to abandon their inventions altogether.

There is plenty of entrepreneurial spirit in China. "Chinese scientists want to be rich and famous," says Xiao, who wants a "clear and stable system" that enables start-ups to flourish. The research outputs of Xiao's laboratory belong to Peking University, whose Office of Science and Technology Development is responsible for transferring her research to industry. "The



**Chu Jian in 2006, who was then the vice-president of Zhejiang University in Hangzhou.**

office is a part of the administration department of Peking University and does not have its own intellectual property lawyer," she says. Xiao worked for many years at NIH, and contrasts the situation in China with that of the United States. "I had nothing to worry about in terms of commercializing my research there. The NIH has a strong patent office that takes care of intellectual property matters. Scientists in China have to deal with things by themselves, and the patents are often fragmented."

The research community in China wants the government to acknowledge the contribution made by scientists working on publicly funded projects and to give them stronger incentives to carry out research with potential commercial impact. For research scientists, ownership priority over their inventions is an important step in that direction. Speaking at the Research Assessment and Evaluation symposium in Shanghai in October 2014 (see page S10), Shen Wenqing, former deputy director of the National Natural Science Foundation of China, said: "The most important reform is reducing the administrative intervention from the government." At the local level, some provinces are trying small-scale reforms: for instance, since 2014, a research team in Hubei province can now own up to a 99% share of the benefits of their research. But this applies only to projects funded by the provincial government of Hubei — those funded by the central government allow for no such ownership.

**PARADOX OF TRANSITION**

The shadow of the old system still hangs over every corner of China's scientific enterprise. The balance of administrative power of governments and of market forces is a frustrating paradox.

Entrepreneurs may find themselves navigating a complicated sea of regulations issued by different government departments, in many cases trying to get one department to intervene against the other. "The reality is that when you need them, they disappear and you cannot find them," the young researcher says, "and they always appear where they should not be." For example, the China Food and Drug Administration (CFDA) has failed to remove traditional Chinese medicine injections from the market, even though their safety and efficacy are unproven and people spend billions of yuan on them each year. Yet the CFDA requires start-ups to have their own production factory and certificate of Good Manufacturing Practice, which makes it almost impossible for an innovative pharmaceutical company to get up and running. Government officials are trying to intervene too much in market processes, explains Guo Chongqing, a research engineer at Tongji University in Shanghai. "Officials in governments do not have crystal balls. How could they plan the way that industries will develop?"

The downstream businesses that are essential in supporting the translational medicine ecosystem are also

***"How can we balance the interests of the hospital, the start-up and the researchers?"***

unformed. Most venture capital firms in China are reluctant to consider the large risks associated with drug development — and often lack the expertise to understand the technology, says Tang Yanmin, director

of the Beijing office of Morningside Ventures, a venture capitalist headquartered in Hong Kong and one of the few firms that invest in early stage biotechnology in China. Tang adds that Chinese venture capitalists generally prefer the safer returns from investing in generic drugs and medical devices, based on cost advantage and state protection.

Tang believes that the returns for innovative drugs will rise in the future as domestic pharmaceutical companies complete more original R&D and respond to the government's emphasis on advancing the industry. The fruits of China's burgeoning research are ripe for harvest. But at the moment, with so little clarity on how to proceed, concerns about corruption charges — such as those facing Chu — are too serious to ignore. "Hoping that the governments will demolish all the invisible walls and draw clear lines overnight is unrealistic," says Zhejiang's Wang. He understands why so many scientists who tried to commercialize their research gave up, but he is determined to succeed. "Yes, there are still many obstacles from the old system," says Wang. "But I want to get things done." ■

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