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China is rising through the innovation ranks

By Geoff Dyer

One of the specialities of modern China is an ability to generate statistics that strike fear into governments and boardrooms around the world.

Companies talk endlessly about the "China price" – how Chinese manufacturers have driven down the cost of goods, from socks to semiconductors. At other times it has been the number of mobile phone users in China (440m) or the proportion of world cement it consumes (40 per cent).

Now the theme is turning to science. Having spent two decades muscling in on one manufacturing sector after another, China wants to spend the next two decades moving from "Made in China" to "Invented in China". Here, too, it has some numbers to show it is serious.

According to the Organisation for Economic Co-operation and Development, China overtook Japan last year in terms of spending on research and development and ranks in second place behind only the US. In the last decade, R&D has more than doubled as a share of the country's gross domestic product. China has also just overtaken Germany in terms of patent filings to stand fifth in international rankings.

Japan and South Korea invested heavily in universities to modernise their economies in the past and China is doing the same. The number of university students has more than quadrupled since 1998 to 16m. While the US produces 137,000 engineers a year with at least a bachelor's degree, China churns out 352,000.

Not only are one-quarter of foreign PhD candidates in the US Chinese but a growing number of them are heading back home: Beijing says 170,000 Chinese who studied abroad have returned, 30,000 of them last year.

Multinationals are lining up to open research centres in China, inspired in part by the abundance of local scientists who are paid only about 20 per cent of that which western counterparts receive. Academics estimate that 250-300 foreign companies have R&D centres in China.

Having watched first Japan, then Taiwan and South Korea develop knowledge-based economies, China's leaders are in a hurry to do the same, especially given the rapid rise in the country's own labour costs. President Hu Jintao in speeches regularly extols the cause of "independent innovation".

It all looks like another episode in the relentless advance of the Chinese economic juggernaut. Yet beneath the surface, China's science drive faces a host of problems, ranging from academic fraud to weak financial markets. At the corporate level, Chinese innovation remains weak. Having a top-down government plan for fostering innovation is one thing; turning it into reality is a much harder task.

Indeed, the problems are so entrenched that a recent report by CLSA, the regional brokerage, maintains that China lacks the legal and economic environment to foster innovation. It concludes: "China is not an innovative economy and has no innovative companies."

The sheer weight of numbers and scale of the Chinese economy will ensure that some research-based companies come through. But whether it is a trickle or a flood will depend on how well China overcomes these obstacles.

The problems begin with academic research. China may be spending a lot more money in the laboratory but there are big questions about the results. Many potential worries were brought to the fore by a recent scandal at Jiaotong University in Shanghai where Chen Jin, a dean, claimed to have invented a sophisticated form of microchip that could process 200m instructions per second. Instead, an inquiry revealed he had scraped the name off a Motorola product and claimed the work as his own.

The scandal was not as damaging as the one in South Korea involving Hwang Woo-suk, a scientist whose claims to have produced the world's first stem cells cloned from human embryos were revealed to be a fraud. But it did expose the same problem of a government desperate to show off research triumphs. Like Mr Hwang, Mr Chen had been given generous public grants, while the announcement of his chip design was trumpeted at a press conference attended by leading government officials and which made front-page news. Wen Jiabao, the prime minister, even visited his lab.

Even before the Jiaotong revelations, Chinese academia was witnessing a slew of allegations about endemic plagiarism and fraudulent research. A Chinese magazine article exposed academics and students who had created counterfeit versions of respected journals so that it would seem their work had been published.

"People used to think that only officials could be corrupt," says Tang Anguo, director of the higher education institute at East China Normal University in Shanghai. "But I can tell you that in Chinese academia, there are many similar cases [to the Chen one]."

The statistics show quality might be suffering. In 2004, China was in ninth place in the ranking of published scientific papers and a handful of Chinese scientists have made the cover of international journals such as Nature and Science. However, China ranked only 124th in the average number of citations per paper – a measure of the modest influence of much of its scientific output.

Some Chinese academics say the low quality of research reflects not just the growing pains of a rapidly expanding system but is a direct result of political meddling. Liu Ming, a professor at Zheijiang University, says most important decisions in universities – such as promotions, funding and publications in periodicals – are made by administrators and politicians rather than as a result of peer review. "In university circles there is common agreement that the greatest barrier to academic development is the improper interference of the government," he says.

It is not just the academic research apparatus that needs an overhaul if China is to be more innovative, according to many observers, but also the education system. University teachers say there is too much emphasis on theory and rote learning and insufficient attention given to problem-solving and working in a team. Classes are also overloaded: some doctoral advisers have more than 50 candidates to supervise.

A report by McKinsey estimates that only 10 per cent of the engineering graduates of Chinese universities have the practical and language skills needed to work for a multinational company. The consultancy warns of a looming talent shortage. The Chinese even have a phrase for this type of student – "stuffed ducks" who are good at memorising facts and passing exams but have little initiative.

With its Confucian heritage, China places great emphasis on education, but there is also a heavy deference towards authority. Employers regularly complain that although they hire graduates who seem brilliant on paper, it can be very hard to get them to voice opinions. Japan, South Korea and Taiwan all had to overcome this sort of reticence in their young graduates and the Chinese government is trying to address some of these problems. It has introduced changes in the curriculum that emphasise communication and teamwork and a core of elite universities has been established, which will be given additional resources. Yet even top universities operate under very tight budgets.

One of the biggest obstacles to innovation might not be in the lab or the classroom, however, but the fate of stock market. Over the last couple of decades, small private companies have been one of the main engines of innovation, yet China's financial system does not provide enough support to private entrepreneurs. State-controlled groups garner around 75 per cent of bank credit in China and dominate the ranks of the 1,300 companies on the stock market.

Although research companies sometimes need years and millions of dollars to get a product to market, China's entrepreneurs often have to raise start-up capital from family members or informal networks of lenders. "Informal networks work really well to set up a backyard factory," says Andrew Grant, head of the China practice at McKinsey. "But they do not work if you want to shift to an operation of 1,000 people."

In Japan and South Korea, research has been concentrated in big companies with the resources to take chances, such as Sony or Samsung. But in China the large companies are mostly state-owned and run by executives allergic to taking big risks. "One of the keys will be the financial system," says Andy Rothman, an economist at CLSA who

prepared its report on China's science drive. "The question is, can it become a genuine system that allocates funds to private sector companies to fund their own research?"

On top of these obstacles, Chinese innovation faces the further threat of intellectual property theft. The immediate threat to research from patent violations can be exaggerated: companies are usually more concerned about someone making fakes of a finished product than having secrets stolen from a lab. But both Chinese and foreign groups regularly warn that such legal uncertainties will inhibit investment in knowledge industries.

Against these deep-seated problems, there are two wild cards that could work in China's favour. The first is the role of the multi-nationals. The extent of multinational research is hard to gauge because some of the R&D centres in China are more about public relations than science. Sylvia Schwaag Serger, science counsellor at the Swedish embassy in Beijing who has written several papers on Chinese research, estimates that only 30 overseas companies are doing innovative research.

In the long run, however, multi-nationals could provide a strong platform for China's innovation push. A young generation of scientists is being trained at Microsoft, Intel and other leading companies in how to manage complex research projects that span different disciplines, how to establish links with university researchers and how to collaborate with other companies that have niches of expertise.

Armed with such skills, some of these young scientists are bound to strike out on their own. "There will inevitably be a spill-over from the multi-nationals into the Chinese economy," says Ms Schwaag Serger.

The other swing factor is the returnees. Of the 30,000 overseas graduates who returned last year, some will have been enticed by government grants and others by the booming economy. Many talk about a patriotic urge to make a contribution to their country. The returnees bring not just the skills they learnt abroad but also a greater willingness to throw ideas around.

"The success of Chinese scientists in the west shows that they can be innovative," says Wang Baoping, research director in China at Novo Nordisk, the Danish diabetes specialist. "What they need is the right environment."

In addition to returnees, China has the advantage of attracting many -Taiwanese nationals who have watched their own country establish research-based industries. Indeed, Taiwanese companies and returnees are already a driving force in corporate innovation in China. According to Douglas Fuller at the American University in Washington, companies founded by ethnic Chinese or returnees are responsible for 503 of China's 616 US utility patents in information technology. (Utility patents are for genuine innovations rather than adaptations).

For two decades, the huge Chinese diaspora has helped accelerate the country's entry into manufacturing, with both capital and management know-how. Now it could provide the same crucial boost to China's innovation drive.