The flaws in China's plan to lead world technology

China's stunning advances in high-tech sectors are not quite as impressive as the statistics suggest, says Guy de Jonquières. He assesses the strengths and weaknesses of Beijing's industrial and scientific strategy

China's economic and industrial achievements over the past three decades have repeatedly stunned the rest of the world. But the country's vaulting ambitions for the future are more breathtaking still – none more so than its goal of becoming an innovation powerhouse by the end of this decade and by 2050 a global leader in science and technology.

The scale of China's ambitions is reflected in its state-backed New Emerging Industries programme. It aims not just to catch up with, but to leapfrog the world leaders in seven sectors, including clean energy, information technology, biotechnology, advanced manufacturing and new materials. Funding is estimated at between $1.5 trillion and $2 trillion over five years, contributing substantially to China's plan to lift research and development spending from 1.9% of GDP today to 2.5%.

Guy de Jonquières is a senior fellow at the European Centre for International Political Economy (ECIPE)

China can already claim to have made big strides in the past few years in science and technology. Among these are:

- It has more patent applications than any other country, having overtaken the U.S. three years ago.
- R&D spending has been rising by 20% a year to about $300bn annually, second only to the U.S. and more than Germany and Japan combined.
- Output of scientific publications has soared and the Royal Society, Britain's leading scientific institution, says China is on course to be the world's biggest source by 2020.
- It turns out more than a million engineering graduates yearly.
- It now has more installed genome sequencing capacity than any other country.

This is extraordinary progress by a country that ranks only 90th in the World Bank's international league table of income per head and still has 160m people living in poverty. Not surprisingly, it has inspired forecasts in the West that China will soon win the race to dominate the industries of the future. Yet, as always with China, it pays to check what lies behind the official data. And on closer investigation, the picture turns out to be decidedly less impressive than it first appears.

> "Chinese companies lack internationally recognised consumer brands and the downstream marketing and distribution networks from which established international industry leaders earn much or most of their profit"

The surge in patenting is driven less by a spontaneous burst of innovation than by generous incentives intended to swell the number of filings. The quality of patents is far more questionable than their quantity. China itself classifies only a third of the annual total as "innovation" patents, and some independent analyses put the proportion lower still. Some Chinese scholars have warned that the patenting stampede risks devaluing the system.

The quality of Chinese scientific publications is equally questionable. They attract relatively few citations, a key measure of other scientists' opinion of their worth, and the number of papers retracted after being found to involve plagiarism and even fabrication has risen steeply. A recent investigation by *Science* magazine, published by the American Association for the Advancement of Science, uncovered widespread evidence in China of "a flourishing academic black market, involving shady agencies, corrupt scientists and compromised editors."

China's claimed advances in research look similarly shaky. The China Association for Science and Technology, a professional body, says 60% of government funding for scientific R&D is embezzled or otherwise misappropriated. Wan Gang, the science and technology minister, has declared himself "stunned, angry and distressed" at cases of graft and other abuses by China's scientists.

Meanwhile, China's engineering graduates may be numerous, but their quality, too, is uncertain. A poll of leading multinational companies by McKinsey management consultants found that almost

all of them considered western-educated engineers more employable than those trained in China or India. Engineering UK, an industry body, calculates that, proportionately, Britain produces two-and-a-half times more employable engineering graduates than does China.

Partly for those reasons, China still depends far more heavily on technology developed elsewhere than on home-grown varieties. In 2012, China paid out 18 times more in royalties on foreign patents than it earned in royalty income from abroad. A similar story is implicit in China's determined – but only partly successful – efforts to compel foreign companies to hand over their most advanced proprietary technology in exchange for access to its market.

As for genome sequencing capacity, it also turns out to be less impressive than it may seem. Genome sequencing requires scientific precision but basically is now a well-established repetitive routine, and the machines China uses to do it are imported.

China is seeking to tackle the abuses, malpractices and distortions that plague its scientific and research communities. But even if its efforts succeed, its hopes of scaling the technological heights face other questions. One of the biggest is whether the forthright scientific inquiry and bold original thinking needed to advance the frontiers of science can flourish in a country whose education system is heavily geared to rote learning and whose political regime not only discourages freedom of expression but has recently launched an even harsher crackdown on dissent.

In any case, China will need more than laboratory breakthroughs if it is to become an innovation leader. It will also need the industrial and institutional structures that enable inventions to be brought to global markets quickly and profitably.

China undoubtedly has some agile, fast-moving and profitable high-tech companies, such as Huawei and ZTE in

Background Briefing

Chinese innovation: looking for the fifth great invention

Naysayers who doubt China's ability to innovate should look to the history books. From paper to pasta, gunpowder to the goldfish, inventions made in China centuries ago continue to be world standards.

To be sure, China's more recent history has been less technologically creative but, as its recent runaway success leads to rising labor costs, the world's most-populous country knows it has to transform the economy from a bargain basement producer of others' ideas and start to hone its ancient high-tech traditions.

"China must rely on scientific and technological innovation to improve the overall quality of its economy, move upward in the industrial value chain, foster a new competitive edge," Prime Minister Li Keqiang said in January at a ceremony to honour scientists in Beijing. "The country needs breakthroughs in frontier sciences and technologies, as well as in its strategic sectors, which are vital to the national economy and people's livelihood."

This is no idle talk. The Chinese are pumping money into innovation at world-beating rates. Chinese R&D was estimated at $284bn last year, up 22% on 2012. That's still way behind the United States, but U.S growth was just 4% and at current rates China could be ahead by 2022, leaving Europe behind along the way.

Of course, research spending is about quality as well as quantity. Chinese research faces clear hurdles in its bid to overtake the big hitters of the West. corruption, threats to intellectual property rights, inefficient resource allocation, the predominance of large state-owned enterprises lacking the agility of U.S. or European competitors. Yet Li's words indicate a keen awareness of those problems. As lower-cost rivals emerge in south and southeast Asia and well as new African producers, necessity could prove the mother of invention in driving China towards a more innovative future.

Already there are plenty of examples of Chinese companies managing to take on western tech firms at their own game.

By some counts, Huawei Technologies Co. is now the world's largest producer of telecom equipment. Its annual R&D spending reached $5.46bn last year from a mere $389m ten years ago. Huawei runs 20 research centres around the world, including one employing 10,000 engineers in Shanghai. From moving fast to adapt to innovation from elsewhere, Huawei has been scooping up tech world awards for its own ideas. It's currently devoting $600m on research into 5G network technology with the goal of producing speeds up to 100 times faster than today's 4G providers.

Other successful Chinese innovators include e-commerce giant Alibaba, Lenovo, the largest global seller of personal computers by unit sales; or Tencent which runs the WeChat instant messaging app boasting 600 million users. Pharmacist Hon Lik is credited with inventing the electronic cigarette and China's rush to install renewable energy – it's the world's biggest producer of wind power – has led to the development of innovative wind turbines.

Chinese culture celebrates the "four great inventions" of its ancient dynasties – paper, printing, gunpowder and the compass. It may be just a matter to time before they need to add more. ■

telecommunications, Lenovo in laptops, Alibaba, Baidu and Tencent in internet services and BYD in electric vehicles. Although none has yet pioneered genuinely new markets, many have become successful 'fast followers' that have prospered at home through incremental innovation – adapting or improving on existing technologies and processes. But to breed more such companies, China will need to overcome several, often self-inflicted, handicaps.

> "The quality of patents is far more questionable than their quantity. China itself classifies only a third of the annual total as 'innovation' patents"

One is massive economic distortions and misallocation of capital. Most of China's fast-moving technology companies are private. Yet the lion's share of government subsidies and bank credit goes to state-owned enterprises (SOEs), which dominate many important national and local markets, particularly finance and network industries such as energy, telecoms and air transport.

SOEs owe their privileges not to superior commercial performance but to political favouritism and incestuous relations with the ruling Communist party. Most are far less efficient, enterprising and agile than private Chinese companies and earn poor returns on the abundant capital showered on them by the state. Indeed, one recent study by an independent Chinese think tank, Unirule Institute of Economics, finds that without subsidies, the SOEs would collectively have lost money.

Capital misallocation has in many sectors led to chronic over-capacity and ruinous price competition, notably in solar panel production, where the industry leader collapsed amid heavy losses and had to be bailed out by its local government. By the same token, local protectionist barriers have fragmented China's home market, limiting economies of scale. The country's more than 100 home grown car makers together account for less than a quarter of their own domestic market.

Chinese companies are also short of international experience. Few, even among its technological 'fast movers', have a global footprint. They lack internationally recognised consumer brands and the downstream marketing and distribution networks from which established international industry leaders earn much or most of their profit.

One way to acquire a global presence quickly is to buy it rather than build it, and Chinese companies are increasingly seeking to do that through foreign acquisitions. Despite scare stories about China "buying up the world", however, these are still running at a fairly modest level and their targets are mainly small niche companies and troubled or orphan producers whose owners are eager sellers. Beijing is acutely aware that snapping up other countries' industrial 'crown jewels' could stir up a political backlash, as did the ill-fated hostile bid by China National Overseas Oil Corporation for Unocal, the U.S. oil company, in 2005.

So how is China faring overall in its drive to scale the technological heights? Probably the single most telling benchmark is Total Factor Productivity (TFP). This is a 'residual' that measures productivity increases that cannot be accounted for just by labour and capital. It covers inputs such as technical skills, management, organisational competence, resource allocation, productive R&D and effectiveness at applying technology. The standard achieved by the best international performers is known as the "technology frontier".

In the early part of this century, China was registering double-digit annual improvements in TFP. But since 2007 the rate of increase has halved, and capital and labour productivity gains have also slowed. An analysis by EY, an international accountancy firm, finds that, far from moving closer to the "technology frontier", China has of late begun to slip further away from it.

These trends are not encouraging. But they are reversible if China changes course, as its leaders now seem resolved to do. At their Plenum in November, top officials of the ruling Communist Party endorsed a far-reaching economic reform programme calling for accelerated modernisation of the financial system, increased competition, greater reliance on market forces, promotion of innovation and private enterprise and stricter disciplines on SOEs.

These plans – if carried through – could remove a number of the self-imposed obstacles to China's exploitation of its undoubted technological and scientific potential, as well as giving renewed impetus to its flagging economy. Whether they will be enough to enable China to realise its dreams of becoming a trailblazer at the frontiers of science and a dominant force in the industries of the future remains an open question. ■

guy dej@gmail.com