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Section 5:
Country Trends

Tipping the balance: The rise of China as a science superpower

Andrew Plume

The Chinese mainland is home to one of the oldest civilizations in the world, and has seen massive technological and social change since it emerged as the modern state we know today as the People's Republic of China. In the past 30 years, under reforming leaders such as Deng Xioaping, China has undergone the fastest Industrial Revolution in history, and is set to be the dominant global economic force within decades. Yet as China catches up with and overtakes the West as an economic and political powerhouse, will its scientific achievements keep pace? Chine once led the West technologically. Could it do so again – or does it already?

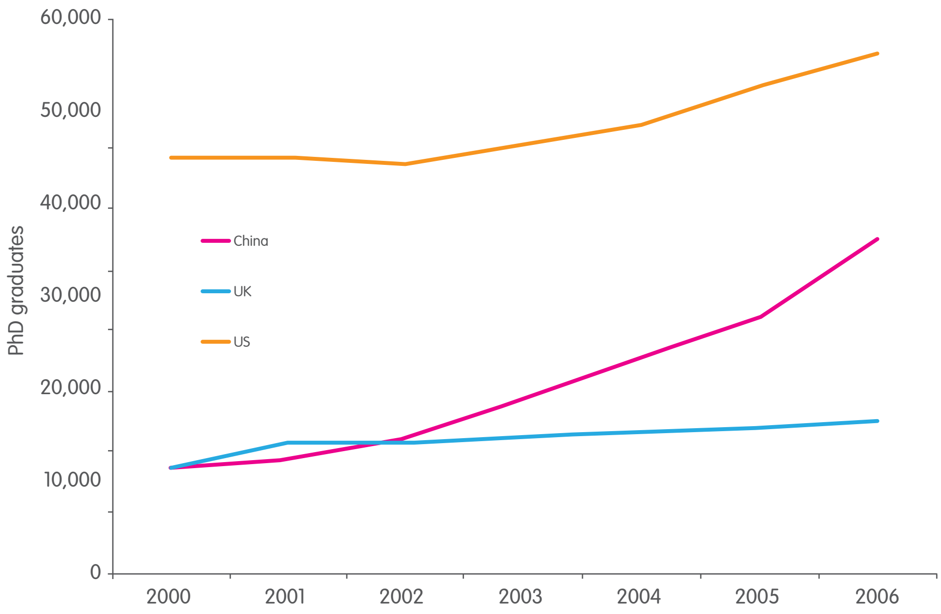
Early innovation, stagnation and re-emergence

Ancient China saw numerous technological innovations including paper and papermaking, woodblock and movable type printing, the invention of matches, the magnetic compass, cast iron and the iron plough, chain and belt drives, the propeller, and machines of war such as the crossbow, gunpowder, the cannon, and the rocket. However, while Europe underwent a scientific revolution starting in the 16th century, science and technology in China stagnated, a trend that accelerated with the creation of the People's Republic of China in 1949 under the Communist rule of Mao Zedong. This was a period during which science in many industrialized nations was undergoing a post-war transition from "Little Science" characterized by individual or small-group efforts into the present era of "Big Science" typified by large-scale projects usually funded by national governments or inter-governmental groups. It was not until the establishment of a technocracy in the 1980s under the leadership of Deng Xiaoping that China started on its current path of scientific and technological advancement. The rise of China as a scientific nation can be documented on both the input and output sides, with a clear causal relationship between the two.

Returns on investment in Chinese science

In 2006, China embarked upon an ambitious 15-year plan[1] to raise R&D expenditure to 2.5% of GDP, identifying energy, water resources, and environmental protection as research priorities. As part of this plan, investment in human resources is emphasized. China has become a higher education powerhouse, turning out more Ph.D. graduates than the UK annually since 2002 and closing on the US (see Figure 1). Perhaps a more immediate indicator of the scientific might of China is the size of the Chinese R&D workforce, which by 2007 already stood at 1.2 million people, exceeding that of the entire EU-27 grouping and poised to overtake the US (see Figure 2). In the absence of more recent figures, China may well already have surpassed the US in both of these key input metrics, but especially in number of researchers.

Figure 1 – Number of PhD graduates per country or country group in the period 2000-2006. Data from Appendix table 2-40 of Science and Engineering Indicators 2010 (National Science Foundation).



The future of Chinese science

In terms of research output, China has shown remarkable growth. The number of articles appearing in the international literature – the most commonly-used indicator of research productivity – has risen exponentially in recent years. To see how this is perturbing the global balance of scientific output, each nation's share of global article output can be determined. In 2008, China stood second only to the US by this metric, with 11.6% versus 20% of the global output, respectively. However, forecasting shares suggests that the dominance of the US is almost a thing of the past: based on a linear trend, China's article share will surpass that of the US in 2013. Of course, this projection assumes that the observed trends to date will be maintained in the coming years, but it remains in keeping with another recent estimate of 2014 for China to surpass the US[2]. Indeed, the recent growth trends in the Chinese research workforce highlighted above are likely to manifest in key output metrics with a delay of just a few years.

China lost its scientific and technological edge from the 15th century onwards by becoming culturally insular, shunning exploration of the wider world and remaining suspicious of importing outside ideas and influences. Just as business depends on trading goods and services, so science depends on exchanging ideas and data, and self-imposed isolation is disastrous in either case. Now, in the 21st century, as China opens itself up to global markets – both of commerce and ideas – it again looks set to lead the world.

References:

1. Medium- and Long-term National Plan for Science and Technology Development 2006-2020

2. Leydesdorff, L., & Wagner, C. S. (2009). Macro-level indicators of the relations between research funding and research output. Journal of Informetrics, Vol. 3, No. 4, pp. 353–362.

Figure 2 – Number of researchers per country or country group in the period 1995-2007. Data from Figure 3-48 of Science and Engineering Indicators 2010 (National Science Foundation).

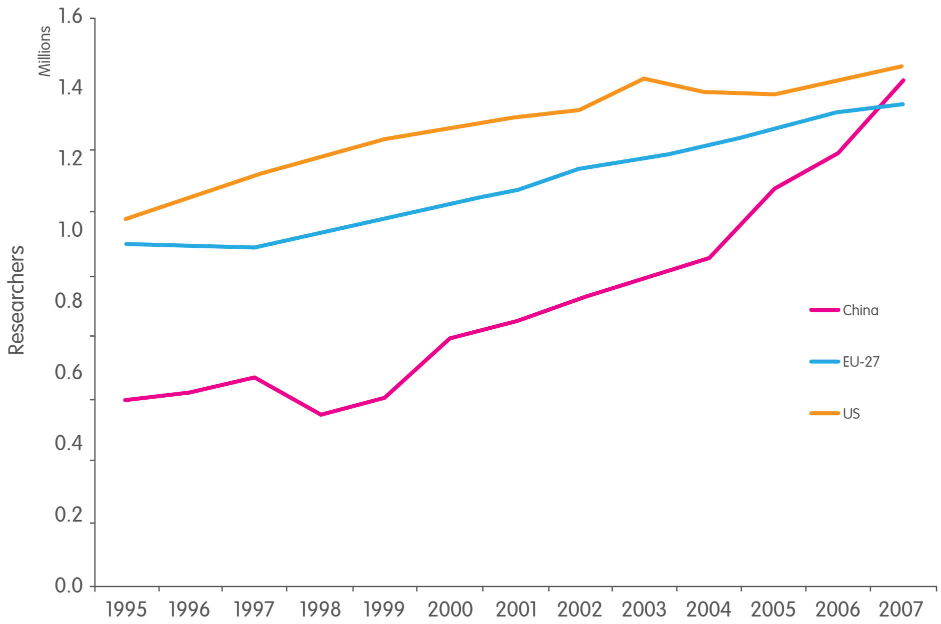


Figure 3 – Share of global articles per country or country group in the period 1996-2016 (actual 1996-2009, projected 2010-2016). Data from Scopus.