nature medicine

The great pretenders

Some analysts believe that the economic hegemony of the US is on its last legs, but the same does not seem to be true of its scientific supremacy.

The past few months have seen the publication of several articles and books arguing that the days of the US as the only economic superpower are over, and that it's either China's turn to call the shots or time for a triumvirate among the US, China and the European Union (EU).

Whether or not you believe that the US is in a steep decline, there is no question that we are witnessing the start of an era of worldwide economic turbulence. It is therefore pertinent to wonder whether these winds of change will also have an effect on the scientific status quo. In other words, is the US scientific and technologic preeminence also coming to an end? The comprehensive report *US Competitiveness in Science and Technology* (http://www.rand.org/pubs/monographs/MG674/), published last month by the RAND Corporation, is a timely and helpful document addressing this question.

The RAND report was inspired in part by a series of analyses earlier this decade—most famously, a document from the US National Academy of Sciences entitled *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Future* (http://books.nap.edu/catalog.php?record_id=11463)—warning about a series of perceived threats to US scientific leadership, primarily a lack of sufficient investment in science and technology, and the emergence of other nations as potential new leaders. The authors of the RAND report, Titus Galama and James Hosek, set out to investigate what data (if any) substantiated those claims.

In broad terms, the RAND report asks two questions: what are the implications of the rise of other nations for US performance in science, and what is the evidence that the US has not been investing enough in research and development (R&D)? The authors' review of the evidence led them to conclude that the picture is not as grim as painted by the early reports. The US still leads global scientific production by a wide margin judging from a variety of indicators, including numbers of papers, citations and patents. Also, it has invested more in R&D (particularly in the private sector) and has added more scientists to the workforce than the EU or Japan over the past decade. And although it is true that the growth of emerging countries (particularly China) seems staggering on the basis of their recent scientific spending, these nations have started from a very small base and still account for only a small fraction of publications, citations and patents.

Although the RAND report is a breath of fresh air for the US, it would be a mistake to conclude that there are no reasons for concern, and the document itself identifies a few. One of the most interesting is that the US educational system is not producing enough domestic talent to fill all of the available positions in science and technology, and the country is relying excessively on foreign scientists to do its research. In fields such as engineering, for example, over 50% of all PhDs are awarded to non-US citizens, and in 2005, as many as 20% of research scientists aged 21–35 were from other countries. In a climate in which there are unprecedented restrictions on foreigners moving to the US, such as a marked reduction in the number of visas available, this dependence could quickly become problematic.

Threats to the US scientific dominance notwithstanding, the authors of the RAND report are right in concluding that a changing of the guard is not imminent. As they remind us, to perform well in science and technology, a country needs at least three elements to be in place—infrastructure, workforce and education. Decades of investment have led the US to develop a very strong foundation for these pillars, ruling out the possibility that its research system is in danger of collapse. At the same time, the report includes plenty of data to show that the rest of the world has a lot of catching up to do before it seriously threatens the scientific position of the US, and that different regions need to tackle different problems if they want to become more competitive in R&D.

For example, the EU's average spending in science as a percentage of its gross domestic product (GDP) has not matched that of the US, although there is wide variation in the investment of its member countries. More worrisome is that the number of researchers per thousand workers in the EU is roughly half of what is found in the US, even though the number of all PhDs in the EU is about 25% higher than that of the US (see **Figure 1**). This suggests that the EU investment in education versus infrastructure capable of absorbing this human

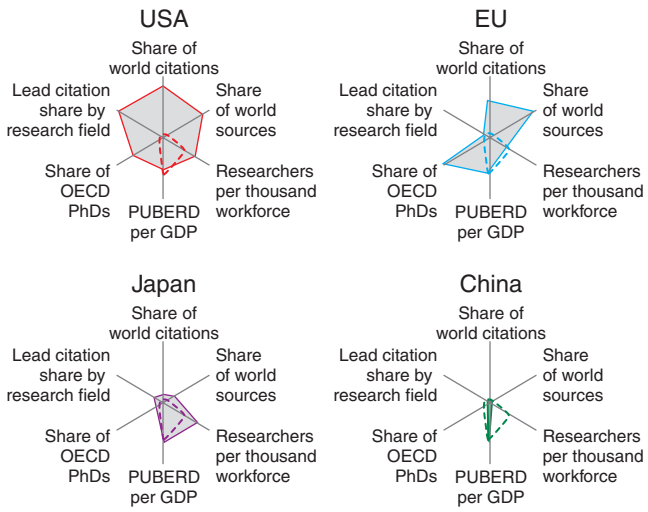

Figure 1 Research footprints. The British company Evidence created these 'research footprints', cited by the RAND report, as a useful way to compare the scientific input, activity and output of a series of countries or regions. The dashed shape is the average of a comparator group of 25 countries. Note that data on China's share of PhDs from OECD member countries was unavailable and therefore has not been plotted. OECD, Organisation for Economic Co-operation and Development; PUBERD, public expenditure on R&D. Reproduced from the UK Office of Scientific Innovation's *PSA Target Metrics for the UK Research Base* (http://www.berr.gov.uk/files/file38817.pdf).

capital is not in equilibrium, something that can only be good news for other regions of the world eager for new talent.

In the case of Japan, its percentage of researchers in the working population is similar to that of the US, but the productivity of those researchers is substantially lower on the basis of the number of publications and citations. Moreover, the number of research disciplines in which Japan leads the share of citations (an index of a country's breadth of research strength; see **Figure 1**) is small compared to the number of fields led by the US. So, despite Japan's expressed intention to achieve scientific leadership, it does not look as though the country's investment is giving the desired returns, perhaps making it necessary for Japan to reevaluate its priorities.

Last, China's case is fascinating. On the one hand, its economic growth is undeniable. Since 1975, its compounded annual growth rate has been 13% (about twice that of the US, the EU or Japan), and its GDP is now larger than Japan's and almost as large as that of the EU. Moreover, its public expenditure on R&D as a fraction of its GDP is already quite close to what each of those three regions spends.

On the other hand, every other indicator reveals that China is not having a global impact on science and technology. It accounts for a minuscule fraction of total publications, citations and patents, and has a very small percentage of researchers. This suggests that China is currently investing more heavily in infrastructure than in increasing its scientific workforce. Moreover, some analysts have contended that China's rapid growth has resulted from absorbing foreign technological advances and not from domestic innovation.

It may be argued that these are still early days for China's scientific emergence. However, it would seem important for this country's competitiveness to balance more carefully its investment in the three pillars of scientific performance mentioned above, and to act on the need to develop its own technologies and intellectual property.

Unfortunately, the RAND report does not always distinguish between military and nonmilitary research, or among the life sciences, physical sciences and engineering. Also, despite its depth and rigor, most of the data discussed by the authors are only as recent as 2003–2005. It does not analyze more recent claims of reduced R&D funding in the US, the effects of a weak dollar and China's increased efforts to lure back its diaspora of researchers. The impact of these factors on US science has not been studied in great detail, but it's not difficult to imagine that they would add up to a declining trend in the different indicators scrutinized by the authors of the report.

These limitations, however, do not detract from a remarkable document that makes incisive diagnoses on the strengths and weaknesses of the different players on the scientific stage. And while the report concludes that the US is not at immediate risk of losing its scientific supremacy, the advances made by other countries should be taken seriously as indicators of their potential for scientific leadership. It is indeed possible that, if the same report were written in five years' time, a very different picture might emerge—a reminder that complacency has no place when you want to stay at the top.