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A G2 FOR SCIENCE?

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POLICY CHALLENGE

Both the European Union and the United States must adapt to the scientific surge from China and other emerging nations. In the US, decision makers fear that their open model for building scientific power, based to a great extent on recruiting talent from abroad, has passed its peak. But for the moment the US-China connection is still strong, growing, virtuous and mutually beneficial. In fact, the emerging multipolar science world looks set to be dominated by a US-China G2. With its more inward-looking perspective, the EU needs to do more than focus on internal integration. The European Research Area programme provides the framework for a

SCIENTIFIC RESEARCH used to be predominantly a developed-world activity, with the United States at the forefront and the European Union close behind. But a more multipolar scientific world is in the making, in which several emerging nations will participate prominently. The most striking case is China, which is going through a uniquely rapid rise. In fact, the future multipolar scientific world looks set to be dominated by a G2 – China and

1. http://www.gov.cn/english/.

2. Publications and citations as recorded by Thomson's ISI-Web of Science journals, which includes only journals that satisfy a number of quality criteria (internationally peer-reviewed). These journals carry an English-language bias as well as a disciplinary bias in favour of biomedicine and life sciences. For a similar analysis of world scientific publications, using the Scopus database, see Royal Society (2011).

Estimates of the number of scientific researchers provide broad support for the trends and shifts suggested by the R&D data (Figure 2, panel B, on the next page). China has more than doubled its research workforce, boosting its world share from 13 percent to 25 percent between 1995-2007. It now has as many researchers in its workforce as the EU and US: about 1.4 million.

And there are many more Chinese researchers to come, as indicated by bachelor, master and PhD degree award trends. This holds particularly for natural sciences and engineering. While western governments are concerned about lagging student interest in these areas, which are considered vital for knowledge-intensive economies, the number of first university degrees awarded in these fields in China has risen spectacularly from about 239,000 in 1998 to 807,000 in 2006. The trend is also seen in the award of PhD degrees in China, where natural sciences and engineering doctorates increased more than tenfold up to 2006, close to the number awarded in the US (about 21,000). In the EU there has been little increase in the number of doctorates. It is also worth noting that, in the US, 31 percent of doctorates are awarded to students from China, 14 percent to students from India, and seven percent to students from South Korea.

The Chinese programme of building indigenous scientific capacity concentrates on the top end. Of the 1700 Chinese chartered institutes of higher education, six u-

3. See http://www.arwu.org/.

4. The pattern of foreign PhDs in the EU is completely different to the US. First, there are fewer foreign PhDs in the EU: Other-EU nationals represent five percent of doctoral candidates, Extra-EU nationals represent 17 percent, spread between Asia, Africa and Latin America. Major destination countries are the UK (for Asia), France (for Africa) and Spain (for Latin America). Source: Mougeroux (2006).

5. See eg China's Thousand Talents Programme, offering positions, D:0.0219 r

attract the best foreign talent. The EU has not managed to establish such a virtuous open model.

What if the rise of indigenous scientific and technological capacity in Asia/China should eventually persuade their foreign-educated scientists to return home? As Table 3 shows, this does not yet seem to be happening, at least not immediately after graduation. But Asian scientists could be returning home at later stages in their careers. There is no doubt that China is aggressively seeking to bring home talented individuals[5]. But hard data supporting the importance of these return flows is still lacking. In any case, return flows at later career stages still leaves plenty of scope for the host country to benefit from imported foreign talent.

INTERNATIONAL COLLABORATION IN SCIENCE

Is China also becoming a new partner for scientific cooperation with the west? The data does not show major shifts in collaboration patterns (Table 4). The emerging scientific powerhouses, particularly China, are still relatively under-represented as partners for the west. China's collaboration is mostly with other Asian economies. Its collaboration with the US has increased over time on par with the growth of its own scientific power. The intense flow of PhDs between the US and China undoubtedly contributes to smoother US-China collaboration. European countries, missing out on this flow of talent, benefit less. The EU's collaboration with China remains at a far lower level that it could be, considering the growth of China's scientific power.

By contrast, intra-EU collaboration has substantially increased over time, suggesting progress has been made in building the integrated European Research Area (ERA), but diverting from extra-EU collaboration.

IMPACT BEYOND SCIENCE

Beyond academia, foreign-born PhDs are also widespread in the US private sector research workforce. Foreigners made up 25 percent of tertiary-educated workers in science and engineering occupations in the US in 2003. For holders of doctorates, the figure was 40 percent (NSF, 2010). About half of the foreign-born scientists and engineers in the US are from Asia (16 percent from India, 11 percent from China, 4-6 percent each from the Philippines, South Korea, and Taiwan). The Chinese share increases to 22 percent for those with a PhD.

Foreign talent is thus vital for US science and engineering[6]. This explains why the US fears that its science machine will start to splutter if the pool of mobile foreign talent entering the US dries up. There is no clear evidence so far to justify this fear. For the moment, the increase in Asia's own capacity to produce science

Table 4: Collaboration trends; International Collaboration Index for selected country pairs (1998-2008)

With US	1998	2008	With China	1998	2008
	0.67	0.74			

Source: Bruegel based on NSF, Science and Engineering Indicators 2010. Note: an index of international collaboration corrects for the effects of the unequal size of countries' research establishments. Values above '1' indicate greater-than-expected rates of collaboration.

6. There is also evidence that foreigners are increasingly responsible for US patents. Freeman (2005) reports that one quarter of US patent applications filed at the World Intellectual Property Organisation in 2006 were authored by a non-US national, up from seven percent in 1998. Of US technology and engineering start-ups, about one quarter have an immigrant as a key founder. For Silicon Valley start-ups, this may be even more than half (Demos, 2008).

and engineering degrees does not seem to have disconnected the US from the pool of potential Asian scientists. In fact, the contrary seems to be the case.

On the back of an increase in its indigenous scientific and technological capacity, Asia has become an increasingly attractive location for multinational companies' research activities. In an UNCTAD survey of the world's biggest corporate R&D spenders, China (third) and India (sixth) were already among the top-ranked countries for corporate R&D. As future target locations, China was ranked first and India third (UNCTAD, 2005).

When asked why they are moving their R&D labs east, western firms report not only lower labour costs and the importance of the growth potential of Asian markets, but also, and equally important, the quality of R&D resources and the proximity to universities and institutes (Thursby and Thursby, 2006). The increase in Asia's indigenous scientific capacity is therefore increasingly becoming a factor in the attractiveness of Asia for western corporate R&D labs.

EU POLICY IMPLICATIONS

Emerging economies have grasped that scientific power is based on ambition and massive investment in R&D and higher education. Their governments have firmly built investment in higher education and science into their development policies as they vie to build competitiveness in technology-intensive sectors. The result has been a continued increase in the scientific power of these countries.

The benefits from a more global science world will accrue to many, but some will benefit more than others. The open US scientific system has traditionally benefited from foreign brains. The US's dominant position in science is based on its openness to the brightest talents of all nationalities. Its top position continues to attract the best talents of all nationalities, who disproportionally contribute to US scientific, technological and economic success. With continued high attrition rates and high stay rates for Asian scientists, this open model, at least for the moment, continues to bear fruit for the US, even if its most important source country, China, is rapidly developing its own scientific capability and wants to bring its foreign-based scholars home.

China's scientific growth model, aspiring to be indigenous, involves sending out its increasingly better locally-trained scholars to the best institutes in the world, and reaping the benefits when they return, typically at later stages in their careers when policymakers should therefore promote scientific collaboration outside the EU, should do more to attract and retain the bo

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