4e Séminaire SciScI - OST
Mercredi 4 avril 2012
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"China and the USA: a G2 for Science?"

RESUME

We are evolving towards a global science world. There are important shifts in where science is being produced, and new scientific powerhouses are emerging. We will see how these shifts affect the science process itself (mobility of researchers, collaboration between scientists…), and, beyond science, how they impact research innovation, and ultimately growth and competitiveness. I will also underline some policy implications, particularly for Europe.

First of all, the globalization of science is of course part of the overall process of globalization of the economy. Firms tend to be more active internationally, not only in the production of sales, but also in their R&D activities. This open perspective means that firms are much more looking for external scientific sources on a global scale, and scientific talents are increasingly mobile. With the help of ICT and Internet, the cost of international scientific activity has been drastically reduced. Increasing a policy stating that it is important to improve the collecting of science research and spending efforts on stimulating the internationalization of higher education in science is triggering a switch. In Europe, we have improving data, certainly thanks to the European projects ERA and EHA.

However, it isn't that straightforward a process. One important opposing force is the enduring national dimension of many science education and technology policies. Another one is that despite the reduced cost for international collaboration, we lack effective exchange and proximity. The inertia of some long-time networks people tend to stick to also hinders the globalization process. The only spectacular feature is the rise of China. Since 2004, it has dramatically increased its scientific output, now only standing second to the US. Other countries are also rising in upright patterns, such as South Korea, Brazil or Turkey.

This rise of other poles is not necessarily a story of old poles declining. We still see an absolute growth of US and EU scientific publications. According to the Science and Engineering Indicators issued by the NSB, Europe has been topping the charts above the US since 1994. China's growth is bigger than the growth of other Asian countries, but the Asia 10 group is already almost as big as the US.

The rise of China is very much tied to specific fields: material sciences (the highest growth rate), chemistry, physics, mathematics, engineering, computer sciences and geosciences. China is much weaker in the medical sciences (where the US is very strong), though it recently started to get more into bioengineering.

If we look at the TOP1 (the publication that gets the highest number of citations), we see the US still owns the dominant position, though it is declining (62% of TOP1 citations in 1998, 52% in 2008). The EU beats the US in terms of number of publications, but if you look at the TOP1, we only represented 25% in 2008. China was nowhere in 1998 and is quickly catching up, representing more than 10% of TOP1 citations in engineering (where the US and the EU aren't so strong), Chemistry and Material Sciences.

Another important element to take into consideration is the frontier, where new science is being created.

A few examples show that the US is also very predominant on the frontier (93% of Phase O clinical trials for cancer therapy in 2007, 85% of publications in the Silicon Carbide Ceramics new discipline in 2006…).

Clearly, the important shifts going on in terms of output partly are the reflection of differences in input (funding). Japan and South Korea are holding the top of the chart in terms of R&D investment as share of their GDP. The US are still dynamic but at a lower level, while Europe doesn't seem to get in the movement. If we look at R&D workforce, there again the rise of China is spectacular. The pool of researchers working in that field is about the same size as in the US. It is also interesting to look at the number of researchers and students trained for research positions. Of course the US still is the largest PhD-producing country — even though, aggregated together, EU countries produce more — but it actually trains more foreign students (especially from Asia) than domestic ones. PhD degrees produced in China have dramatically risen. The country is investing heavily in science training and education to improve its publications output. It is nevertheless a very unequal scientific landscape, since there are very well and very badly funded institutes.

What do these new trends and shifts in scientific research imply? Will it stimulate scientific activity and production? Will science be more effectively produced? Do we see more collaboration going on? Effects beyond science are also important to consider: new technologies, innovations, firms generated in the new scientific hotspots, but also multinational firms locating R&D labs close to those new poles. How does this geographical shift affect firm strategies? Does multi-polarity lead to more or less mobility?

First element: the number of foreign tertiary students going abroad continues to increase (+50% between 2000 and 2005). Not surprisingly, the major source country is China, followed by India, and the major destination is still the US, followed by the UK. PhD students are the most mobile internationally. There again the major source country

is China, and the major destination is the US. In Europe, 5% of the doctoral candidates come from outside the EU.
Although there are more and more Asian students studying in the US, there is also evidence that students are massively returning to China. To increase that return rate, government institutions offer positions, funding and preferential tax treatment for overseas talents. But when do they come back? Unfortunately, we don't trace that kind of information in the EU, and I really think we should start doing it. The students that come to the U.S. for a PhD want to continue to build up their scientific abilities in the US, get a post-doc position, and only return later in their careers. The US wishes to keep them in the hope to have them contribute to the quality of American scientific research. The share of temporary residents staying at US universities in post-docs positions rose to 57% in 2006. Half of all science and engineering workers with a PhD are foreign-born, and they also represent an important share of the non-academic science and engineering workforce. This tends to show that the "pull" factor (scientific capacity of a host country) matters more than the "push" factor (lack of scientific capacity in the home country).

An increasing convergence doesn't necessarily mean less international mobility; on the contrary, it could make it even more rewarding. These foreigners end up not only in the academic work sphere, but also in the private corporate workforce, where they establish international networks for recruitment, collaboration and ideas development, and many studies show they also often contribute to start-ups and patents.

Mobility seems on the rise, and scientific publications are increasingly internationally co-authored, especially in the EU, but despite the increasing of international collaboration, the patterns of scientific collaboration only change gradually. New poles are only very slowly entering into these old networks. Most of Europe's scientific publications will be with the US and most of the countries collaborating with the U.S. are European. The US is also overrepresented with Europe's usual partners, such as South Korea, Taiwan, Israel, Mexico or Canada. If you take a look at the Chinese perspective, you'll see a mirror image regarding its collaboration with the U.S., almost at par. It also shows the Asian dimension, with an overrepresentation of Japan, Singapore, South Korea and Taiwan. The E.U. countries are much less represented, and especially strong in intra-bloc collaborations.

The effects of this shifting in the geography of science and these multiple poles is, to me, a win-win game for science, at least for a number of players. A multi-polar science world is in the making, with a strong and virtuous US-China nexus. We can also definitely speak of an Asian pole, even though regional integration is not straightforward. Concerning the E.U., do we have one European pole, or is it just a collection of loosely connected nodes, with some of the poles? And even if the EU were perfectly integrated, would it be equivalent to and as strong and efficient as the virtuous US-China nexus?

In fact, we should consider the possibility that this growing multi-polarity could create a G1 in the future. China's ambitions for 2011-2015 is to put the emphasis on innovation, and especially on new strategic sectors like green science, IT or biotech, with the objective to build up world class universities and gain science leadership by 2050.

The EU really needs to engage in this multi-polar world as fast as possible to try and benefit from this trend and turn it into a virtuous circle as well. The only way to achieve this is to aim for excellence in science and technology capacity; that is the pull-effect that will allow foreign students to be attracted to the EU. It needs to become a hub for in- and out-going flows, and a bargaining chip for scientific cooperation, trade and ideas networks. To build excellence, cooperation should be supported through bottom-up excellence support, rather than top-down support. We need to pen circulation inside EU to allow specialization in hot spots to attract foreign talent and to allow diffusion of results while avoiding circulation diversion. Openness at the borders is very important, for international students as well as scholars. Mobility of researchers is crucial for the creation of networks and scientific cross-benefits. So we need to speed up the ERA policy agenda, with a focus on external openness, and intra-EU mobility driven by excellence criteria.