National Research and Innovation Systems Worldwide and their Ties with France

Synopsis

CHINA

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OST Observatoire des Sciences et des Techniques

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China: a country under strong internal pressure

China's huge size and unusually high economic growth rate (approximately 8% in 2000) means that it possesses the world's sixth largest GNP, but which amounts to only $840 in GNP per capita, placing it among the poorer nations in the world, in 128th place. Marked economic and social disparity between rural and urban regions is growing wider, and an estimated eight million peasant farmers migrate each year to the already crowded cities.

Similarly, China, with 3% of the world share in scientific publications, is one of the leading newly scientific nations while nevertheless facing significant challenges in modernizing its agriculture, rebuilding its industry, and extending adequate infrastructure to the whole country. This contrasting perspective is behind a sustained effort by decision-makers to make the best and most coherent use possible of the nation's bilateral scientific and technical ties.

I. OVERHAULING THE RESEARCH AND INNOVATION SYSTEM TO REFLECT POLITICO-ECONOMIC CHANGES

I.1. SCIENCE POLICY GUIDELINES TAKE A U-TURN

In the 1950's China's fledgling scientific and university system, conceived along the lines of the Soviet model, suffered serious setbacks as a result of the « Great Leap Forward » (1958-1976). It was not until the 1980's and the founding of the National Natural Science Foundation of China (NSFC) that a Western-type model of competitively-financed research was instituted.

China's current scientific research structure is struggling to include a more fundamental orientation (fundamental research accounts for less than 6% of China's GERD) along with its principal mission of carrying out applied research and technological development. Recent directions taken by the national research effort have managed to push the GERD/GDP ratio from 0 .7% in 1998 to 1% in 2000 (see figure 1) (of which the biggest slice--60%--is due to firm-level research) and will undoubtedly correct the current imbalance.

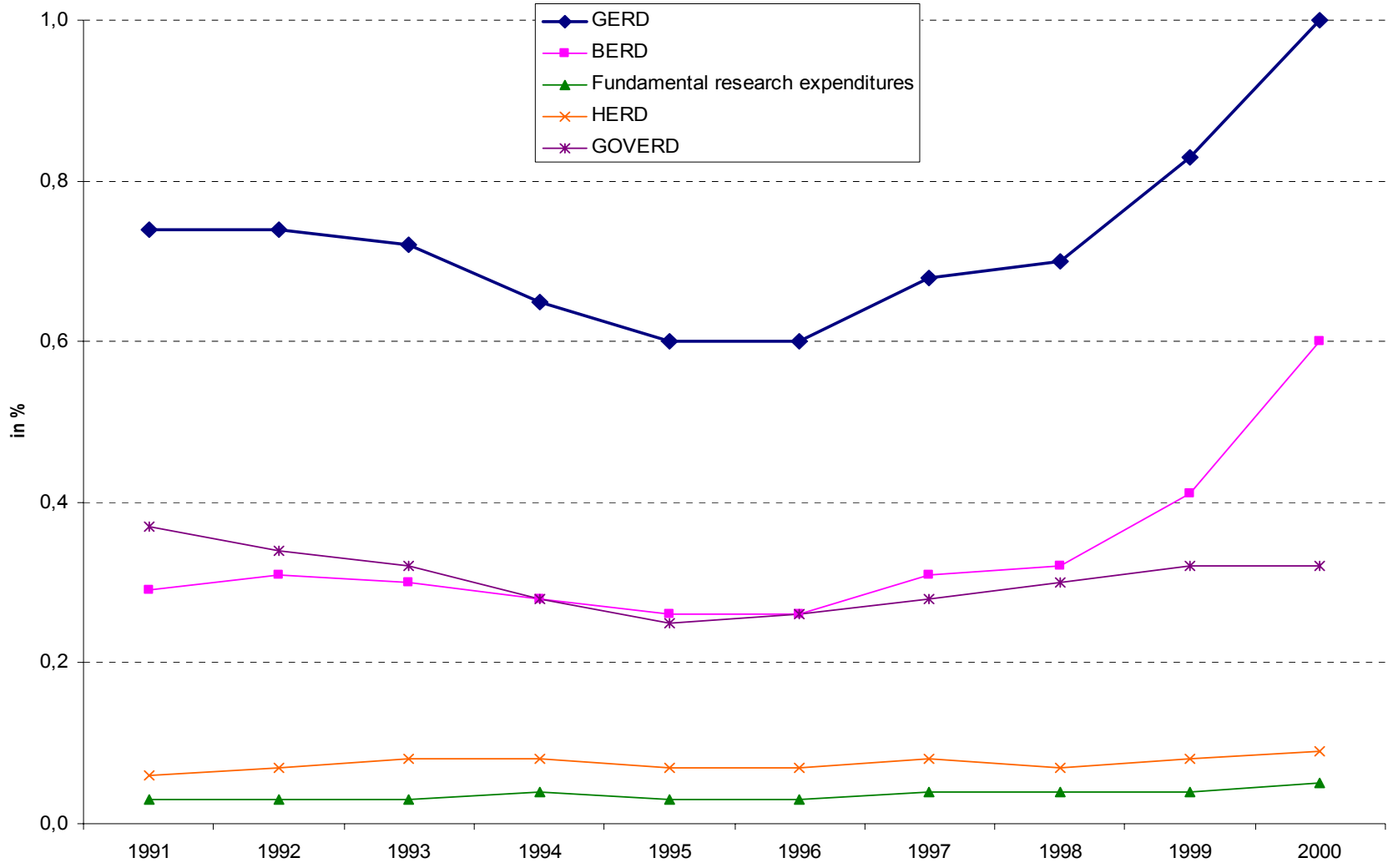
I.2. A NEW RESEARCH SYSTEM OVERLIES BUT DOES NOT REPLACE THE FORMER ONE

All in all China's research system today represents the superimposition of a new, efficient dynamic North-American-type system over an older Soviet-style system composed of less responsive laboratories.

As competitive funding of research progressively replaces recurrent block grants, a gap is widening between nationally recognized laboratories of excellence—such as the « National Key Laboratories »--and second-rank research units which are the losers in a science policy shift towards a leaner and meaner national research effort. One of the results of this situation is to exacerbate the regional imbalances within China, especially since regional government is responsible for one-third of public research grant funding; dynamic national excellence labs cluster in the major metropolitan areas and reap most of the benefit from China's international scientific exchange.

The co-existence of these parallel but opposite universes will likely continue despite significant efforts being made by the central government. Finally, military research spending is another source of funds for Chinese laboratories but one impossible to gauge (defence spending may represent as much as 15% of GDP).

Figure 1: Evolution in the ratios to GDP of GERD, BERD, HERD, GOVERD, and fundamental research expenditure by China in the period 1991-2000



I.3. Overall scientific and technological performance widely varied

The system of public research is of very modest size, with about 700,000 civil researchers and engineers, and is tied to the university system which itself is not large (some three million students). Innovation, never easy to gauge, is also a weak point of the Chinese system judging from the very small volume of industrial R&D and the corresponding low numbers of Chinese patents filed in international systems. Patent figures for 2001, nevertheless, represent a marked turnaround as they are five times greater than in 1996.

An analysis of Chinese scientific publication as reflected in the Science Citation Index, SCI (Cf. table 1 and figure 2), reveals a significant increase in publication in the last few years, and especially since the integration of Hong Kong in 1997. By this measure, China has become the world's 11th largest science producer, with a clear specialization in physical sciences (mathematics, physics, chemistry, and engineering sciences) and also very recent but spectacular progress in fundamental biology research.

Citation analysis, however, along with relative impact measures for Chinese publications, show that Chinese scientists publish more than are read abroad; relative impact for all disciplines taken together is only 0.43 (compared to 0.94 for France). But significant progress has been made between 1997 and 2000 in this area, an indication of increasing international attention being paid to Chinese scientific expertise.

II. A limited internationalisation

II.1. Theoretical questions raised by the nature of China's international market insertion

China's opening to world markets, in particular with its entry into the World Trade Organisation, has not so far been accompanied by a similar movement in Chinese science, which suffers from both the unattractiveness of scientific careers in China and the lack of social scientists (nearly nonexistent in China), who typically are the best situated to criticize a research system and steer it toward change. In addition, the idea of innovation has not taken hold very widely in China for a number of reasons especially cultural ones, with the result that the Chinese economy plays catch-up or copycat, basing its growth on a strategy of price competition.

II.2. US and Southeast Asian predominance

The massive and continual flow of skilled scientific labour to the United States weighs heavily on Chinese research as it deprives the nation of its best talent. The US National Science Foundation has calculated for 1999 that 30,000 Chinese students were studying in the US and that nearly 90% of those obtaining doctorates planned to stay and look for work.

A look at co publication data reveals that the US is by far and away China's leading scientific partner, accounting for almost 30% of co publication, followed by Japan, with France occupying a modest 8th place with about 3%. At the same time, there is in recent years a noticeable and growing diversification among China's research partners led by the countries of Southeast Asia (South Korea, Singapore, et al.) and, to a lesser extent, Australia and Canada.

II.3. A meagre and uneven European presence

Other than the United Kingdom and Germany, who figure in 3rd and 4th position respectively, European nations figure very little in the international co publications of Chinese science. For the most part they count for less than their average international co publication worldwide.

Despite an agreement signed in late 1998 with the European Union authorizing Chinese scientists to participate in the Fifth Framework Programme funding requests, there have been few EU-level moves towards creating member-state synergies for scientific collaboration with China. In fact, European countries have been moving in the other direction, with the most advanced developing their own individual China policy.

	1989	1993	1997	2000
World scientific publications	440 479	497 876	535 495	559 454

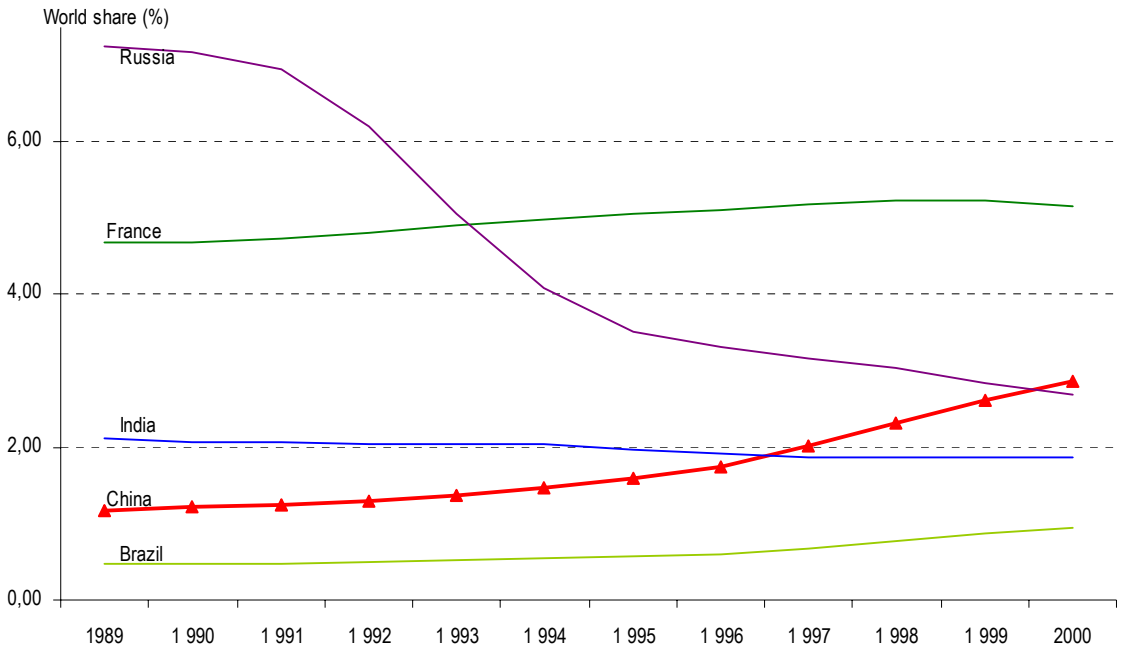
data ISI (SCI, COMPUMATH), processing by OST

Table 1: China's share of world scientific publications for eight disciplines (1989, 1993, 1997, and 2000); comparison with Russia, India, Brazil and France for 2000

	World share (%) in scientific publications							
	China				India	Russia	Brazil	France
Disciplines	1989	1993	1997	2000	2000	2000	2000	2000
Fundamental Biology	0,34	0,40	0,56	0,90	1,02	1,33	0,87	5,5
Biomedicine	0,69	0,65	0,79	0,97	0,97	0,31	0,68	4,7
AppliedBiology/Ecology	0,34	0,55	0,97	1,40	1,80	1,90	1,48	4,3
Chemistry	1,04	2,04	3,85	6,34	3,67	4,87	1,00	5,4
Physics	2,31	3,13	4,42	5,31	2,65	7,37	1,57	5,6
Sciences of the Universe	0,96	0,99	1,41	2,08	1,54	2,65	0,89	5,8
Engineering Science	1,69	2,19	2,98	4,11	2,29	2,70	0,77	4,4
Mathematics	2,22	3,03	4,46	6,30	1,87	4,22	1,03	7,9
Total	1,03	1,36	2,02	2,88	1,86	2,69	0,94	5,2
Number of publications	4 538	6 779	10 791	16 098	10 415	15 056	5 251	28 812

data ISI (SCI, COMPUMATH), processing by OST

Figure 2: Evolution in world share of scientific publications from 1998 to 2000 for China, Russia, India, Brazil and France



data ISI (SCI, COMPUMATH), processing by OST

III. France: The need to define a clear strategy for scientific partnership with China

III.1. Quantitatively, France is a minor partner even by European standards

France plays a very modest role in China's international scientific cooperation. Furthermore, predominant fields for collaboration reflect more French research's strengths than China's, a situation which can be at least partially explained by the tradition of science as development aid.

On the other hand, Chinese students in France account for barely more than 1.5% of all international students (Cf. figure 3), despite a clear upturn since 1998. And two out of three doctoral students are enrolled in social science programs, a sector virtually unknown in China.

III.2. Scarce resources for scientific cooperation with China due to long-time indecision

The fact that France is largely outpaced by Germany and the United Kingdom as a scientific partner to China is due to a long absence of any priority given to scientific and technical collaboration with this country. Meanwhile, the paucity of involvement by private sector actors with Chinese science is at least as flagrant.

The pact signed between French and Chinese governments in 1997 has nevertheless had the effect of turning things around; China has become a Foreign Ministry priority, and the Ministry has doubled the funds allocated to scientific relations while increasing the number of its scientific attachés.

The main mechanism for Franco-Chinese cooperation is comprised of so-called Advanced Research Programs, which on the French end are administered by the AFCRST and are co-financed by both countries' governments. These programs are essentially small-scale initiatives chosen in part for their potential for triggering long-term collaborations through joint laboratories. At the same time, many research institutes and universities in France maintain bilateral relations with Chinese scientific institutions. Lastly, various scholarship programs initiated by respective ministries constitute another albeit limited and irregular policy tool for encouraging scientific exchange.

III.3. Policy alternatives and outcomes for French scientific cooperation with China

France faces two choices for scientific cooperation with China, in light of the preceding analysis:

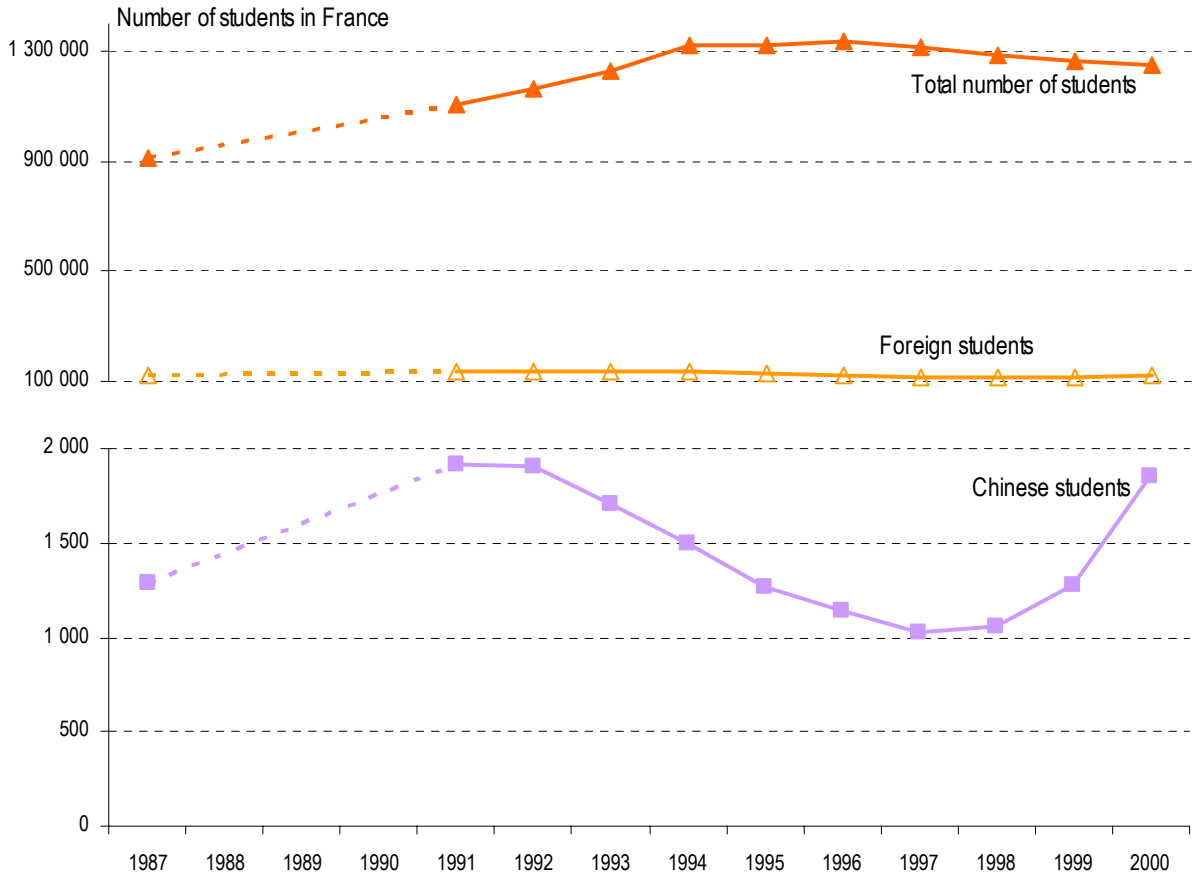
- The first option would be to base scientific outreach to China specifically on the strong points of French laboratories, which would lead to ties with the most visible laboratories in major metropolitan centres such as Hong Kong and Shanghaï. This policy direction would be reinforced by a policy of decentralized decision-making.

- The second option would be to focus on the Chinese research and innovation system as a whole, selecting priorities according to the wishes of Chinese partners, and taking into account the mass of demand originating in less highly-regarded laboratories in China's vast interior. Here the selection criterion is less that of the hoped-for excellent scientific results and more a matter of the progress to be made by collaboration, which necessitates the weight of public powers.

Neither of these two paths can be defended as the right way in absolute terms; political arbitration has

a role to play in defining policy in this area; little can be said against a mixed policy approach even if certain points remain negotiable. That being said, it is clear that even if a hybrid policy reflecting heterogeneous goals is adopted, the overall heading must be presented in coherent and unequivocal terms.

Figure 3: Evolution in total number of students for international and Chinese students in France from 1987 to 2000, for all degree levels taken together



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This document presents the highlights of a « Dossier on China » performed in October 2002 by the Observatoire des Sciences et des Techniques, in cooperation with the Ministry of Foreign Affairs. The aim is to analyse the context of the scientific research and technological development of China, viewed as an important scientific partner for France. Available on the OST website: **http://www.obs-ost.fr**.