

Eastward ho! – The geographic drift of global R&D

Bob Stembridge
Thomson Scientific
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With comparatively low costs and a dramatic increase in the graduate-educated labor force, coupled with an ambitious five year plan to transition from a manufacturing to innovation-based economy, China is proving to be something of a magnet for globalization of R&D. A continental drift eastwards towards the Asia Pacific region is in progress.

Introduction

International boundaries have today become considerably less important in how R&D activities are structured, and in how collaboration between research groups occurs — particularly in the light of recent advances in information and communication technologies.

Organizations are also reaching beyond their home borders as a way of addressing:

- rising R&D costs
- risks in product development
- shortened product life cycles
- increasing multidisciplinary complexity of technologies
- intense competition in domestic and global markets.

These factors together have led to increased globalization of R&D, with China in a pivotal role.

Metrics of R&D growth

In order to understand the level of R&D activity of a region, there are a number of measures we can examine:

- R&D spend
- Numbers of researchers involved in R&D
- Number of scientific papers published in scholarly journals
- Number of inventions described in patent applications

Looking at the first of these, R&D spend as a proportion of GDP grew dramatically in China from 0.9 per cent in 2000 to 1.34 per cent in 2005¹. R&D spending rose from 89,600 billion yuan to 245,000 billion yuan over the same period. According to an OECD report published December 2006², China is predicted to be the second largest spender on R&D in 2006 at USD136bn behind the US (USD330bn) but ahead of Japan (USD130bn)². This R&D investment expenditure is directed towards high technology areas such as electronics and telecommunications, medical and pharmaceutical, and aerospace sectors³.

Figure 1: Comparison of computing patents from China, Japan and Korea 2000-2005

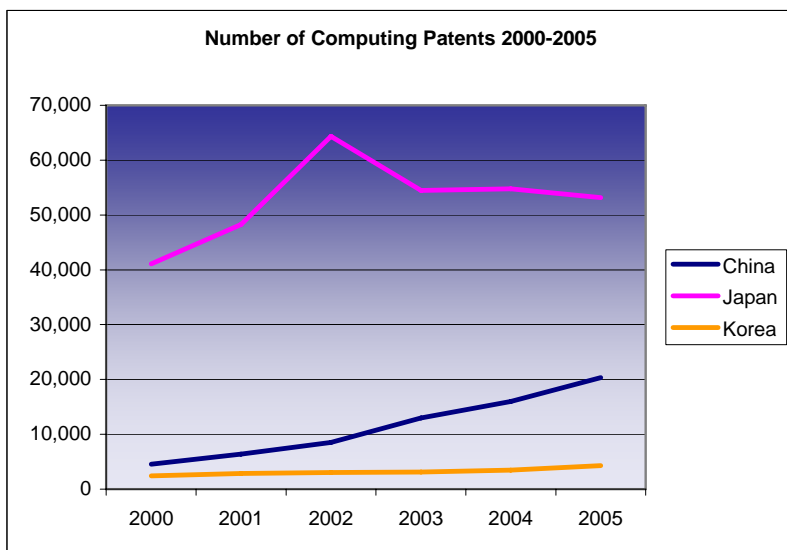
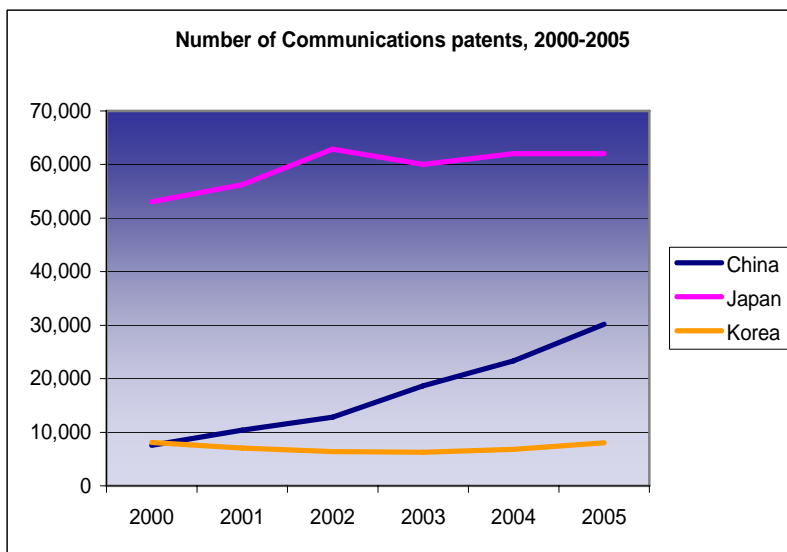


Figure 2: Comparison of communications patents from China, Japan and Korea 2000-2005



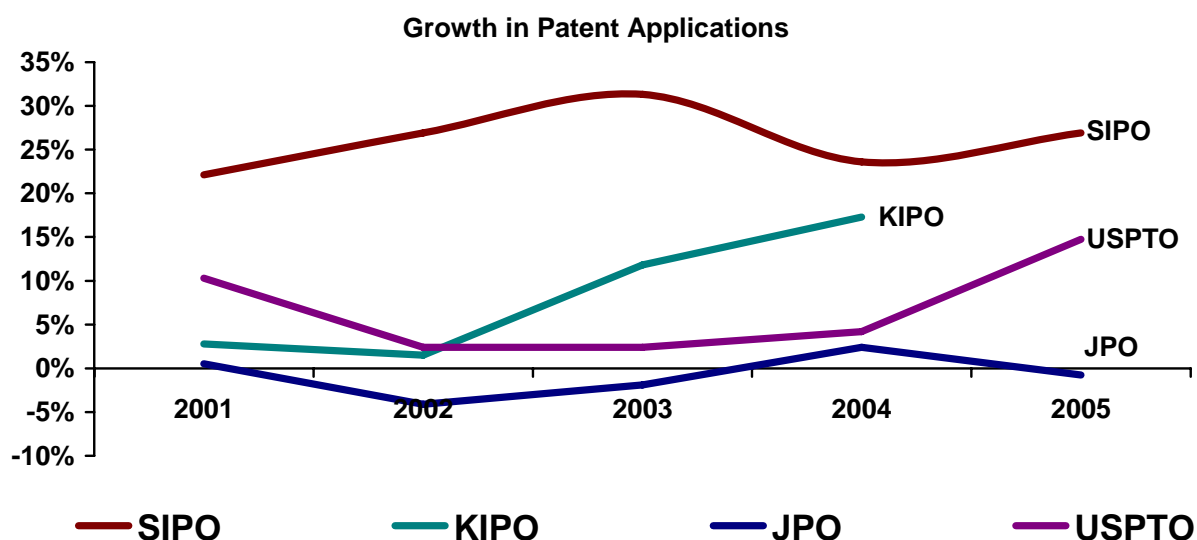
The second measure of the numbers of researchers involved in R&D shows equally dramatic growth. Researcher numbers involved in R&D grew 77 per cent to 926,000 during the period 1995 to 2004, putting China again second only behind the US with 1.3 million researchers².

The dry figures alone belie an astonishing change in China. In the words of Dirk Pilat, head of the OECD's Science and Technology Policy division, speaking in a press release, "The rapid rise of China in both money spent and researchers employed is stunning."

Turning to bibliometric measures, a straight count of the number of scientific articles and patents published are useful measures to gauge the overall growth in R&D activity,

From 1981 to 2005, there has been a 3,500 per cent increase in papers authored by Chinese residents indexed within *Web of Science*[®]. There has been a 29 per cent increase from 2004 to 2005 alone, to over 65,000 papers last year⁴. Similarly, the number of patents has grown consistently on average by 25 per cent each year for the last five years⁵.

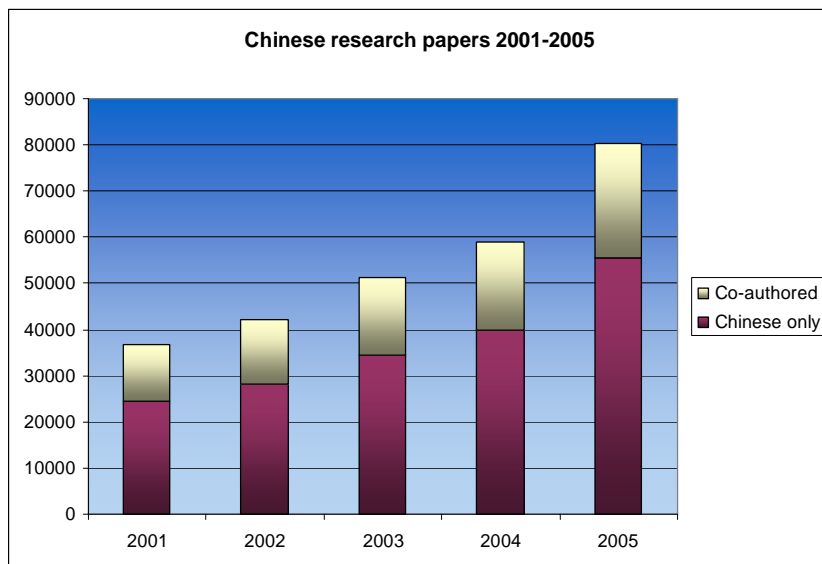
Figure 3: Growth in patent applications from China, Korea, Japan and USA 2001-2005



The red line at the top of figure three shows that the number of patent applications filed in China has been growing on average by 25 per cent each year. That is significantly higher growth compared to other major patent offices, especially patent offices in the United States and Japan, which have seen nearly flat or declining application filings in recent years.

A closer look at research papers published during the 2001-2005 with Chinese authorship shows the increase in collaborative research between China and the rest of the world⁴. The countries and regions which were the most popular collaboration partners for Chinese scientists can also be identified. The US tops the list with Japan and England following in #2 and #3 positions.

Figure 4: Chinese research papers published 2001-2005



Top co-authorship countries & Regions for 2005

Country	# of papers
USA	6940
JAPAN	2575
ENGLAND	1577
GERMANY	1536
CANADA	1294
AUSTRALIA	1144
FRANCE	960
TAIWAN	951
SINGAPORE	855
SOUTH KOREA	757

Closer analysis of patenting trends³ reveals to what extent global companies are investing in China as an R&D partner and to what extent Chinese enterprises are seeking to internationalize the results of their R&D efforts.

Figure 5: Domestic and foreign filed Chinese patent applications 2000-2004

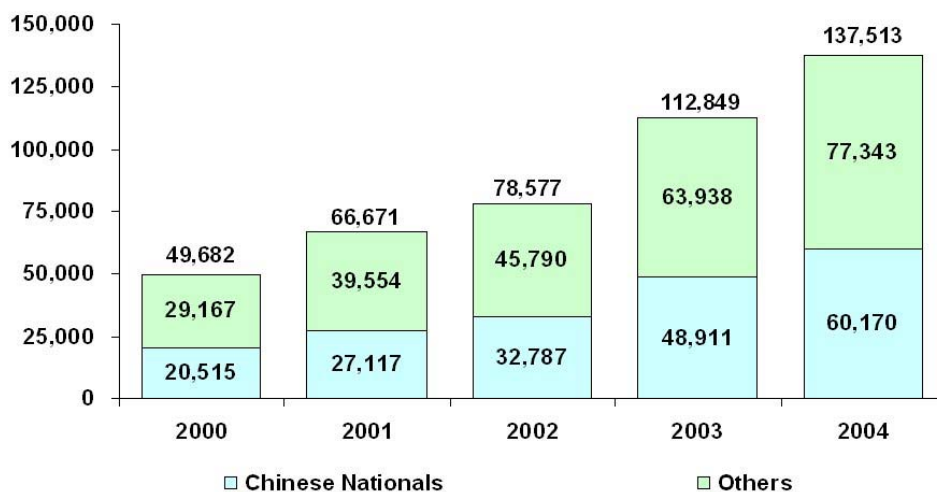


Figure 5 shows the split between domestic and foreign filings of patent applications published in China from 2000 to 2004: each bar shows the number of patent applications filed in thousands.

- The blue portion shows the number of applications by Chinese Nationals
- The green portion shows the number of applications by foreign applicants.

As we have already seen, the total number of Chinese applications has significantly increased. The number of Chinese filings by foreign multinationals has also increased, but the proportion has remained at nearly 60 per cent of total filings each year from 2000 to 2004. These applications by non-Chinese nationals and multinationals are intended to provide protection for their domestic inventions in China, and signal the intention to operate, manufacture and/or sell in China products arising from the innovation covered in the patents.

Globalizing R&D via China

In order to determine to what extent multinationals are globalizing their R&D activities by basing R&D facilities in China and/or collaborating with Chinese research institutes, we need to examine patent applications in China for these multinationals where the research actually originates from China. This can be determined by analyzing the 'priority country' for patent applications. The priority country is the country in which the patent application for an invention is first filed, and is in most cases the country where the research was conducted. In this way, we can see to what extent multinationals are globalizing their R&D and using the scientific and engineering expertise residing within China to conduct their research activities.

Figure 6: Major multi-nationals with R&D originating in China

Company	Industry	Total # of patents	# of inventions with CN priority	%ge of inventions with CN priority
Philips	Electrical engineering	42136	252	0.598%
IBM	Computers	66146	171	0.259%
Mitsubishi Electric	Electrical engineering	154008	242	0.157%
Siemens	Electrical engineering	89137	93	0.104%
Sandoz	Chemical/Pharmaceuticals	6861	4	0.058%
Pfizer	Chemical/Pharmaceuticals	5952	3	0.050%
Matsushita Electric	Consumer electronics	262895	128	0.049%
Hitachi	Electrical engineering	212136	101	0.048%
Sharp	Consumer electronics	66656	27	0.041%
BASF	Chemical/Pharmaceuticals	30548	12	0.039%

Philips heads the list of major multinationals with R&D originating in China, despite only a fraction (less than 1 per cent) of its inventions originating there. Of these, a number of patents are assigned to the Dongruan Digital Medical System Co Ltd, and some inventions are co-patented with the Philips China Investment Co Ltd.

It is clear therefore that Philips have established research links directly in China. Shenyang Dongruan Group Co., Ltd is a large software enterprise in China. They produce CT scanning, magnetic resonance, X-ray and colored Doppler imaging equipment.

Although the number of applications is still small, they represent a significant shift in the globalization of R&D in that they signal indigenous research facilities developed by foreign organizations on the ground in China.

Measuring collaboration

The other side of the coin is to look at collaboration between Chinese national and foreign organizations as measured by the number of inventions co-patented by Chinese and foreign entities. One of the leading research institutes in China is the Tsinghua University with over 3,700 patents to date, the majority of these published within the last five years. Of these, over 150 have been patented jointly with research partners including organizations in Taiwan and USA.

Figure 7: Tsinghua University inventions co-patented with research partners

58	HON HAI PRECISION IND CO LTD	Taiwan, China
40	HONGFUJIN PRECISION IND SHENZHEN CO LTD	China
24	CAPITAL BIOCHIP CO LTD	China
23	NUCTECH CO LTD	China
13	AVIVA BIOSCIENCES CORP	USA

Conclusions

We have seen that the dramatic increase in national R&D investment is raising global R&D presence and that, as measured by both scientific literature and patent output, China's research is becoming increasingly global. Major multi-nationals are increasingly protecting inventions by patenting in China; some are also filing some patents with priority in China indicating research originating from within China. Based on these trends, China is expected to play a growing role in the globalization of R&D.

References

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(Table showing growth of R&D spending within China 2000 – 2005)
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4. Thomson Scientific original research from *Web of Science*
5. National Patent Office Annual Reports