The growing role of Chinese innovation and the key UK policy challenges

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Over the last decade emerging economies have seen impressive growth in innovative activities. None has been more impressive than China. The trends have fuelled widespread concerns over Western economies' ability to maintain their dominance in knowledge creation and high skill employment. However, innovation is not a zero-sum game; the success of emerging economies need not be at the expense of the West. The key is for knowledge economies to continue to invest in skills and science such that they are in a position both to compete for and to engage collaboratively in tomorrow's breakthroughs.

Rapid growth in Chinese innovation

Statistics highlighting China's technological performance and the rapid growth in innovative activities abound. Over the last decade, there have been large increases in the number of Research and Development (R&D) centres in China (UNCTAD (2005)) and business expenditure on Research and Development (R&D) as a proportion of GDP has increased at an annual rate of almost 19% since 1995, see Figure 1.This increase has been partly driven by Western multinationals, which account for around 25-30% of private R&D expenditure in China, (OECD (2008b, p58)).

At the same time there has been a rapid increase in educational attainment (Li, Fraumeni, Liu and Wang (2009)). In particular, there has been a proliferation of Chinese graduates (Freeman, (2009), many of whom study subjects relevant for high tech research: in 2007 China toped the OECD ranking of the proportion of degrees which are in science and engineering (47%) (OECD (2010).

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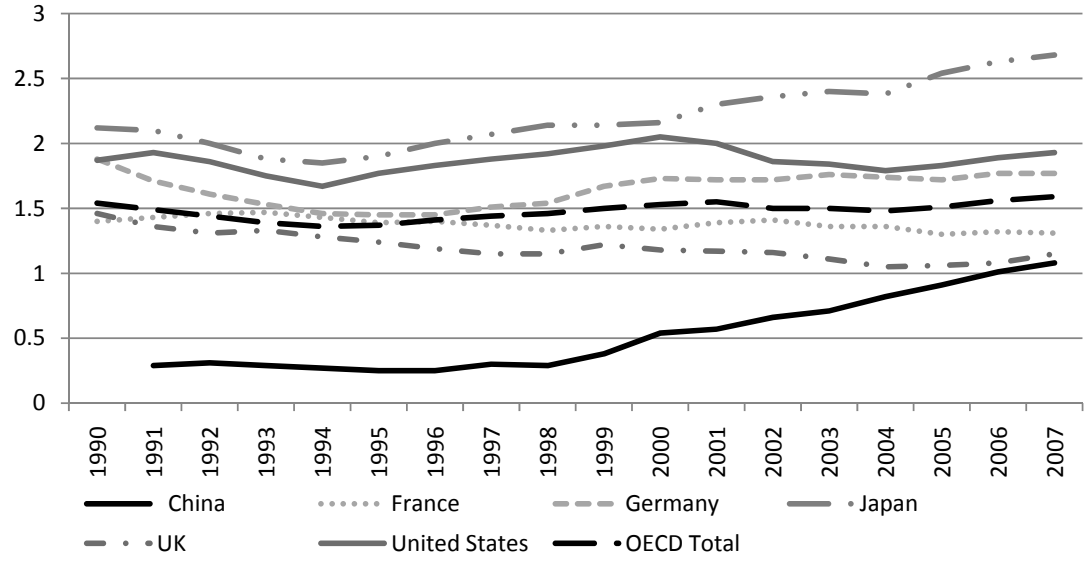
Figure 1: Business expenditure on R&D as a percentage of GDP



Source: MST Indictors, OECD 2009.

The investment in research and skills has been translated into equally impressive growth in innovative outputs. For example, in 2010 China was the fourth largest filer of patent applications to the World Intellectual Property Organization (WIPO (2010)) and under a naive (linear) projection of current trends could be the world's largest by 2015 (Griffith and Miller (2011)).

Operating at the technological frontier?

That China is now a significant presence in creating innovation is relatively uncontroversial. However, whether China is operating at, or even moving towards, the technological frontier is widely disputed. A large part of the academic literature has argued that investment and trade patterns show that China still lags behind the West in terms of technological sophistication, and that technology expenditure in China is still predominantly focused on the lower technology end of research and development (R&D) (Branstetter and Foley (2007), OECD (2008b), Puga and Trefler (2010), Thursby and Thursby (2006) and von Zedtwitz and Gassmann (2002)) In contrast, anecdotal evidence suggests that China is increasingly operating at the technological frontier and has been successful in attracting the cutting-edge research of foreign firms. Examples abound of companies establishing facilities in China to perform cutting-edge research (see Economist (2010)). For example, in 2007 GlaxoSmithkline opened a R&D centre in Shanghai, stating that the centre would contribute

to the firm's global discovery activities. Public perception in the West largely supports this view of China. For example, a recent survey in Newsweek showed that only 41% of Americans believed that the US is staying ahead of China in terms of innovation.[3]

In recent research we provide evidence that Chinese innovation is at least as technologically advanced as that in the West (Griffith and Miller (2011)). Specifically, we use information on patent applications filed at the European Patent Office, and find that the proportion of patent applications created by Chinese inventors that cite the scientific literature – which we use as an indication of an innovation that stems from more fundamental research that is close to the science base – is at least as high as the proportion which is created in the West. That is, Chinese inventors display the capacity to innovate alongside US and European inventors at the technology frontier.

European multinationals innovating in emerging economies

Part of the success of China and other emerging economies has been creating an attractive environment for investment by foreign firms. A 2010 survey of business leaders reported that China, Eastern Europe and India are perceived to be the most attractive regions for FDI over the next three years. At the same time "Western Europe's appeal as the most attractive destination for FDI collapsed from 68% of votes in 2006 to 38% in 2010" (Ernst & Young (2010)). *The World in 2025* highlights that Asia, in particular China and India, is set to become the main destination for the location of business R&D by 2025 (European Commission (2009)). The continuing investments in research capacity and improvements in institutions should work to support increased foreign investment.

We show an increase in Western European multinationals creating new knowledge using inventors located in emerging economies, especially China. While the amount of innovative activity conducted by Western firms in emerging economies is still relatively small, it has increased dramatically, driven by a handful of large multinational firms. This is supported other data sources (UNCTAD (2005)). Much of the knowledge created in emerging economies is destined for the European markets.

OECD (2008a) discusses the importance of multinational firms as drivers of global R&D and knowledge transfer, noting large increases in the share of global multinational R&D

[3] See the Newsweek-Intel Global innovation survey (http://www.newsweek.com/id/222979); an online survey of 4,800 adults in the US, China, Germany, and UK regarding views relating to innovation.

expenditure undertaken by foreign affiliates in developing countries (from 0.8% in 1996 to 6.2% in 2002) and concluding that, while developing economies still have a way to go to catch up with the West's knowledge base, "it is the outward flows of FDI by the multinational firms from developed economies which will facilitate, encourage, and enable this process" (OECD (2008a, p96)).

The Intellectual property regime in China is weak although improving (Strokova (2010)). One of the ways in which Western firms overcome this is by holding the intellectual property which results from Chinese innovation in Western firms' home countries (Zhao (2006)). Continuing improvements in China's Intellectual property regime are likely to be important for economic growth in general (Acemoglu et al (2005)), and to affect both the level of investment in intellectual property by foreign firms (Belderbos (2006)) and the type of innovations that are created (Javorcik (2004), Mansfield (1994), Branstetter, Fisman and Foley (2006)).

Chinese inventors often work alongside inventors from the firm's home country in creating patentable technologies. This is likely to aid the flow of knowledge across different parts of the firm (Singh (2005)). It has been suggested in the literature that Chinese inventors are more likely to work in teams that include inventors from other countries because this is a mechanism used to control for inferior expertise. For example, Branstetter and Foley (2007) report that nearly half of US patents with Chinese inventors involved international teams and suggest that this may be the result of "China's raw engineering talent...requiring additional input from skilled researchers in more advanced countries in order to generate true innovation."[4] However, we find no compelling evidence the Chinese inventors are more likely to be working on teams or with inventors from firms' home countries when they are involved in creating patentable technologies that are near science.

Concerns in the west

The growth in innovation in emerging economies (both by domestic firms and Western multinationals) has led to concerns in the West that China's progress may lead it to rival the West's positions as technological leaders, and potentially result in a loss of high skilled jobs. The European policy debate had focus heavily on the relatively low proportion of GDP that is

[4] For direct quote see http://www.voxeu.org/index.php?q=node/710

invested in R&D. The latest figures (2007) show that business expenditure on R&D in the EU-15 amounts to 1.2% of GDP compared with 1.9% in the US and 1.1% in China.[5] There has been a particular concern in the UK, where levels of business R&D intensity are low (1.15% in 2007) and have been declining. The Lisbon target to substantially increase R&D spending by 2010 will be missed by a large margin (see van Pottelsberghe (2008)). Concerns also stem from the much more rapid increase in investment by firms in emerging economies, and the surveyed opinion that Europe is becoming an increasingly less desirable location for R&D. (Ernst & Young (2010))

These concerns are not completely unfounded. Soete (2009), in work prepared for the European Commission, concluded that if the recent trends in R&D continue then "in 2025, the United States and Europe will have lost their scientific and technological supremacy for the benefit of Asia". Freeman (2006, 2009) outlines the potential for shifts in the global job market for science and engineering workers towards China to erode US dominance by diminishing the current comparative advantage in high tech production. Articulating many of the concerns in the West, he says that the increase in highly skilled graduates in China "threatens to undo the 'North-South' pattern of trade in which advanced countries dominate high tech while developing countries specialize in less skilled manufacturing". [6] Such concerns have been reported widely in the media.[7]

The concerns over Western economies' ability to maintain their dominance in knowledge creation and high skill employment are perhaps unsurprising. Innovation has been the engine of economic growth, and lies at the heart of increased living standards. However, there are many channels through which the West can benefit from technological advances in emerging economies.

Firms locating activity offshore, either to adapt products to local markets or gain access to specific skilled workers or localised technologies, potentially at lower cost, can lead to

[5] Source: MST Indicators (2009); Business Expenditure on R&D (BERD) as a proportion of GDP.
[6] Li, Whalley, Zhang and Zhao (2008) and Freeman (1995) also discuss the global implications of the increase in skills in China. There is also literature on the impact of low wage competition in production on the West, which finds mixed results. For example, Liu, and Trefler (2008) consider the impact of outsourcing to China on the U.S. labour market, finding only very small effects. Bloom, Draca and Van Reenen (2008) present evidence that Chinese import competition has reduced employment growth in European countries but has led to an increase in firms adopting information technology. Bernard, Jensen and Schott (2006) consider the impact of US manufacturing industries' exposure to low-wage country imports and find a negative association with plant survival and growth.
[7] For examples of media coverage see, "Nightmare Scenarios", The Economist, 5 October 2006 or "How to Keep Your Job Onshore" at Business Week, 20 August 2007.

standard gains from trade, both directly through improved performance and indirectly if knowledge is transmitted back to the home country.[8] Emerging economies also represent new markets for goods and services developed in Western European economies.

Of course, there are important benefits from having activity located in Western economies. Most directly, Western governments are justifiably keen to encourage high skilled employment. Countries also benefit from the creation of innovations indirectly in the form of spillovers – the knowledge which accrues to third parties. Such spillovers are often geographically concentrated because researchers that work in close proximity are more likely to interact and share tacit knowledge. However, there is evidence that knowledge flows across national borders (Iwasi and Odagiri (2004) and Singh (2006)) and that knowledge is less restricted by distance than was the case 20 years ago (Griffith, Lee and Van Reenen (2011)).

It is also the case that innovation is not zero sum game – that more research is being carried out in China does not imply that less will be undertaken in the West. Abramovsky, Griffith and Miller (2011) directly consider the impact of firms increasing offshore inventors on the number of inventors located in the home country and find no evidence of a negative effect. Indeed, it might be expected that there are more synergies in the creation of new technologies than new goods or services such that an increase in knowledge output in China compliments, rather than substitutes for, knowledge created in the West.

Lagging behind in Skills and Investment

The challenges for Western governments relate not to devising policies to deter investment in China or other emerging economies, but to ensuring that they make sufficient investments in their own economies such that they remain leaders in innovation. In large part this means ensuring that we have a high skilled workforce – that can engage, both competitively and collaboratively, in creating new knowledge and that is flexible enough to adjust to changing economic conditions – and that we invest sufficiently in science and research.

[8] This idea is similar to the argument that there are gains from increased trade in goods and manufacturing in a world with differentiated inputs, where different countries produce different inputs. See, for example, a recent article by Amiti and Konings (2007). See also, Griffith, Redding, and Van Reenen (2004).

In 2006, China's President, Hu Jintao, launched a plan to make China an innovation-oriented economy and leading science and technology power, proclaiming that "by the end of 2020… China will achieve more science and technological breakthroughs of great world influence, qualifying it to join the ranks of the world's most innovative countries".[9] In support of this ambition, the Chinese government has made unprecedented investments in research capacity and increased incentives for firms to invest in innovation. Notably, measures have included increased funding for science and higher education, national funds for, among other purposes, science and technology based start ups and basic research (via the National Science Foundation), R&D tax credits, investment in science and technology infrastructure and direct investment in research (See chapter 11 of OECD (2008b) for a comprehensive discussion).

Juxtapose this with recent policy moves in the UK, and in the West more generally, where austerity packages to reduce borrowing have commonly involved real cuts to the budgets for science, direct research funding and higher education. Even where science budgets have been relatively protected from spending cuts, as in the UK, investment as a proportion of national income is due to fall in coming years. Failing to invest sufficiently in science and skills can be short sighted. The impact of such spending occurs in the long run, in the form of higher productivity and economic growth. Being able to compete with China in 10 years time requires investment in skills and research today. This was recognised in 2009 by US President Obama's American Recovery and Reinvestment Act that increased in spending on science, stating, *"We'll provide new technology and new training for teachers so that students in Chicago and Boston can compete with kids in Beijing for the high-tech, high-wage jobs of the future."*

The current economic climate should not prevent investment in our capacity for economic growth in the future. The impact of China's rise will depend largely on whether we are with them at the technology frontier or onlookers from the sidelines. We should choose the former.

[9] The Chinese government's 2006 'Medium- and Long-term National Strategic Plan for Science and Technology Development' included a range of targets (including to increase R&D intensity to 2.5% by 2020) and policy measures. See Box 2.3, OECD (2010). See Wilsdon and Keeley, (2007) for quote (from a speech given 9 Jan 2006).

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