

UK Global Innovation

Engaging with new countries,
regions and people



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Foreword

This year's Olympics focused our attention once again on China. The stunning ceremonies and victories in Beijing reinforced a widespread acceptance among politicians and policymakers of the importance of trade and academic links with the world's most populous nation.

But there is a danger in the rush to embrace Chinese students and trade links that we ignore other rapidly growing economies – places like Brazil – and small but innovative new players like Estonia. Yet our own innovative capacity depends as much on building links with these new kids on the block as with China and India.

In this report, we learn a lot about the extent of innovation in China, India, Estonia, Brazil and South Africa. We see their strengths and weaknesses. But we also show where there are real opportunities for the UK, and for its regions and nations.

The UK has one great advantage in this respect: the diversity of its population. International students and migrants are not only a source of income, ideas and skills, they are also potentially an invaluable way in which communities and small businesses can develop trade relationships in new markets.

But this is not an area where we can afford to stand still. The more global players there are, the tougher it is for the UK to benefit from its links with emerging economies and the more important it is that we work together to sell the UK as a good place to do business, to partner for research or to come to study.

If we get it right, this can be a win-win situation. Emerging economies can benefit from access to world class universities and research, as well as inward investment. The UK can access new sources of innovation and inventiveness, as well as new markets. To do so, we must make the fullest use of all the resources at our disposal.

Jonathan Kestenbaum
CEO, NESTA

October, 2008

NESTA is the National Endowment for Science, Technology and the Arts.

Our aim is to transform the UK's capacity for innovation. We invest in early-stage companies, inform innovation policy and encourage a culture that helps innovation to flourish.

Executive summary

The UK is a highly internationalised country. A long legacy of international engagement has developed a tradition of dealing with foreign countries and peoples. This is reflected in the global reach of some well-established UK organisations such as the British Council, the BBC World Service, the Royal Society, the Wellcome Trust and the Commonwealth. The UK is also a successful magnet for foreign direct investments, especially in R&D, and is regarded as one of the world's favourite destinations by big international players.¹

But the nature of international relations is changing. And this reflects the interplay of three main drivers: international diaspora (migration), ICT, and the entrance of new countries to the global knowledge economy. Together, they are creating a new form of globalisation, described by some as 'globalisation from below', which is based on the interactions of people and small organisations across borders,² cultures and distance. This new form of globalisation gives a bigger clout to the 'soft power' of small players in global relations.³ The 'soft power' of countries interplays with traditional 'hard power' (e.g. diplomacy, military, economic weight, etc.) to leverage greater influence. For example, both the Chinese and Indian diaspora add to the growing power of the Chinese and Indian economies' role in the world.

Through its cultural diversity, linguistic coincidence (English as a global lingua franca), migrant population, foreign students, international academics, and high level of ICT and transport connectivity, the UK is well placed to benefit from the rise of 'globalisation from below', particularly in the area of innovation. Other countries including Australia, Brazil, Canada, Israel, South Korea, Taiwan and the US have shown how diasporas', immigrants' and foreign students' social networks can extend a country's business and economic relations. By learning from their

experiences, the UK can benefit from this form of globalisation too.

Internally, globalisation remains concentrated in London and the South East; they are also the main routes through which other UK regions and nations link to globalisation.⁴ This South Eastern dominance is often attributed to the lack of multinationals, big universities or highly skilled immigrant communities outside the capital.

But this might be changing with the spread of in-migration, ICT, and universities across the country. People and businesses are increasingly leaving cities for rural areas, using ICT to create new ventures and to conduct business.⁵ ICT, foreign students and migration are also providing cities outside London and the South East with a greater opportunity to connect more directly with the rest of the world. UK government and Regional Development Agencies should see these changes as potential catalysts for the redistribution of global benefits, especially in their impact on the ability of regions to innovate.

Externally, UK global relations remain largely defined by the strength of existing legacies, but there are growing signs of change. The growth of investment in and from China, the expansion of trade with countries outside the Triad, and the growing role of the new EU Member States in European innovation reflect this change. UK government will need to develop a better understanding of the underlying currents of 'soft power' and 'globalisation from below' and how they are impacting on UK relations with the rest of the world, potentially re-drawing the old map of traditional UK relations. The UK government, devolved administrations and Regional Development Agencies will also need to recognise the opportunities arising from emerging innovation hotspots beyond China and India and in emerging regions within these countries.

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Part 1: Introduction

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Globalisation is one of the great issues of our age. For some, it is the source of economic prosperity and cultural enlightenment. For others, it is a threat to existing jobs and a source of external cultural imperialism. For these reasons, it is critical to understand not only its nature, but how it is changing.

And an important feature of that change is the way that different places are becoming more innovative and outward-looking in order to benefit from globalisation. Emerging economies from China to Brazil are inventing more, investing more in research and increasing their international trade. The flow of students and workers from country to country is growing, and with it the exchange of knowledge and ideas. Within the UK, regions are yet to challenge London's monopoly as the centre of everything global.

What is globalisation?

Globalisation means different things to different people. The OECD defines it as a dynamic and multidimensional process whereby national economies across the globe become 'increasingly interdependent'.⁶ Others define it as "a set of processes expressed in transcontinental or interregional flows and networks of activity, interaction and power".⁷

'Globalisation' lacks precise definition as it can take different forms – cultural, physical and virtual.⁸ It can also manifest itself politically, culturally and economically. For example, KOF, a research institute at the Swiss Federal Institute of Technology in Zurich, ranks the UK fifth in political globalisation, but seventh in social globalisation and 27th in economic globalisation.⁹

Political and cultural forms of globalisation are often seen as forces of hegemony and cooperation,¹⁰ while economic globalisation is perceived as both a force of integration¹¹ and a force of disintegration within and between countries.¹² In places where globalisation has helped reduce the prosperity gap between regions and countries, it has been hailed as an integrating force;¹³ but where this gap has widened, it has been regarded as a disintegrating force.

This is an issue that remains fiercely debated between supporters and opponents of globalisation. While those who favour globalisation emphasise the positive impacts of external openness on the performance of economies,¹⁴ opponents highlight the negative impact of globalisation on internal economic sectors that lose out in the process.¹⁵

In this paper we argue firstly that globalisation is increasingly driven by 'grass-roots' and 'bottom-up' coalitions and networks (and less by governments and large corporations); secondly, that different places benefit and lose out from globalisation in accordance with their 'absorptive capacities'; and finally, that new entrants to the world economy are changing the geography of globalisation.

1.1 A new wave of globalisation

Since the Industrial Revolution, there have been many waves of globalisation triggered largely by falling transport costs and a progressive liberalisation of trade and capital flows.¹⁶ In the 1980s, however, globalisation came into its own with several developing

countries breaking into global markets by playing host to 'Western' multinationals.¹⁷

By the late 1990s, the world was already beginning to witness the genesis of a new wave of globalisation conducted by small and big players alike.¹⁸ The rapid rise of information and communication technologies (ICT) – particularly the Internet, mobile telephone networks and commercial satellite communication systems – has added a new dimension: the ability to 'move' goods and ideas without leaving one's home or office.

Immobile communities have acquired the ability to conduct international business without having to travel, while disconnected scattered communities around the globe can re-connect and share information and experience in so-called 'virtual spaces'. This ICT-powered globalisation has created a new wave of globalisation, one that extends beyond the global flows of people, finance and goods,¹⁹ to include:

- The rise of transnational ethnic communities facilitated by ICT.²⁰
- The creation of global virtual communities (e.g. Wikis, Facebook, Second Life, open source communities).²¹ The emergence of dense transnational social networks that bind places together creating so-called 'global enclaves',²² such as the strong and dense linkages between places like Bangalore and Silicon Valley in IT²³ or London and New York in finance.²⁴
- The globalisation of careers²⁵ and skills markets (with off-shoring and outsourcing).²⁶
- The active and fast-growing participation of new countries and firms from the developing world in the global economy.

While there were older versions of such trans-territorial communities, they existed only at a limited scale. For instance, at the beginning of the 20th century there were around 37 intergovernmental organisations (IGOs); by its close, their number was approaching 300. Likewise, in 1909 there were 371 officially recognised international non-governmental organisations (such as the International Chamber of Commerce, International Trades Unions, or the Rainforest Foundation); by 2000 there were around 25,000.²⁷

1.2 Globalisation is a transformative force

The current wave of globalisation is progressively transforming the international balance of economic power. It is drawing on connections of people and groups, including those within intergovernmental organisations, non-governmental organisations (NGOs) and multinational corporations.

Connections between communities of shared interest across countries and territories are bringing distant places closer; yet, they are also paradoxically creating greater distances between places close to each other.²⁸ They are forging new connections between countries and within them, with places that are better integrated into global flows reaping significant rewards, whilst the rest struggle on its margins.²⁹

The active and growing participation of new entrants from developing countries in the world economy is another significant driver of this new globalisation. Some commentators have predicted that within 40 years, Brazil, Russia, India and China together could have larger economies than the UK, Germany, Italy, France, Japan and the USA combined.³⁰ China is now the third most popular research and development (R&D) destination in the world (after the US and the UK) with India sixth and Singapore ninth.³¹ Furthermore, multinational enterprises are no longer the preserve of the developed world; they are emerging from developing countries³² too with China's Lenovo groups and Huawei Technologies, India's Infosys, and Turkey's Koç and Doğuş business groups all seen as global players.

Different communities living side by side can have very different experiences. For instance, while most developing countries rank low on various globalisation indices, their cities often score highly, as with cities in Mexico, Brazil, and South Africa. Sectors of low globalisation share the same space with highly globalised sectors:³³ slums and high-rise glass and steel modern office buildings can co-exist in close vicinity of each other, as in Mumbai and Bangalore. This is not just a developing world phenomenon: in London, the workers in Tower Hamlets and those in the nearby City of London financial district exist close to each other but experience the impact of globalisation in different ways. Deprivation and wealth rub shoulders without mixing.

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1.3 Summary

Nations, regions and cities are becoming increasingly linked and interdependent, leading to some important changes in the way innovation happens across the globe.

Traditionally, governments and large corporations have played a major role in driving globalisation. However, this is changing rapidly. Smaller players such as transnational communities and smaller businesses are now becoming active actors in the globalisation process. Their involvement forges new connections between countries and within them, thereby bringing distant places closer and making close places more distant from each other. The nature of globalisation is also changing with the emergence of new economic players from the developing countries; some of their cities and regions have become dynamic innovation hotspots. All this opens new channels of global interaction and is nurturing the development of global flows of talents, capital and ideas.

This means that across the globe, the ability of places to innovate depends not only on their ability to become an integral part of these global flows, but also to identify, exploit, and absorb external knowledge. Those places that succeed in developing outward-looking networks and absorbing external knowledge reap significant rewards from it, while other places become ever more marginalised.

Part 2: The internal and external shapers of globalisation

Internal and external factors combine to shape the spatial distribution of economic flows under globalisation.³⁴ For example, a local economy has to achieve a certain level of internal capability before it can take advantage of economic globalisation. Recent research comparing the performance of 62 world economies found that sound performance in indigenous factors, such as culture, education and human capital, were crucial to reaping the benefit.³⁵

External factors help shape the way globalisation manifests itself locally, too. The extent to which other countries experience increased economic openness, rapid technological changes or changing socio-economic and political conditions can significantly impact on the performance of local economies.³⁶ The needs and opportunities of international partners change and evolve accordingly, and new competitors emerge. This often requires local players to adapt to the changing international scene, and to continuously manage, maintain and create new international relations.³⁷

The more connected a place is, the better able it is to attract global flows; and the greater its absorptive capacity,³⁸ the greater its ability

to reap the benefits at home. Consequently, places benefit or lose from globalisation in accordance with their 'internal capacities' ('absorptive capacity' and 'connectivity'), as well as their ability to adapt to and manage external changes. Table 1 summarises these shapers.

2.1 Internal shapers of globalisation

Absorptive capacity

"Absorptive capacity is the ability necessary for the host country to absorb and adopt new incoming technology from a foreign country."³⁹ More broadly, it is the ability of one place to absorb and adopt knowledge incoming from another place.

Some places are better able to absorb ideas, attract talent and create opportunities than others.⁴⁰ The Golden Horseshoe region in Ontario (Canada), Silicon Valley (US), Thames Valley (UK), Bangalore (India), Greater Shanghai (China) and San Paolo (Brazil) are good examples. These places are magnets for talent, investments and knowledge; they are also examples to others seeking to learn how they do it.

Table 1: Internal and external shapers of globalisation

Internal capacities	External change
Absorptive capacity	New opportunity
Connectivity	Legacy opportunity

34. Kui-Wai Li, Pang, I. and Ng, M. (2007) 'Can Performance of Indigenous Factors Influence Growth and Globalisation?' CSGR Working Paper No. 215/07.
35. Ibid.
36. OECD (2007) 'Globalisation and Regional Economies – OECD Review of Regional Innovation.' Paris: OECD.
37. Weiss, C. (2005) Science, technology and international relations. 'Technology in Society.' Volume 27, Issue 3, pp.295-313.
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National studies have focused on how several countries in North East Asia (Japan and South Korea) and South East Asia (Taiwan, Singapore, and parts of Mainland China) have caught up technologically and economically with Western Europe and North America.⁴¹ Their absorptive capacity has allowed them to benefit from their participation in global economic activities, such as trade, foreign investment and migration.⁴² Some say the ability of such countries to catch up technologically reflected their "balanced ability for innovation and imitation" and "the extent to which [they] are equipped with the necessary capabilities" to innovate and imitate.⁴³ Many developing countries already recognise the critical importance of 'absorptive capacity' that is embedded in local institutions and specialists who are able to identify, adapt, and effectively use the scientific and technological achievements of other countries to develop their own unique solutions and meet their needs.⁴⁴

Within regions, "the concentration of assets such as universities, technical research facilities and knowledge centres increases their [places'] relative accessibility of knowledge".⁴⁵ Local culture (for example a collaborative and open one) can also determine the speed and effectiveness of learning and knowledge transfer within a country or a region.⁴⁶ Places with minimal economic and knowledge disparities can benefit from globalisation more quickly.

The variable capacity of places to attract talent, knowledge and investment has been an

important issue of investigation for regional economists, economic geographers and policymakers. Their work has led to concepts, such as 'innovative environments',⁴⁷ 'learning regions'⁴⁸ and 'localised learning',⁴⁹ designed to reflect the ability of places to engage and learn in a globalised world. Recently, Finnish researchers have attributed the gap between Finland's strong innovation performance and its weaker economic performance to a weaker absorptive capacity in the less knowledge-intensive sectors of the Finnish economy.⁵⁰ They argued that an innovation system requires both the generation and diffusion of knowledge, and its application and exploitation; the effectiveness in any country depends on how good it is at applying and exploiting its innovations.⁵¹

Connectivity

Global flows of people, money, goods and ideas are channelled between places through different networks: physical networks, such as fibre optic cables or airports; organisational networks like multinational firms; and social and business networks, including inter-firm and interpersonal relationships. The rapid expansion of such networks has led to the emergence of specialist global circuits of economic activities as well as a global hierarchy of places on such networks.⁵² Indeed, some have argued that the contemporary world economy is dominated by a network of relatively few cities, leaving most other places peripheral.⁵³

These networks do not emerge or take shape randomly, but reflect external and internal

Box 1: The concept of 'absorptive capacity'

The concept of 'absorptive capacity' was first coined by Cohen and Levinthal (1990)⁵⁴ in reference to a firm's ability to identify, assimilate and exploit knowledge from external sources. It encompasses three different processes: (1) search; (2) assimilation of what is found; and (3) its commercial application. Hence, it refers not only to 'absorption' in the received meaning of the term, but also to the ability to exploit and create knowledge more generally. Zahra and George (2002)⁵⁵ added two further dimensions: potential absorptive capacity (important in acquiring and assimilating

external knowledge) and realised absorptive capacity (referring to the functions of transformation and exploitation of the gathered knowledge).

Absorptive capacity at the spatial level has been defined and measured in various ways, including being equated with human capital, research and development, financial institutions and as governance institutions. Increasingly, however, composite indicators combining several proxies have been created to measure absorptive capacity at the regional level,⁵⁶ drawing largely on investment in R&D and the availability of human resources.

forces. For example, in order to participate successfully in international strategic alliances, small firms must have strong internal innovation capabilities. Local firms sometimes form alliances and partnerships with foreign firms to gain access to otherwise inaccessible technical and market knowledge.⁵⁷ Such cross-national alliances help transfer knowledge from the global to the local.⁵⁸ But the extent to which local firms benefit depends on their ability to identify, interact, assimilate and exploit new sources of knowledge – in other words, their absorptive capacity.⁵⁹

Traditional global flows such as trade and foreign investment remain important channels of knowledge flows and transfer, too. However, the extent to which they help spread knowledge depends on the size of the ‘knowledge gap’ between the places involved, and on their ability to absorb new ideas.⁶⁰ The ‘knowledge gap’ may indicate the directions in which learning is flowing; but that knowledge can only be realised when firms or places have sufficient absorptive capacity.⁶¹ Local players need to be involved in activities that demand and value the sort of knowledge made available through such global flows in order to appreciate them.

Migration also supports the absorptive capacity of places. By adding to their stock of human capital, migrants can increase the ability of places to innovate;⁶² they might also benefit other sectors and regions of the host economy.⁶³ Moreover, the migration of highly skilled talented people is an important channel of international knowledge transfer and dissemination,⁶⁴ particularly of tacit knowledge.⁶⁵ Capturing and utilising the knowledge of migrants is not a straightforward process,⁶⁶ as labour migration is largely driven by demand for skills and talent. This demand changes frequently and varies across regions.⁶⁷ Migratory flows therefore follow certain geographic patterns. Skilled migrants tend to live around major urban centres, while unskilled migrants often move to rural areas.⁶⁸ As a result, access to the benefits of migrant talent is not equal.⁶⁹

Finally, transnational social networks such as ethnic diaspora communities, professional communities of practice and virtual global networks help to shape the local globalisation experience. Alejandro Portes, who coined the term ‘globalisation from below’, argued that: “they are no different from the large global corporations, except that these enterprises emerge at the grassroots level and its activities

are often informal”.⁷⁰ Immigrants groups use ICT to link with their countrymen around the world,⁷¹ communities of practice function as global knowledge development and transfer networks⁷² (e.g. Java developers, or the UNDP Global Communities of Practice⁷³), while many virtual-based communities have arisen as networks of communication, enculturation, knowledge exchange and trade (e.g. Second Life and Facebook). Such forms of globalisation are driven by networks of ‘cognitive communities’ formed on the basis of shared interests around practice, knowledge or ethnicity.⁷⁴

2.2 External shapers of globalisation

Legacy opportunities

UK globalisation, while increasingly expanding into new regions and countries, remains largely concentrated within traditional relationships, particularly within the trade Triad – a reference to the United States, the European Union and Japan.⁷⁵ Countries enjoy historic relationships that reflect their history and geography. The UK’s relationship with North America and the Indian sub-continent has been shaped by historical events such as colonialism and the Empire;⁷⁶ UK companies maintained close relationships with former British colonies after independence.⁷⁷ Culturally, organisations like the Commonwealth, the British Council and the BBC have sought to capitalise on these legacies. The UK’s relationship with Europe is shaped both by history and the power of geography. Such legacies may offer unique opportunities to develop special and strong relationships between some countries as with the UK and India or the UK and the US. Similarly, European Commission science and technology collaboration programmes are also largely affected by historical legacies (for example, collaboration with Spanish and Portuguese-speaking Latin America) and geography (for example, collaboration with the Southern Mediterranean countries).

New opportunities

The situation may be changing fast. While history and legacy still shape many official relationships between countries and places, forces of ‘globalisation from below’⁷⁸ are changing the trajectories of international relations and the globalisation map. These global relationships are conducted by individuals, non-governmental organisations and businesses. The power of such informal globalisation was documented by AnnaLee Saxenian in her study of the economic and

55. Zahra, A. Z. and George, G. (2002) Absorptive Capacity: A Review, Reconceptualization, and Extension. *Academy of Management Review*, Volume 27, Number 2, pp.185-203.
56. Kinoshita, Y. and Chia-Hui Lu (2006) ‘On the Role of Absorptive Capacity: FDI Matters to Growth.’ William Davidson Institute Working Paper Number 845. Ann Arbor: William Davidson Institute, University of Michigan.
57. Ratten, V. (2005) ‘How Firms Learn through Alliance and Acquisition Experience.’ Presented at Australian and New Zealand International Business Academy Conference, Melbourne, Australia.
58. Levinson, N. S. and Asahi, M. (1995) Cross-national alliances and interorganizational learning. *Organizational Dynamics*, Volume 24, Number 2, pp.50-63.
59. Dunning, J. (2000) *Regions, Globalization, and the Knowledge-Based Economy*. Oxford: Oxford University Press.
60. Kinoshita, Y. and Chia-Hui Lu (2006) ‘On the Role of Absorptive Capacity: FDI Matters to Growth.’ William Davidson Institute Working Paper Number 845. Ann Arbor: William Davidson Institute, University of Michigan.
61. Girma, S. (2005) Absorptive Capacity and Productivity Spillovers from FDI: A Threshold Regression Analysis. *Oxford Bulletin of Economics and Statistics*, 67 (3), pp.281-306.
62. Lucas, R.E. (1988) On the mechanics of economic development. *Journal of Monetary Economics*, 22, pp.3-42. Also see Romer, P.M. (1990b) ‘Human capital and growth: theory and evidence.’ *Carnegie-Rochester Conference Series on Public Policy*, 32, pp.251-286.
63. Straubhaar, T. (2000) ‘The International Mobility of the Highly Skilled: Brain Drain, Brain Gain, or Brain Exchange.’ *HWWA Discussion Paper 88*. Hamburg: Hamburg Institute for International Economics.
64. OECD (2007) *Globalisation and Regional Economies – OECD Review of Regional Innovation*. Paris: OECD.
65. The knowledge that people carry around with them, which is otherwise difficult to access.
66. Kale, D., Wiold, D. and Chataway, J. (2006) ‘Diffusion of knowledge through migration of scientific labour in India.’ *IKD Working Paper Number 17*. Accessed at: http://www.open.ac.uk/ikd/workingpapers/workingpaper_17.pdf on March 8th, 2008.

67. Mahroum, S. (1999) Highly Skilled Globetrotters. In: OECD (Ed.) 'Mobilising Human Resources for Innovation.' Proceedings of the OECD Workshop on Science and Technology Labour Markets. Paris: OECD.
68. Williams, A., Balá, V. and Wallace, C. (2004) International Labour Mobility and Uneven Regional Development in Europe Human Capital, Knowledge and Entrepreneurship. 'European Urban and Regional Studies.' 11(1), pp.27-46.
69. Martin, P. (2003) 'Highly Skilled Labor Migration: Sharing the Benefits.' Geneva: International Institute for Labour Studies.
70. Portes, A. (1998) 'Globalisation from Below: The Rise of Transnational Communities.' Working Paper 98-01. Accessed at: http://www.transcomm.ox.ac.uk/working_papers.htm.
71. Mahroum, S. (2006) Transnational Knowledge Through Diaspora Networks. 'IJMS.' Volume 8, Number 1.
72. As defined by Wenger and Snyder (2000): "A group of people who are informally bound together by shared expertise and passion for a joint enterprise." Wenger E. and Snyder, W. M. (2000) Communities of Practice: The Organizational Frontier. 'Harvard Business Review.' pp.139-145.
73. Accessed at: <http://www.undp.org/knowledge/cops.htm>
74. Accessed at: <http://www.undp.org/knowledge/cops.htm>
75. Wenger, E., McDermott, R. and Snyder, W. M. (2002) 'Cultivating Communities of Practice.' Cambridge, MA: Harvard Business School Press.
76. Rugman, A. and Collinson, S. (2005) 'Multinational Enterprises in the New Europe: Are They Really Global?' Working Paper. Bloomington: Kelly School of Business, Indiana University.
77. Rt. Hon. Alistair Darling MP, Former Secretary of State for Trade and Industry (2006) Speech to the First Annual UK/India Investment Summit, Lancaster House, London, 10 October 2006. Accessed at: <http://www.dti.gov.uk/pressroom/Speeches/page34077.html>
78. Brian, A. and Blanton, R. G. (2002) Colonial style and colonial legacies: Trade patterns in British and French Africa. 'Journal of Third World Studies.' Accessed at: http://findarticles.com/p/articles/mi_qa3821/is_200210/ai_n9134671/pg_9

knowledge links between California and Asia created by Asian immigrants and students.⁷⁹ From remittances to transnational knowledge networks, ethnic, nationality or professional networks transcend physical geography to transfer money and knowledge around the world.⁸⁰ Such globalisation is creating new opportunities across these networks.

Some governments have started this. They have taken steps to formalise such networks by creating formal governance structures around them. For example, the Korean Government subsidises and supports professional associations of Korean scientists in Canada, China, Europe, Japan and the United States; likewise the Nigerian government set up the 'Nigerians In Diaspora Organization' (NIDO), with links to various countries in Europe and the United States, and the South African Government has given support to the South African Network of Skills Abroad (SANSA).⁸¹ In Europe, too, countries like Austria and Switzerland created formal agencies (ASCINA and Swiss Talent) to organise and leverage growing national-global links developed by their nationals abroad.⁸²

2.3 Summary

Innovation is not evenly distributed across the globe. Not every city or country has the ability to compete in the global economy and draw on globalisation to become more innovative. A place's ability to innovate depends on both external and internal factors. Internally, its capacity to develop its own innovations depends on the capacity of its businesses and people to identify, exploit, and absorb knowledge. This is also critical to its ability to connect with other places.

External factors also have a major impact. Historical and institutional networks originally set up by governments – particularly involving the trade Triad – can provide unique opportunities to develop strong relationships between countries. However, non-official actors such as individuals, NGOs, and businesses are playing an increasingly active role in the setting up of global networks, thereby providing new windows of opportunities for absorbing external knowledge.

Part 3: How globalised is the UK?

The UK economy has a long tradition of openness towards the world. It embraces free trade in goods and services and is the world's second largest exporter of services and the eighth largest exporter of goods.⁸³ The UK is also the world's fourth most attractive destination for foreign investors after China, India and the US.⁸⁴ Oxford Economics calculated that more Fortune 500 companies have their headquarters in London than any other city, with almost a third of all foreign exchange transactions undertaken there.⁸⁵ According to a study by the Danish research unit, FORA,⁸⁶ the UK ranks third in 'Global Market Conduct', a concept based on three main indicators: the assessment of global company strategy; the share of exporting companies among newly-established

companies; and cross-border mergers and acquisitions.

Table 2 shows that only Switzerland and Sweden are stronger than the UK in the Global Conduct League, placing the UK ahead of all other G8 economies. However, a foreign policy globalisation table compiled by the consultancy AT Kearney placed the UK 12th on the basis of four key components of global integration: trade and investment flows; movement of people across borders; volume of international telephone calls and Internet usage; and participation in international organisations.⁸⁷ While various indices provide varying rankings for the UK, they tend to agree that the UK is among the most globalised countries in the world and that it outstrips any other major economy in Europe in this respect.

Table 2: Index for global market conduct

Country	Rank	Country	Rank	Country	Rank
Switzerland	1	New Zealand	10	Hungary	19
Sweden	2	Belgium	11	Italy	20
UK	3	France	12	Czech Republic	21
Finland	4	Australia	13	Portugal	22
Germany	5	Canada	14	Poland	23
United States	6	Ireland	15	Mexico	24
Netherlands	7	Austria	16	Turkey	25
Japan	8	Norway	17	Greece	26
Denmark	9	Spain	18	Korea	27

Source: FORA, 2005

79. Portes, A. (1997) 'Globalisation from Below: The Rise of Transnational Communities.' Princeton: Princeton University Press.
80. Saxenian, A-L. (2006) 'The New Argonauts: Regional Advantage in a Global Economy.' Cambridge, MA: Harvard University Press.
81. Poros, M. (2001) 'The role of migrant networks in linking local labor markets: The case of Asian Indian migration to New York and London.' 'Global Networks.' 1(3), pp.243-59.
82. Mahroum, S., Eldridge, C. and Daar, A. (2006) 'Diaspora Options: How Developing Countries Could Benefit from their Emigrant Populations.' 'International Journal on Multicultural Societies.' Volume 8, Number 1, pp.25-42.
83. 2004 figures from Russo-British Chamber of Commerce website. Accessed at: http://www.rbcc.com/about/uk_info.html and World Trade Organization, 2005
84. AT Kearney (2005) 'FDI confidence index.' Volume 8. Accessed at: http://www.atkearney.com/shared_res/pdf/FDICI_2005.pdf
85. Oxford Economic Forecasting (November 2006) 'London's place in the UK economy, 2006/07.' Accessed at: http://213.86.34.248/NR/rdonlyres/FDE5A744-1E6B-4C0E-9569-EAE36325737B/0/BC_RS_LKPUK0607_ExecSumm.pdf
86. FORA (2005) 'Dutch Capacity for Productivity Growth: From Benchmarking to Policy Priorities.' Copenhagen: FORA.
87. 'Foreign Policy.' Accessed at: http://www.foreignpolicy.com/story/cms.php?story_id=4030

The UK is at the crossroads of global flows of people. The UK is gaining and losing highly-skilled workers through immigration and emigration.

Thirty-eight per cent of the foreign-born labour force is classified as highly skilled by the Office of National Statistics (ONS).⁸⁸ That proportion is even higher in newly arrived immigrants, where over half (52.1 per cent) are classified as professional and managerial.⁸⁹ The UK labour market has a higher share of foreign-born highly skilled persons (around 18.8 per cent of its highly skilled population), than most of its European Union neighbours including France (14.1 per cent) and Germany (4.4 per cent).⁹⁰ The UK boasts a larger share of highly skilled migrants from outside the OECD (11.1 per cent)⁹¹ than most other EU countries.

But the UK also has the highest share of its highly skilled nationals residing abroad (18.9 per cent of total highly skilled population) of all OECD countries. This mirrors a greater and a longer-term trend for the UK: a recent study by the Institute for Public Policy Research (IPPR) has shown that between 1966 and 2005, the UK experienced a total net loss of some 2.7 million UK nationals.⁹²

The UK private sector knowledge base is highly internationalised, too. About 40 per cent of manufacturing expenditure on R&D is carried out by foreign-controlled affiliates.⁹³ Furthermore, a very high share of the UK's business R&D is financed from abroad – around 27 per cent, compared with 2 per cent in Germany and 10 per cent in

France.⁹⁴ This largely reflects the prominence of multinationals in the UK economy; they help the UK compensate for the relatively low R&D expenditure of indigenous businesses.⁹⁵ Nevertheless, this high foreign investment in UK R&D also reflects the quality of the UK knowledge base. The UK also has the OECD's highest share of foreign ownership of domestic inventions (38 per cent compared to 13.9 per cent in Germany and 23.4 per cent in France), while 19 per cent of patents owned domestically were made overseas.⁹⁶ Thus, the level of investment in 'exchanged' knowledge is quite high.

The FORA study ranks UK tenth in the OECD for global knowledge sharing in 2005.⁹⁷ The latter is based on a set of eight indicators including:

- Growth in foreign R&D.
- Scientific articles with foreign co-authors.
- Scientific articles cited in US-issued patents.
- Import of disembodied technology and know-how.
- National ownership of foreign innovations.
- Share of foreign workers in the work force.
- Students enrolled in other OECD countries.
- Share of students from other OECD countries.

Table 3: Index for global knowledge sharing

Country	Rank	Country	Rank	Country	Rank
Ireland	1	UK	10	Turkey	19
Switzerland	2	Denmark	11	Czech Republic	20
Canada	3	Austria	12	Germany	21
Australia	4	Sweden	13	France	22
United States	5	Greece	14	Korea	23
Hungary	6	Mexico	15	Poland	24
Netherlands	7	Finland	16	Spain	25
Norway	8	New Zealand	17	Italy	26
Belgium	9	Portugal	18	Japan	27

Source: FORA, 2005

88. ONS (2005) Chapter 8: The foreign-born population. In: 'Focus on People and Migration: 2005.' Accessed at: http://www.statistics.gov.uk/downloads/theme_compendia/fom2005/08_FOPM_ForeignBorn.pdf

89. Rendall, M. and Salt, J. (2005) 'Focus on People and Migration: The Foreign-born Population.' London: ONS.

90. OECD (2005) 'Database on immigrants and expatriates.' Paris: OECD.

91. Ibid.

92. Sriskandarajah, D. and Drew, C. (2006) 'Brits Abroad: Mapping the Scale and Nature of British Emigration.' An IPPR Report. London: IPPR.

93. OECD (2006b) 'Measuring Globalisation: OECD Economic Globalisation Indicators.' Paris: OECD.

94. Veugelers, R. (2005) 'Internationalisation of R&D in the UK: A Review of Evidence.' Cambridge: A.D. Little. Accessed at: <http://www.berr.gov.uk/files/file30063.pdf>

95. Ibid.

96. Ibid.

97. FORA (2005) 'Dutch Capacity for Productivity Growth: From Benchmarking to Policy Priorities.' Copenhagen: FORA.

Table 3 shows the UK in tenth place behind the US and several smaller countries, but well ahead of other larger economies such as France, Germany and Japan. The UK also outpaces some very innovative small nations like Denmark, Sweden and Finland.

In the public knowledge base, UK universities play an important role in internationalisation, drawing leading academics and students from all over the world. According to the Observatory on Borderless Higher Education, the number of foreign students attending UK universities in 2007 was about 330,080.⁹⁸ While this represented a doubling in numbers in a decade, the pace of globalisation is apparent in the fact that it represented a decline in global share.⁹⁹ The UK hosts a large number of foreign doctoral students too; OECD data indicates that over a third of PhD enrolments in the UK are by foreign students.¹⁰⁰ In absolute terms, the UK comes second only to the US in this regard.

The internationalisation of the UK education system is also reflected in the increasing number of overseas academic staff teaching and doing research, linking the UK to other leading global knowledge centres in the process. In 2005/06, 19.1 per cent of academic staff were non-UK nationals, a proportion expected to increase significantly in the coming years.¹⁰¹ Most specialised in science and technology.

Other research by Evidence Ltd, a UK-based consultancy, points to a rapid growth in UK international collaboration activity (over 11 per cent in five years), particularly relative

to domestic research output, and faster than other G7 economies.¹⁰² In fact, the UK is ahead of other major European economies, though behind the Nordic countries, in the intensity of its researchers' activities with international partners (12.58 per 10,000 inhabitants compared to 8.89 for France or Germany) as measured by joint publications.¹⁰³

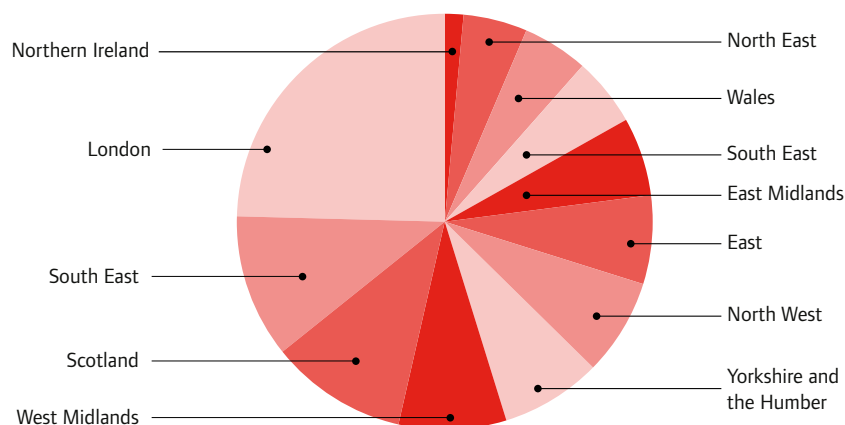
3.1 The internal distribution of UK globalisation

The UK economy and knowledge-base are highly globalised, especially compared with other major economies. However, UK globalisation projects itself differently within the UK. For example, while London is ranked as the world's number one city for global connectivity (on the basis of co-location of firms in advanced producer services¹⁰⁴), Manchester is ranked 84th, Bristol 87th, Birmingham 90th and Edinburgh 96th.¹⁰⁵ In fact, London often acts as a 'globalisation gateway' between other UK cities and the world.¹⁰⁶

Migrants

A quick look at the internal geography of some of the globalisation forces in the UK reveals the clustering nature of globalisation at the local level. For example, around a third of migrants cluster in the South East of the country, and 45 per cent of foreign workers on work visas live in and around London.¹⁰⁷ Forty-three per cent come from other European countries.¹⁰⁸ However, there is a growing internal migration within the UK, especially away from cities and into rural areas.¹⁰⁹ Some cities have bucked the

Figure 1: Regional distribution of foreign students in the UK 06/07



Source: HESA Student Returns, 2006/07

98. HESA figures give a higher number of around 351,000 foreign students.
99. The Observatory on Borderless Higher Education, 2007. Available at: http://www.eua.be/fileadmin/user_upload/files/newsletter/International_Student_Mobility_-_Patterns_and_Trends.pdf
100. Indicators for Education Systems (INES) project conducted jointly by the OECD, UNESCO and Eurostat. There are 25,000 overseas enrolments, representing 36.7% of all enrolments in the UK.
101. Universities UK. Available at: http://bookshop.universitiesuk.ac.uk/downloads/Policy_per_cent20Brief_per_cent20Talent_per_cent20Wars.pdf
102. Adams, J., Gurney, K. and Marshall, S. (2007) 'Patterns of international collaboration for the UK and leading partners (summary report)'. A report commissioned by the UK Office of Science and Innovation. London: Office of Science and Innovation.
103. Veugelaers, R. (2005) 'Internationalisation of R&D in the UK: A Review of Evidence'. Cambridge: A. D. Little. Accessed at: <http://www.berr.gov.uk/files/file30063.pdf>. Note that in terms of total publications, Germany and France have a larger share of co-publications.
104. Such as accountancy, advertising, banking/finance, insurance, law, and management consultancy.
105. Taylor, P. and Aranya, R. (2006) Connectivity and City Revival. In: 'Town & Country Planning'. November 2006, pp.309-314.
106. Neal, Z. (2008) The Duality of World Cities and Firms. 'Global Networks.' Volume 8, Number 1, 2008. Neal ranks London first on the 'betweenness' index.
107. ONS (2005) Chapter 8: The foreign-born population. In: 'Focus on People and Migration: 2005'. Accessed at: http://www.statistics.gov.uk/downloads/theme_compendia/fom2005/08_FOPM_ForeignBorn.pdf
108. Ibid.
109. Mahroum *et al.* (2007) 'Rural Innovation'. London: NESTA.

trend: major cities like Sheffield, Manchester, Birmingham and Liverpool have all reversed their population decline between 1991 and 2005.¹¹⁰

Academic inflows

This tendency can also be seen in the inflows of international academic and research professionals to the UK, who also tend to concentrate in a few research-intensive universities, such as Cambridge, Oxford, and London universities.¹¹¹ Indeed, in 2002–03, 12 institutions were responsible for employing half of all academic immigrants, with 31 per cent of the total concentrated in just four institutions.¹¹²

International students

International students are more dispersed across the UK than other facets of globalisation, but they too tend to cluster in London and the South East. The quality of the Scottish universities is reflected in the fact that Scotland ranks third in the UK for its attractiveness to foreign students. Figure 1 gives an overview.

FDI

Foreign Direct Investment (FDI), an important knowledge transfer channel,¹¹³ is also regionally concentrated. The bulk of investment in the UK goes to London (21.69 per cent), South East (16.51 per cent) and East of England (14.13 per cent). Northern Ireland (0.88 per cent), Wales (2.08 per cent), and the North East (2.19 per cent) draw relatively little foreign

investment.¹¹⁴ A geographic breakdown is given in Figure 2.

These clustering patterns reaffirm the role of indigenous local factors in shaping the distribution of global flows internally as well as the role of global flows in reinforcing spatial disparities.

3.2 The external distribution of UK globalisation

The UK has developed strong links with the rest of the world, particularly with countries in the Triad. Many of these links reflect long-term historic legacies. Despite the recent intensification of the UK's links with emerging countries such as China or those in Latin America, most movements of goods, people and knowledge remain focused on the traditional Triad countries.¹¹⁵

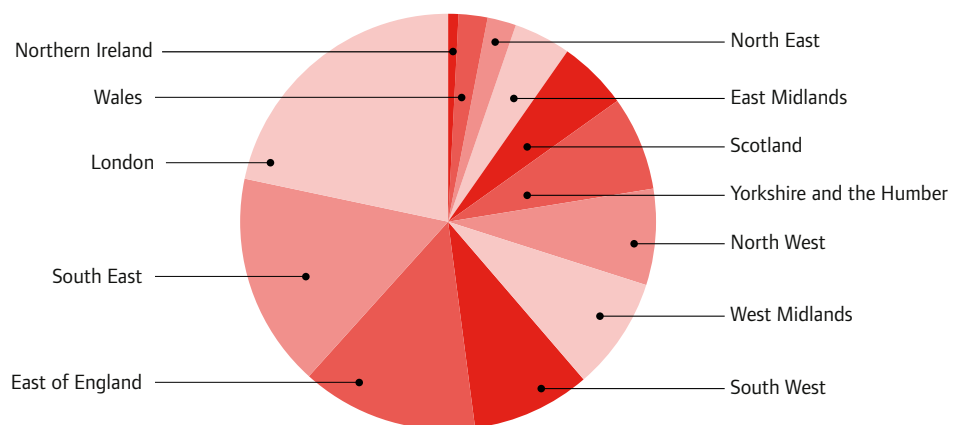
Trade

Trade relations illustrate this privileged relationship between the UK and the Triad. The UK trades more with the United States than with any other nation. UK exports to the US in 2005 totalled £31.0 billion, 8 per cent up on 2004 (£28.5 billion) and UK imports from the US in 2006 totalled £25.8 billion, 15 per cent up on 2005 (£22.2 billion).¹¹⁶

More than half of total UK trade is with the European Union.¹¹⁷ Leading destinations for

- 110. Athey *et al.* (2007) 'Innovation and the City.' London: NESTA.
- 111. Mahroum, S. (1999a) Global magnets: science and technology disciplines and departments in the United Kingdom. 'Minerva.' 37(4), pp.379-90. Also see Solesbury, W. (2005) 'The Impact of International Mobility on UK Academic Research.' London: WSA.
- 112. Sastry, T. (2005) 'Academic Retention and Recruitment in Context.' London: ACU.
- 113. Coe, D. and Helpman, E. (1995) International R&D spillovers. 'European Economic Review.' 39(5), pp.859-887.
- 114. Source: LexisNexis Corporate Affiliations Database. Cited in: Filippaios, F. and Kottaridi, C. (2007) 'Mapping Foreign Direct Investment in UK Regions: The Role of Environmental Determinism and Dynamism.' Working Paper 2007-10. Accessed at: <http://econpapers.repec.org/paper/uopwpaper/>
- 115. Hamilton, D. (Ed.) (2008) 'Globalisation and Europe: Prospering in the New Whirled Order.' Washington, D.C: Center for Transatlantic Relations.
- 116. See FCO website: <http://www.fco.gov.uk/servlet/Servlet?pagename=OpenMarket/Xcelerate/ShowPage&c=Page&cid=1007029394365&a=KCountryProfile&aid=1020687801023>
- 117. See BERR website: <http://www.gnn.gov.uk/Content/Detail.asp?ReleaseID=344542&NewsAreaID=2>

Figure 2: Regional distribution of FDI in UK in 2004



Source: Filippaios, F. and Kottaridi, C. (2007) 'Mapping Foreign Direct Investment in UK Regions: The Role Of Environmental Determinism And Dynamism.' Working Paper 010. Tripolis: University of Peloponnese, Department of Economics.

UK products and services in other EU Member States include Germany and France, which respectively account for 9.9 per cent and 9.7 per cent of all UK exports.¹¹⁸ Finally, Japan is the UK's largest export market after Europe and the US, and the UK is Japan's ninth largest market.¹¹⁹ According to UK Trade and Investment, Japan imported £8 billion worth of UK goods and services in 2005.¹²⁰

Foreign investment

Investment patterns also reflect this trend. Even though the UK has become China's biggest investment market in Europe,¹²¹ the Triad remains the main source of foreign investment. The UK has attracted more US FDI than from Germany, France, Spain, Italy and Ireland combined.¹²² The UK is also the number one destination for Japanese investment in Europe, with about a quarter of the total Japanese FDI going to the UK.¹²³

R&D

International R&D exchanges are largely with the US and the EU too, particularly with Germany and France. According to the OECD, over 50 per cent of R&D spending in the UK was under US control¹²⁴ and most other foreign expenditure came from other European countries.¹²⁵ The share of expenditures from

outside Europe and the US is just 6 per cent. Likewise, a majority of overseas UK R&D expenditure goes to the US.¹²⁶

Academic collaboration

Research collaboration with the United States remains very important. In 2003, 10.6 per cent of UK papers were co-authored with US collaborators; this compares with 6.5 per cent in 1994.¹²⁷ Nearly a third (30.5 per cent) of the UK's most cited research papers written between 1997 and 2001 had an American co-author.¹²⁸ While collaboration with China is growing, it is at a slower rate than with other research-based countries; research collaboration with India also remains low.¹²⁹ UK outward academic mobility is also high – at around 45 per cent of the highly cited researchers – exceeding that of the US and considerably higher than that of Italy or France.

According to Higher Education Statistics Agency data, between 1994-5 and 2002-3, 44 per cent of academic immigrants arrived from the core 15 EU countries, 19 per cent came from the US and 37 per cent from the 'rest of the world'. This reflects the continued concentration of collaboration with the EU and the US, despite growing collaboration with the rest of the world. While the number of

Table 4: Top ten non-EU countries of domicile in 2006/07 for HE students in UK HEIs

Country of domicile	2005/06	2006/07	% change
China (People's Republic of)*	50,755	49,595	-2%
India	19,205	23,835	24%
United States	14,755	15,955	8%
Malaysia	11,450	11,810	3%
Nigeria	9,605	11,135	16%
Hong Kong	9,445	9,640	2%
Pakistan	7,940	9,305	17%
Taiwan	6,180	6,795	10%
Japan	6,200	5,705	-8%
Canada	4,640	5,010	8%
Other non-EU	223,855	239,210	7%

Source: HESA Students in Higher Education Institutions 2005/06, 2006/07¹³⁰

* Figures for China do not include students whose domicile was recorded as Hong Kong, Macao or Taiwan

118. ONS (2007) 'The Pink Book.' London: ONS.
119. See FCO website: <http://www.fco.gov.uk/servlet/Servlet?pagename=OpenMarket/Xcelerate/ShowPage&c=Page&cid=1007029394365&a=KCountryProfile&aid=1018965326618>
120. The UK receives four times more projects than Germany and six times more than France. See UKTI website: https://www.uktradeinvest.gov.uk/ukti/appmanager/ukti/countries?_nfs=false&_nfpb=true&_pageLabel=CountryType1&navigationPageId=/japan
121. GLA Economics (2004) 'Enter the Dragon: An analysis of Chinese FDI into London.' London: GLA. Available at: http://www.london.gov.uk/mayor/economic_unit/docs/enter_the_dragon.pdf
122. Source: US Department of Commerce (2007). See: <http://www.ukinvest.gov.uk/Information-sheets/4018290/en-GB.html>
123. See FCO website: <http://www.fco.gov.uk/servlet/Servlet?pagename=OpenMarket/Xcelerate/ShowPage&c=Page&cid=1007029394365&a=KCountryProfile&aid=1018965326618>
124. See OECD website: <http://www.oecd.org/dataoecd/27/59/40280783.pdf>
125. Veugelers, R. (2005) 'Internationalisation of R&D in the UK: A Review of Evidence.' Cambridge: A.D. Little. Accessed at: <http://www.berr.gov.uk/files/file30063.pdf>.
126. Ibid.
127. International partnerships of research excellence. See: <http://www.wolfson.ox.ac.uk/UK-US-Academic-Collaboration/GarethRobertsIPoREx.pdf>
128. Ibid.
129. Evidence Ltd (2007) Patterns of international collaboration for the UK and leading partners (summary report). Available at: <http://image.guardian.co.uk/sys-files/Education/documents/2007/07/13/OSICollaborationSummaryRepo.pdf>
130. Accessed on April 25th 2007 at: <http://www.hesa.ac.uk/index.php/content/>

international staff has significantly increased over the past ten years, the proportion of Chinese, Japanese and East Asian staff has grown at a slower pace than the proportion of Western European staff. Universities UK research shows that in 2003/04, 3,018 permanent academic staff came from Western Europe and Scandinavia, compared to 1,285 in 1995/96.¹³¹ Over the same period, the proportion of Chinese, Japanese and East Asian staff increased from 268 to 526.¹³² This relatively low total includes Japanese staff, who have historically had stronger academic links with the UK than China.

International students

External globalisation can also be reflected in the geographic origins of the international student population in a country. In this respect, the UK is more diversified. About 40 per cent come from the European Union and North America and another 43 per cent from Asia,¹³³ many from South East Asia.

As Table 4 shows, the growth of Indian students is spectacular (24 per cent), but so is that from Pakistan (17 per cent) and Nigeria (16 per cent). Apart from Japan, the rates are generally all on the rise. China registers a small percentage drop but this needs to be monitored to see whether it represents a trend.

Students from other European countries have increased by 7 per cent over the same period. But this increase masks a drop in traditional source countries like Ireland and Greece and a sharp increase from the new EU Member States, especially from Poland (56 per cent) and Cyprus (21 per cent). The population of European students went up from 106,225 in 2005 to 112,260 in 2007.

3.3 Summary

The UK is one of the most open economies in the world. Its knowledge-base and economy are highly globalised, thereby allowing it to act as a magnet for talents, ideas, and capital. However, while some of its cities and regions form an integral part of global knowledge flows, others seem to struggle to be part of them. Foreign people, capital, and businesses tend to cluster in a few places, namely in the South East and London.

Traditionally, the UK has developed strong links with the rest of the world. Collaborations with countries forming the Triad are particularly

intense, but despite some encouraging signs of change, links with emerging countries in Asia and Latin America remain loose and fragmented.

Only a small number of places in the UK and a limited number of countries in the world seem to be playing an active role in the globalisation of the UK economy and knowledge-base.

131. Universities UK (2007) 'Talent wars: the international market for academic staff.' Policy Briefing. London: Universities UK. Available at: <http://bookshop.universitiesuk.ac.uk/downloads/Policy%20Brief%20Talent%20Wars.pdf>

132. Ibid.

133. See Universities UK website: <http://bookshop.universitiesuk.ac.uk>

Part 4: New players on the global innovation scene

The rise of China and India are already extremely prominent in policy, business and academic discussions around the changing innovation landscape. Their rapid and complex transformations have captivated, motivated and re-energised established players like the UK and US – challenging traditional thinking, systems and structures, and presenting new opportunities and challenges.

But there are other emerging players that need to be analysed and embraced if the UK is to remain a truly globally engaged innovation leader. For example, Brazil and South Africa are often ignored as emerging players. Following the Goldman Sachs report on the 'BRIC economies' (Brazil, Russia, India and China), most people focused on India and China, with little consideration of Brazil despite its being the largest Latin American economy, and the ninth largest country in the world with a growing reputation for science and innovation.

South Africa may be a less obvious innovation power, but it attracts interest because of its transition to democracy, its relationship with the rest of the African continent as well as Asia, America and Europe, and the place of its innovation system in these dynamics. South Africa is occasionally tacked onto the other BRICs to make BRICS. When Goldman Sachs conducted their first analysis of Brazil, Russia, India and China, they didn't ignore South Africa. They thought that its growth would be impressive, as would its capacity to innovate.¹³⁴ But its smaller size and complexities make it a less obvious innovation power.

The emergence of new innovation hotspots is not the preserve of developing countries. Closer to home, Eastern Europe has seen rapid innovation in places like Estonia, and the Czech

and Slovak capitals of Prague and Bratislava. In this paper, we focus on Estonia due to its leadership in e-Government and e-public services, which may offer lessons to a UK government interested in innovation in public services. Estonia is also often ranked first among the former Eastern Bloc countries for its levels of innovation.¹³⁵

The experiences of the countries introduced below are presented as snapshots of changes happening around the world. The challenge is to understand the scale and the nature of these changes and how may they impact on the UK.

4.1 Brazil: entering an era of global innovation

Basic economic and science and technology data

Brazil has the largest economy in Latin America. It is the fifth largest country in terms of land mass, the fifth most populous, and the ninth biggest economy in the world by GDP.¹³⁶ Since returning to democracy in 1985, Brazil has slowly gained political and economic stability. President Luiz Inácio Lula da Silva, known universally as Lula, of the centre-left Workers Party, has since his election in 2003 embarked on an ambitious programme of macro-economic reform – targeting inflation, floating the exchange rate and introducing a range of business-friendly policies to encourage a strong trade environment. On the back of these economic foundations, Brazil's economy annual growth rate in 2007 was an estimated 4.5 per cent, significantly higher than its 2.9 per cent rate in 2005.

134. Goldman Sachs (2005) 'How Solid are the BRICs?' Global Economics Paper No: 134. Available at: http://www2.goldmansachs.com/hkchina/insight/research/pdf/BRICs_3_12-1-05.pdf
135. As for example in INSEAD's Global Innovation Index 2007.
136. Portfolio Investment Opportunities in Brazil, Morgan Stanley, March 2008.

Table 5: Brazil's Key Country Indicators

Population (estimate for 2008)	191,908,598	Life expectancy at birth (Women, Men) 2003	75.2, 67.2
Area (sq km)	8,515,000	Total labour force 2004	99,470,000
Currency	Réal	Government type	Federal Republic
GDP (USD PPP) 2007	\$1.838 trillion		

Source: CIA Factbook

Whilst macroeconomic reform has been a key stimulant in Brazil's growth, another key factor is the country's vast stores of natural resources, particularly iron ore which is highly prized by major manufacturing nations such as China. Importantly for Brazil, major discoveries and the development of offshore fields has resulted in Brazil becoming largely self-sufficient in oil.¹³⁷

The distribution of this growth remains uneven. In a country of over 190 million people there is extreme inequality with nearly a quarter of Brazilians living on less than a dollar a day.¹³⁸ A number of factors contribute in some part to this unevenness – the nature of Brazil's massive geography, the uneven patterns of migration and investment flows, as well as the impact of government funding distribution which has favoured more developed centres. The distribution of science and technology research and development also follows similar uneven patterns. State governments from the Southeast region account for 73.9 per cent of total state expenditure in R&D, followed by the South region with 14 per cent and the Northeast region with 8.6 per cent.¹³⁹

Such growth characteristics are not unique to Brazil and underline the varying capacity of different regions within a country to benefit from global engagement and internationalisation. Sao Paulo and Rio de Janeiro have long been considered the key international hubs for accessing Brazil, but secondary cities like Recife and Ilhéus are emerging too, leveraging the benefits of a more internationalised economy. They are embracing global collaborations and foreign markets like never before.

Brazilian innovation performance

State funding remains dominant

Like many developing countries rich in natural resources, Brazil has traditionally relied on the outside world for access to new innovations

and technologies through foreign investment, multinationals, international partnerships and imports. Domestic R&D, while better than other Latin American countries (Mexican expenditure on R&D is currently at 0.4 per cent, and Peru spends only 0.1 per cent of its GDP on R&D),¹⁴⁰ is low by OECD standards with Brazil investing around 1 per cent of its GDP in R&D for the last five years (the current OECD average is approximately 2.2 per cent of GDP).¹⁴¹ Of the 1 per cent of GDP Brazil invests in R&D, roughly 60 per cent comes from the public sector and the remaining 40 per cent from the private sector.¹⁴²

The overwhelming majority of funding for science and technology comes from the federal level of government, although the states do play a role in funding some R&D and in directly funding appropriate targeted sectors within their jurisdiction. The one exception to this is the state of Sao Paulo. Despite being the largest recipient of federal funds, Sao Paulo's state investment in R&D actually exceeds the federal investment with state funding supporting three state universities, 19 research institutions and FAPESP, the state's science and technology support agency (FAPESP, 2004). The strong support by the state government makes the state of Sao Paulo the second largest investor in R&D in Latin America.¹⁴³

Whilst not on the scale of Sao Paulo, other states are also becoming increasingly active in R&D investment, including Rio de Janeiro, Minas Gerais and Rio Grande do Sul. The Amazonian regions are also becoming increasingly active, particularly in the biotechnology sectors.

Natural resources management and exploration drive many of Brazilians' innovations

Traditional innovation statistics can often present a skewed picture for a country like Brazil, which like Australia, Canada, Norway and other economies based on natural resources tends to benefit more from process

137. Ibid.

138. DFID (2008) 'Brazil Country Profile.' London: DFID. Available at: <http://www.dfid.gov.uk/countries/caribbean/brazil.asp>

139. See http://www.infoexport.gc.ca/science/brazil_home-en.htm;jsessionid=Q5P3SF5EF2FXKCTHNCACFEQ

140. UNDP Human Development Report 2007, Table 13.

141. OECD Science and Technology Scoreboard 2007.

142. OECD (2007) 'Report on Innovation Policies in Brazil.' Paris: OECD.

143. de Brito Cruz, C. and de Mello, L. (2006) 'Boosting Innovation Performance in Brazil.' Economic Department Working Paper No. 532. Paris: OECD.

innovation (resource management, exploration and extraction) than product innovation.¹⁴⁴ Hence much of its innovation can go unnoticed as it is undertaken less through formal R&D and more through practical learning and collaboration with suppliers, customers, competitors, government and universities.¹⁴⁵

Indeed, in the natural resource sector, Brazil has global innovators

Petrobras, the Brazilian oil company, has been an innovative leader in the industry for a number of years. To date, it is the only operator company to drill, test and evaluate pre-salt rocks. It is also the global leader in 'oil shale' research, exploration and processing. (Oil shale is a sedimentary rock that, when heated, releases a petroleum-like liquid.¹⁴⁶) Petrobras' commitment to R&D is demonstrated in its combining the company's refinery operation with research and development strategies. One of its business units includes the 'SIX Technological Park', which is among the world's biggest large pilot plants, and it has units created to supply demand from several refining processes and labs equipped with state-of-the-art equipment. It has developed and patented an innovative technology that processes 7,800 tons of schist (medium-grade metamorphic rocks) daily.¹⁴⁷ On the basis of this and other factors, in early 2008, Petrobras was acknowledged by a Management & Excellence (M&E) survey as the world's most sustainable oil company. Ranked first, scoring 92.25 per cent, the company is the global reference in ethics and sustainability based on 387 international indicators, including lower pollutant emissions and oil leaks, less power consumption, and a transparent vendor service system.¹⁴⁸ Despite these accolades, this type of innovation is not picked up under ordinary innovation indicators and so Brazil's innovations are not fully recognised on the global innovation stage.¹⁴⁹

Overall S&T indicators are on a constant upward swing

When measured in education and scientific publications, Brazil's innovative capacity is clearly increasing. In 2005, Brazilian scientists published three times as many scientific papers as in the early 1990s, a total of 15,777, representing about 1.7 per cent of world production and making Brazil the 17th largest producer of science in the world. More recent indicators show a continued upward trend: according to the Thompson ISI database, Brazil is now the 15th largest producer of scientific publications in the world. It rose from 23rd place in 1999, growing at around 8 per cent

per year, dramatically outstripping other Latin American countries and overtaking countries with significant science bases such as Belgium and Israel in the process.¹⁵⁰

The number of graduates and PhDs continues to increase very rapidly

The number of PhD students graduating also increased almost fivefold between 1990 and 2000, whilst the number of higher education institutions in Brazil has more than doubled since 1997, to a total of 2,398. All these indicators point to a growing absorption capacity in the Brazilian innovation system. In fact, 21 per cent of young Brazilians now enter higher education and enrolment is rising by 5-10 per cent per year – a statistic that bodes well for the future but needs to continue to rise if Brazil is to achieve its innovation potential.

Main government policies, initiatives and strategies for science, technology and innovation

A £10 billion Action Plan for Science and Technology

The Brazilian Government has shifted its innovation policies from inward looking protectionism, to an outward looking combination of science and technology promotion, R&D support in the business sector and trade competitiveness.¹⁵¹ The National Action Plan For Science and Technology 2007-2010 was formally launched by Brazil's Science Minister in November last year. With a budget of around £10 billion, the four strategic objectives of the new Plan are to consolidate Brazil's science and technology systems; encourage innovation in the private sector; enhance capability and research in strategic areas; and invest more in research for social development.

The Plan is an integral part of the Government's 'Programme for Accelerated Growth' and includes an ambitious target to ensure that Brazil spends 1.5 per cent of its GDP on science by 2010.

The 'Law of Innovation'

Previous legislation has tried to address the public-private imbalance in R&D and to encourage the business sector to engage in productivity-enhancing innovative activities. But there is clearly a long way to go. Legislation enacted in 2005 introduced new tax incentives for innovation as part of a broader package for reducing the tax burden on the

144. Rheumne, G., Warda, J. and Tong, J. (2001) 'Investing in Innovation in the Resource Sector.' Members Briefing, Conference Board of Canada.

145. Ibid.

146. 'Gauging the Prospects of a U.S. Oil Shale Industry.' Available at: http://www.rand.org/pubs/research_briefs/RB9143/index1.html, date accessed 30/5/08

147. See <http://www2.petrobras.com.br/portal/ingles/petrobras.htm>

148. See <http://www2.petrobras.com.br/Petrobras/ingles/historia/index.htm>

149. NESTA (2007) 'Hidden Innovation.' London: NESTA.

150. Glanzel, W., Leta, J. and Thijs, B. Science in Brazil Part 1. A macro-level comparative study. 'Scientometrics.' Vol. 67, No. 1 (2006), pp.67-86.

151. OECD (2006) 'Economic Survey of Brazil.' Paris: OECD. p.7.

business sector. It also facilitated the sharing of intellectual property rights (IPR) proceeds between businesses, public universities and research institutions. The newly edited 'Law of Innovation' also includes amendments to facilitate the more strategic use of government procurement to foster innovation.

Sectors and regions specific funds

Legislation enacted during 2000-2002 made use of Sectoral Funds created in 1999, which direct a fraction of the taxation of certain key industries to government selected R&D projects. These funds intensified R&D activities by previously state-owned companies, and also aided redistribution of resources across Brazil. At least one third of each sectoral fund must be spent in the less-developed North, North-East and Central West of the country. Despite this, R&D activity still remains concentrated in the South, with the University of Sao Paulo accounting for almost a quarter of Brazil's scientific publications alone.¹⁵²

Developing science and technology parks around the country

The Government has also invested heavily in the development of new science and technology parks, with over 40 such parks now scattered around Brazil.¹⁵³ The Ilhéus Informatics Pole, a new informatics park, produced over 1.5 million computers in 2006, in the resort town of Ilhéus, with revenues of US\$1 billion that year.¹⁵⁴ The number of incubators has also doubled since 2003 to around 400, all with a shared ambition to accelerate the development of successful entrepreneurial enterprises.

Supporting business R&D is a government priority

A key priority for the Government in the future must be to continue its efforts to support and facilitate business R&D – particularly in key growth sectors of the Brazilian economy. The National Action Plan aims to increase Brazilian private investment to 0.65 per cent of GDP by 2010 (from 0.5 per cent in 2006), though this will require considerable commitment from both government and the private sector. The government's pledge to more than double its own spending on science and innovation, from US\$4.2 billion in 2006 to US\$9 billion by 2010, should act as an important stimulus for private investment – particularly in the government's strategic areas of priority. Such areas include biotechnology and nanotechnology, ICT, health, biofuels, energy (electrical, hydrogen and renewables), agri-science, biodiversity,

the Amazon, climate change, space, nuclear technology and defence.

Main challenges

Difficulties remain in translating academic output into business innovation

Whilst Brazil's commitment to innovation has progressed, there is still significant room for improvement. There is a new 'critical mass' in scientific production in academia, but difficulties remain in translating this into innovation in the private sector despite path-breaking innovation successes in some industries (such as in material science, biotechnology, photonics and tropical agriculture). Brazil is still in the early stages of an innovative private sector and has a long way to go if it is to achieve the aspirations of the National Action Plan for Science and Technology, whereby Brazilian companies will invest an extra £1.7 billion by 2010.¹⁵⁵

Other traditional measures of private R&D investment are less encouraging; patent applications show a disheartening picture. Patent applications have not seen anywhere near the same growth as scientific citations, with one patent application per million people between 2000-2005, which puts it on a par with Mexico, Turkey and Thailand, falling behind countries such as Iran (with 8 applications per million people over the same period, and China, with 16 applications per million people over the same period).¹⁵⁶ Therefore, the challenge of any innovation policy in Brazil is to foster greater public-private links to facilitate this transfer of knowledge and production.

Training for much needed skills is not adequately available

Government policies aimed at boosting business innovation also need to be complemented by measures aimed at tackling the shortage of skills in the labour force available to business. The country has only a limited number of research universities and state-owned research institutes and 70 per cent of enrolment is actually in private higher education institutions where the quality of education is questionable.

There is an alarming absence of science and engineering courses, despite shortages of qualified personnel in IT and biotechnology, and this is hindering the development of these key sectors and hampering their capacity to

152. Glanzel, W., Leta, J. and Thijs, B. Science in Brazil. Part 2 Sectoral and Institutional Research Profiles. 'Scientometrics.' Vol 67, No.1 (2006), pp.87-105.

153. Anprotec (2004) 'Agenda for Entrepreneurial and Innovative Cities.' Brasilia: Anprotec.

154. Interview with ABDI, March 2008.

155. Ciência, Tecnologia e Inovação para o Desenvolvimento Nacional, Plan de Acao 2007-2010, Ministério da Ciência e Tecnologia, November 2007.

156. UN Human Development Report 2007.

attract foreign R&D facilities. Such human resources and skills problems are typical of countries experiencing rapid growth, however, particularly in high-growth knowledge-intensive sectors.

Internationalisation

Brazil may be best known for Carnival, soccer and the Amazon. But it is also a confident player on the global economic stage, boasting some large and successful global companies

such as Globo (media), Petrobras (oil and gas), Vale (mining) and Gerdau (steel).

Brazil is a global investor

In fact, Brazilian overseas investment in 2006 exceeded inward investment for the first time. Foreign investment in Brazil was US\$18.8 billion (19th in global ranking of inward investment), compared to a massive US\$28 billion in Brazilian investments abroad (12th in global ranking of outward investment).¹⁵⁷

Boasts global corporate players

According to the UN's World Investment Report 2007, Brazil boasts two of the world's

Box 2: Case Study – PERNAMBUCO

With so much activity happening in the South of Brazil, it is easy to ignore some of the more interesting developments in the North. The North Eastern State of Pernambuco may be best known for its 114 miles of fine beaches, but it is also making a name for itself as one of Brazil's emerging places to watch.

In the early 1990s, the Federal University of Pernambuco recognised that whilst its computer science department was one of the best in the country, it was unable to retain talent, as the vast majority of graduates were swept up with lucrative job opportunities in the South or overseas. To counter this, a number of the university's professors established the Recife Centre for Advanced Studies and Systems (CESAR) in the state's capital. From 1996 to 2007, the private, non-profit incubator and services centre went from a five-person operation and revenue of \$12,000 to an organisation employing over 600 people, with an income of \$25 million.¹⁵⁸

CESAR's efforts were then complemented in 2001 by the creation of an IT park called Porto Digital on the site of a dilapidated former sugar port. Created with an initial state government grant of \$4 million, this cluster has grown from just three ICT companies initially to over 200 today, 90 per cent of which are graduates of CESAR.¹⁵⁹

The combined impact of these initiatives has had a significant impact on the economy of the state. ITC now accounts for

1.8 per cent of State GDP, compared to a 0.8 per cent average for Brazil. In addition, these three centres have successfully fostered an impressive scale of collaborative activity, as well as a global agenda and reputation. CESAR was international from the outset. Its three biggest clients for R&D are Motorola, Samsung and Sony-Ericsson, whilst its international partnerships include collaborative projects with IIT Guwahati in India, the IAS in Germany and the ICDC in the UK. Impressively, CESAR is currently trialling a new graduate programme with 20 per cent of the 800 students drawn from outside Recife.¹⁶⁰ The programme has attracted students from the USA, Finland, Switzerland and India, which is not surprising given Recife's increasing reputation for world class talent in Java, open software, electronic security and mobile applications.

But ICT is not Pernambuco's only focus. Given the last two science ministers have hailed from this state and the fact that it is now receiving a sizeable portion of the Federal Government's Sectoral Fund for research and development, Pernambuco is broadening its strengths into other sectors. Pharmaceuticals is one such sector, thanks to a US\$65 million government commitment to create a pharmaceutical pole, specifically focused on blood-related products for domestic supply.¹⁶¹ With investment of this scale, and the learnings of places like CESAR, the beaches are certainly not the only thing which will attract people to Pernambuco – although they are a nice bonus.

157. UNCTAD (2007) 'World Investment Report.' Geneva: UNCTAD.

158. Bound, K. (2008) 'Brazil – the natural knowledge-economy.' London: Demos. p.64.

159. Ibid. p.64.

160. Ibid.

161. Ibid.

25 biggest non-financial transnational corporations, with Petrobras in 13th place, and Companhia Vale do Rio Doce ranked 18th. Both specialise in natural resources. A recent Boston Consulting Group Report also identified a number of new emerging global corporate challengers from Brazil who share a desire to globalise and are moving with impressive speed. In a list of 100 new 'challengers', thirteen companies are Brazilian and several have shown strong R&D capabilities.¹⁶²

Its main foreign markets are increasingly in Asia

Historically, Brazil's main markets were the United States, Argentina, Germany, Japan, Italy, France and the United Kingdom. Emerging markets like China, India and Russia are becoming more important; China is already one of Brazil's five most important foreign markets. Trade between Brazil and China has risen tenfold from 2000 to 2007.¹⁶³ Brazil imported \$12.6 billion worth of Chinese goods against \$10.7 billion in exports to China, in 2007. In July 2008, the Brazilian Government launched the Agenda China programme – a partnership between Brazil's public and private sector that aims to triple Brazilian exports to China, particularly in areas such as pharmaceutical products, chemicals, plastics, metals, and agricultural goods.¹⁶⁴

Like most countries, internationalisation is concentrated in major urban hubs, but new cities are emerging as international players too

Major urban centres like Sao Paulo and Rio are the country's most internationalised regions; they are where most multinationals are based and where Brazil's main economic and cultural exchanges with the world take place. But Brazil's strengths are not confined to these major urban centres. There are emerging innovative hotspots that are starting to attract international attention. For example, in the more developed South, Santa Catarina in Florianopolis is developing a name for itself in engineering, whilst Recife in the poorer North East is developing a reputation for its ICT capability.

Brazil-UK links and opportunities

Brazil has historically been an important partner for the UK. Over a hundred years, the British invested in Brazil's railways, ports, power plants, communications, mining, insurance and banking; playing a not insignificant role in Brazil's industrial revolution.

Business links

Brazil-UK relations go way back

During this historical period, Britain developed a preferential and prosperous trading relationship with Brazil – even challenging that of the Portuguese colonisers. Today Brazil continues to be an important strategic partner of the UK, not only in terms of trade, but also through cultural, political, and other collaborative links. Just recently, an exhibition on the HMS Nottingham (the English Fleet ship that originally took the Portuguese Royal Family to Brazil) celebrated 200 years of the Royal Family's arrival in Rio de Janeiro.

UK is an important investor and 'supplier' for Brazil, but not among the top investors

The UK is Brazil's 12th largest supplier of goods, with chemicals, motor vehicles and pharmaceutical products the top three imports. And this trade relationship is growing – in the first quarter of 2008, Brazilian imports from the UK grew by over 25 per cent, compared to the previous year.¹⁶⁵ UK companies are also one of the largest sources of foreign investment in Brazil – with Brazil's hosting of the 2014 World Cup likely to increase the number of UK firms looking to invest in resulting infrastructural opportunities.¹⁶⁶ Nevertheless, the UK is not amongst the top 12 direct investors in the country. In fact, in December 2006 the UK accounted for only 7 per cent of FDI flows in Brazil.¹⁶⁷

Brazil is the UK's most important trade partner in Latin America

Brazil is also the UK's most important trading partner in Latin America, with UK exports of goods and services valued at US\$1.6 billion in 2007 (January–October). From January to August 2007, bilateral trade between Brazil and the UK increased 25.3 per cent (total of US\$3.2 billion) in comparison with 2006¹⁶⁸ with the UK's top exports including organic chemicals, professional scientific instruments, pharmaceuticals, machinery and road vehicles.

Academic links

UK is second only to Canada in its attractiveness to Brazilian students

Student exchanges are another vital area where links between the UK and Brazil could be substantially enhanced. The UK is second only to Canada in its attractiveness to Brazilian students wanting to study English abroad. As Brazil's economy continues to grow, young

162. BCG (2008) 'The 2008 BCG 1000 New Global Challengers.' Available at: http://www.bcg.com/impact_expertise/publications/files/Global_Challengers_short_Feb_2008.pdf

163. Ibid.

164. 'Brazil looking to triple China trade.' Associated Press Business News. Available at: <http://news.moneycentral.msn.com/>, date accessed 04/08/08

165. Bound, K. (2008) 'Brazil – the natural knowledge-economy.' London: Demos, p.64.

166. Bilateral Trade 2008 (Jan-March), The Embassy of Brazil in London. Available at: <http://www.brazil.org.uk/commercial/bilateraltrade.html> [Accessed 4/8/08].

167. Ibid.

168. Ministry of Development, Industry and Foreign Trade (2007) 'FDI inflows in Brazil – inward investment – annual – 1995-2006.' Available at: http://investimentos.desenvolvimento.gov.br/renai_en/arquivos/IEDfluxoSITERENAI.pdf

Brazilians have increasing opportunities for international study. Whilst accurate student data is difficult to obtain, some media reports put the number of Brazilian students in the UK around 9,400, of whom 1,170 are in post-graduate studies – a relatively small number within a potential market of over 250,000 prospective students. But these figures should be treated with caution.

Academic collaboration is also increasing between the two countries

Co-authored papers between Brazil and the UK reached over 5,600 between 1997-2006, which is higher than the number of joint papers between India and the UK. Physics is the subject of the most co-authored papers, with the North West of England generating over 1,000 joint articles. Other prominent disciplines include microbiology, medicine, neurosciences, and space sciences.¹⁶⁹

Sao Paulo and Rio are leading the way in Brazilian collaboration with UK academia

International collaborations from the UK are concentrated on a few universities in Sao Paulo and Rio (which are also the best and most prolific research universities in general). Not surprisingly, given Sao Paulo's dominance in

R&D, the University of Sao Paulo stimulates an extensive number of co-authored papers, and features amongst the top five collaborating organisations for every regional area of the UK. Brazil is also the Latin American research base with the highest level of collaboration with the UK, with such collaboration accounting for 12.8 per cent of all co-authored international Science and Engineering articles.¹⁷⁰

Collaboration with the UK is led by the search for excellence

In the UK, London and the South East, followed closely by the North West, emerge as the main academic and research partners to Brazilian researchers. This reflects the strong presence of world-class universities in these three regions. Figure 3 below shows the geographic distribution of co-authored academic papers between the UK and Brazil.

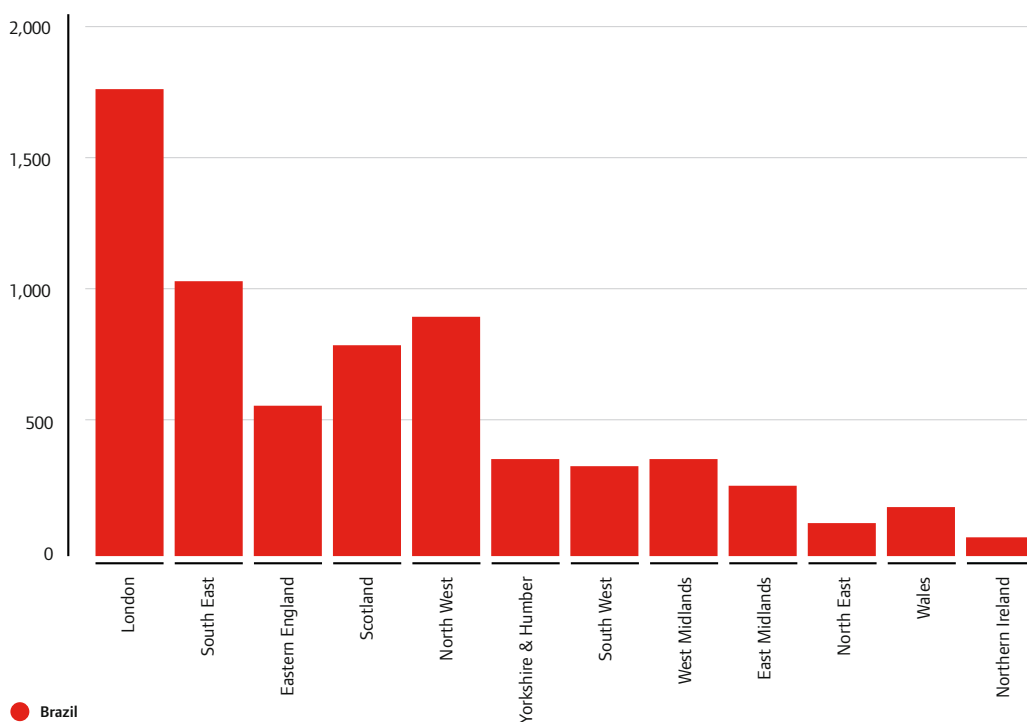
Long-standing institutional links also play a strategic role in strengthening scientific collaboration between the UK and Brazil

A number of well-respected research bodies and universities in the UK also have centres dedicated to Latin America, and Brazil specifically. For example, the University of Oxford has a dedicated Centre for Brazilian

169. Evidence Research, May 2008.

170. Evidence Ltd (2008), unpublished data for NESTA.

Figure 3: Geographic distribution of co-authored academic papers between the UK and Brazil



Source: Evidence Ltd, unpublished data (2008)

Studies, and despite budget reallocations in recent years, the University of London still maintains a strong focus on Brazil as part of its Institute for the Americas.

The British Council has been instrumental in bringing together organisations and institutions in areas of mutual interest

The British Council plays an important role in fostering inter-institutional links. For example, the Brazil-UK Network of Young Scientists brings together outstanding young Masters and PhD students to build long-lasting connections between the two countries through specialised workshops on subjects such as 'Renewable Energy for Sustainable Living'.¹⁷¹ The Council estimates that there are over 100 similar link schemes with Brazil, ranging from simple student exchanges to joint curriculum projects.

Other UK organisations have begun to forge links too

On a smaller scale, the Higher Education Funding Council for England (HEFCE) set up a 'Brazil-UK Collaborative Research Networks' pilot project which ran from 2000 to 2003.¹⁷² Through three main networks – the catalysis network, the corrosion network, and the phytopharmaceutical network – this initiative fostered lasting relationships and stimulated new collaborative efforts in areas such as anti-malaria.¹⁷³

In 2007, the British Academy signed a memorandum of understanding with the Co-ordination of Higher Education Staff Post-graduate Study (CAPES) for the mutual support and exchange of researchers between Brazil and the UK, as well as committing to annual meetings and debates on themes of joint interest.¹⁷⁴

Science and Technology Links

Strengthening the Brazilian IPR regime

A particularly challenging area for Brazil has been that of patent applications and registrations. As this is an area in which the UK has significant expertise and experience, it is able to help Brazil improve its patenting capacity. Patent application numbers are not only a sign of innovation, they are also indicative of the country's legal apparatus. Brazil suffers from insufficient enforcement of intellectual property rights, despite having a comprehensive legal system. A collaboration project between Brazil's INPI and the UK's Intellectual Property Office is currently

underway to help address these issues. The project offers Brazilian authorities training in the enforcement of intellectual property rights. This involves fostering close networks with Brazil by creating ideas exchange regarding patents, geographical indications, technology transfer and trademarks.¹⁷⁵

A strong potential for collaboration around biotech

A number of key sectors also present increasing opportunities for stronger collaboration between the UK and Brazil – both in an academic and industrial sense. Brazil's ambitions in biotechnology, for example, provide one timely and strategic area, given the UK's significant investment in this area. The Brazilian Ministry of Foreign Affairs has specifically highlighted the biotechnology industry as a key area of potential interest for the UK market. The Ministry has pointed to three main areas in which collaboration in the biotech sector can be expanded: support for higher education training schemes; collaborative research between UK and Brazilian small and medium-sized biotech firms; and allowing Brazilian small and medium firms to acquire up-to-date production technologies from the UK.

The biofuel industry represents another important area for collaboration

Another area generating increasing interest globally is the Brazilian bio fuels sector. The Brazilian Government is keen to leverage increasing attention on bio fuels, so it cut taxes on ethanol in 2003 and granted tax breaks to producers of flex-fuel vehicles which run on an ethanol-gasoline blend. The UK hopes to contribute to the development of the Brazilian biofuels industry by providing support for renewable energy trade and sharing expertise on ways to attract carbon financing into biofuel projects. Operating within a framework of environmental sustainability and preservation of biodiverse areas, the UK also hopes to foster networks with other potential fuel hubs such as South Africa through providing network investments.

These are important foundations upon which to build a stronger, more collaborative relationship between the UK and Brazil. As a world leader in soyabean production, efficient ethanol and the manufacture of competitive commuter jet planes, Brazil is becoming an increasingly important player in global innovation. This relationship will become of increasing strategic importance to the UK.

171. British Council (2008) 'Brazil Country Profile.' Available at: <http://www.britishcouncil.org/brazil-science-exchange-collaboration.htm> [Accessed: 11/3/08].

172. UK-Brazil Collaborative Research Networks, Evaluation of Pilot Project, HEFCE 2003.

173. Ibid.

174. The Embassy of Brazil in London 'CAPES and The British Academy sign an exchange partnership.' Available at: <http://www.brazil.org.uk>

175. House of Commons Report, Trade and Industry Committee. 'Trade with Mercosur: Government Response to the Committee's Seventh Report of Session 2006-07.' London: HMSO.

These opportunities are not without challenges

Authorisation from as many as five government agencies can be required to do field research in Brazil, and the process can take up to two years. Such legal barriers also place limitations on other key areas of UK expertise. The laws governing the pharmaceutical sector in Brazil, for example, demands the transference of foreign technology within five years of a foreign firms' instillation in Brazil – creating a huge disincentive to investment.

People links

UK's Brazilian community is concentrated in London

Whilst the last UK Census in 2001 suggested that there are only 8,000 Brazilians living in the UK, UK-based Brazilian organisations and analysts estimate that the Brazilian community is around 200,000, up to 160,000 of them based in London, The district of Bayswater in Central London even boasts the nickname 'Brazilwater'.¹⁷⁶

Community associations and centres are emerging

Brazilian community associations are also instrumental in helping to foster UK-Brazil community ties. One such example is ABRAS, a Brazilian Association based in North West London, which along with providing advice to Brazilians living in the UK, also takes part in cultural events promoting links between the two countries.¹⁷⁷ Just over ten years ago, the Brazilian Educational and Cultural Centre was also established in London to assist Brazilian parents to foster an understanding and appreciation of Brazilian culture in their children, but also in the wider community.¹⁷⁸ The creation of an Overseas Brazilians Day is one suggestion to help reach out to Brazilians and Brazilophiles around the globe, stimulating diaspora networks of entrepreneurs and financiers like The Indus Entrepreneurs (TiE) did for India. Another suggestion involves creating a prize for Brazilian scientific achievement overseas – to showcase Brazilian expertise and engender national pride.¹⁷⁹

UK government efforts

Government efforts in this respect seem to go in three directions: 1. increasing business (trade and investment) opportunities between the two countries; 2. creating platforms for collaboration between stakeholders in the two countries; and 3. supporting and fostering S&T links.

Increasing business opportunities between the two countries

UK Trade and Investment (UKTI) has identified seven priority sectors in Brazil which correspond closely to Brazil's own investment priorities. These are agriculture, engineering environment, healthcare, life sciences, oil and gas, sports and leisure, and infrastructure. To assist businesses with an interest in Brazil, UKTI is putting together a 'Brazil Business Guide' which will hopefully stimulate and aid further investment.¹⁸⁰

Creating platforms for collaboration between stakeholders in the two countries

The Year of Science has brought an element of joint public consultation in science across the two countries. One of two lectures given by Dr Jenny Morton from Cambridge University (the leading authority on research into the treatment of neurodegenerative diseases) in Sao Paulo in September 2007 offered a rare opportunity for dialogue between members of families who live with Huntington's disease and researchers who dedicate themselves to finding answers that could lead to improvements in the treatment offered.¹⁸¹ Also as part of the Year of Science, the UK's new Chief Scientific Adviser, Sir John Beddington, on his first official international trip, visited Brazil in February 2008 to champion opportunities and collaboration.

Support and foster S&T Links

A Joint Economic Trade Committee was created between the UK and Brazil to help promote and develop trade, address barriers and to create a better business climate. One of the key initiatives of this committee was the creation of the UK-Brazil Year of Science and Innovation (2007/08), aimed at promoting the relationship between the Brazilian and UK scientific and R&D communities. Such links are too rare in the current Brazilian climate, so it is hoped that the Year of Science will not only help promote R&D in the Brazilian private sector through helping to foster these links, but that by creating a better understanding of Brazil's science potential it will also benefit trade and investment.

In March 2008, a memorandum of understanding for scientific cooperation was signed between the Brazilian Agricultural Research Corporation (Embrapa) and the UK Cereals and arable farming research company, Rothamsted. This led to an 'Innovation in Agribusiness' workshop, which focused on identifying commercially viable innovations that meet market needs in the industry, and it is

176. House of Commons Trade and Industry Committee (2007) 'Trade with Brazil and Mercosur.' London: HMSO.
177. See www.abras.co.uk
178. Brazilian Educational and Cultural Centre (BrEACC). Available at: <http://www.breacc.org> [Accessed: 30/5/08].
179. Bound, K. (2008) 'Brazil – the natural knowledge-economy.' London: Demos.
180. House of Commons Report, Trade and Industry Committee. 'Trade with Mercosur: Government Response to the Committee's Seventh Report of Session 2006-07.' London: HMSO.
181. UK-Brazil Year of Science and Innovation, Final Report, March 2008.

Table 6: India's Key Country Indicators

Population (2008 estimate)	1,147,995,898	GDP (per capita)	\$2,700
Area (sq km)	3,287,590	Life expectancy at birth (Women, Men)	71, 66
Currency	Rupee	Total labour force	516,400,000
GDP (USD PPP)	\$2.965 trillion	Government type	Federal Republic
GDP (growth)	8.5 per cent		

Source: CIA Factbook

hoped that there will be many other initiatives which stem from this memorandum.¹⁸²

4.2 India: the uneven innovator

Basic relevant economic and science and technology data

India's economic growth has averaged around 8 per cent since 2003, making it the second fastest growing economy in the world.

Goldman Sachs believes it has the potential to grow faster than China in the long-term.¹⁸³ Whilst the economic boom is expected to continue, growth is expected to slow from an estimated 8.7 per cent in 2007/08 to an annual average of 7.6 per cent from 2008/09 to 2012/13.¹⁸⁴

India is remarkably diverse. The country's recent dramatic growth story brings its contradictions to life. It is now the fourth largest economy in the world in its purchasing power, yet the average real disposable income is only around 113,744 Indian rupees (US\$2,830).¹⁸⁵ In this emerging global leader in international high tech sectors like IT and pharmaceuticals, 25 per cent of the population live below the dollar-a-day poverty line. Sixty per cent of India's 500 million-strong labour force work in subsistence agriculture, but at the same time the numbers of graduates, returning diaspora and highly-skilled professionals and business people are increasing. Predictions that India will become a 21st century knowledge superpower may have to accommodate these contradictions. But this does not make India's economic story any less compelling. This vast country's experience is constantly shifting global perceptions about the future potential of science and innovation.

Indian innovation performance

Science and technology became key to India's development following independence from Britain in 1947. Many of the icons of India's innovation system were established immediately afterwards, including the Indian Institutes of Technology (IITs), the Council for Scientific and Industrial Research, as well as the national space and nuclear energy programmes.¹⁸⁶

India's contribution to global science is growing rapidly in quantity and quality

Research papers from India received over 250,000 citations from 2002-06, four times the citations in the early 1980s.¹⁸⁷ Patent applications are also increasing – growing between 2004-5 and 2005-6 by 40 per cent to 24,505.¹⁸⁸

India has a vast science and engineering workforce, but of mixed quality

People are India's most abundant resource and the central pillar of the country's scientific and innovative capability. India already has more than 12 million science and engineering graduates, two million of whom are post-graduates, including up to 300,000 actively engaged in R&D.¹⁸⁹ Despite such talent, India could still suffer from a human resource problem, because its education system – like that of Brazil – is highly variable. A recent McKinsey report revealed that many foreign companies find it difficult to hire good quality graduates.¹⁹⁰

IT and Pharma are the two industries that are leading the growth

India is rising up the global science and innovation league tables, and has the potential and ambition to become a leading global innovator. Its status is increasing in specific sectors. The pharmaceuticals industry is now worth US\$8.2 billion, representing a sixth of

182. Ibid.

183. Bound, K. (2007) 'India: The Uneven Innovator.' London: Demos.

184. Economic Intelligence Unit (2008) 'India Country Briefing.' London: EIU. Available at: www.economist.com/countries/India [Accessed: 31/3/08].

185. McKinsey Global Institute (2007) 'The Bird of Gold': The Rise of India's Consumer Market.' McKinsey Global Institute. p.9.

186. Bound, K. (2007) 'India: The Uneven Innovator.' London: Demos.

187. Thomson Scientific Research Brief (2007) 'Innovation in India.' November 2007.

188. Ibid.

189. Shukla, R. and Kumar, P. (2006) 'Role of Science & Technology, Higher Education and Research in Regional Socio-Economic Development.' NACER Working Paper 98/2006.

190. McKinsey Global Institute (2005) 'Addressing China's looming talent shortage.' McKinsey Global Institute.

the global market. Industry stakes were about US\$4.6 billion in 2004, and are projected to rise to US\$8.3 billion by 2009 – an increase of 80 per cent in just five years.¹⁹¹ The IT sector is also growing significantly – software and IT-enabled services exports grew from US\$12.9 billion in 2003/2004 to US\$17.7 billion in 2004/2005, with over 1.3 million professionals employed in IT and IT-business process outsourcing in 2005/06.¹⁹²

Biotech is growing by a staggering 35 per cent annually

Biotechnology in its own right crossed the US\$2 billion mark in 2006-07, with the sector boasting an impressive growth rate of over 35 per cent annually over the last five years. While this might represent only one per cent of the global biotech market, some industry and policy leaders predict that with the right fiscal and policy initiatives, India could accelerate its biotechnology capacity to capture US\$25 billion by 2015.¹⁹³

More and more Indian cities are adopting high-tech growth strategies

Thirty Indian cities have a population of more than a million. Several, including Hyderabad, Mumbai, Delhi and Chennai, are strengthening their position as hubs for R&D with strong state support. There are also emerging second-tier cities that deserve closer consideration. Ahmedabad has benefited from pro-industry Gujarat state policies, which are now a big draw for investment from savvy Indians overseas; Pune is leveraging its high concentration of scientific institutions (which hosts more than 6,000 international students) to attract investment and collaboration.¹⁹⁴

Main government policies, initiatives and strategies for Science, Technology and Innovation

Government spending is high and rising

Seventy per cent of R&D spending in India is publicly funded, rising to 85 per cent if publicly owned enterprises are included. And government expenditure on science is rising: in 2005, the science budget increased by 24 per cent to reach US\$4.5 billion.¹⁹⁵ In the latest science budget, released in February 2008, the government announced an additional 16 per cent increase in science spending from US\$5 billion to US\$6 billion – a strong testimony to the importance of science to India's future economic development.¹⁹⁶

Further support for young people to pursue careers in science

Central to these budget announcements were initiatives to encourage young people to pursue scientific careers, including a US\$21.25 million scheme called 'Innovation in Science Pursuit for Inspired Research' (INSPIRE) which provides scholarships for young people aged from ten to 32.¹⁹⁷ Skill development is another area of vital importance. Despite the size of the talent pool, skills shortages are prevalent. Workforce development and educational systems have yet to respond to India's changing economic needs. There is also the risk of India's universities responding more to global than local talent needs. The lure of better pay, international experience and emigration attract students to those that are well connected to global markets.

New Institutes of Technology are announced

The Budget also allocated funds to establish three new Institutes of Technology in Andhra Pradesh, Bihar and Rajasthan states, as well as two new Indian Institutes of Science Education and Research in Bhopal and Thiruvananthapuram. Combined with an ambitious plan to build 16 central universities, these new institutions are intended to help India cope with the growing demand for highly skilled workers.

Space technology receives special significance in the budget

India's commitment to space research and earth observation is also visible in the Budget, with the Indian Space Research Organisation receiving a significant chunk of funding. An additional US\$1 billion, a 23 per cent increase from last year, will be allocated to the ISRO to advance India's endeavour to launch its first manned space flight by 2014.¹⁹⁸

A National Science and Engineering Foundation is created to support fundamental research

There is also excitement amongst Indian policymakers about the US\$230 million National Science and Engineering Foundation, announced in 2006, which is expected to inject more dynamism into fundamental research. The new system, however, will overlay rather than replace the existing, complex arrangements, which threatens the effectiveness of such a Foundation in what is already a very bureaucratic system.¹⁹⁹

191. Bound, K. (2007) 'India: The Uneven Innovator.' London: Demos.

192. Ibid.

193. Konde, V. (2008) 'Biotechnology in India; Public-Private Partnerships.' *Journal of Commercial Biotechnology*, 14(1), pp.43-55.

194. Bound, K. (2007) 'India: The Uneven Innovator.' London: Demos.

195. Ibid.

196. News item (4 March 2008): 'Indian government boosts science spending.' Available at: www.scidev.net/en.news. [Accessed: 26/3/08].

197. Ibid.

198. Ibid.

199. Bound, K. (2007) 'India: The Uneven Innovator.' London: Demos.

Challenges

Business R&D funding remains low

Indian spending on R&D as a proportion of GDP, although rising, remains under one per cent – well below the US, Europe, South Korea and China.²⁰⁰ But a better indicator of technological catch-up, as with many other developing economies, could be the country's more impressive trade and investment figures. Until recently, India's private sector did very little R&D: a study by the College of India found that 86 per cent of Indian companies spent nothing on R&D.²⁰¹ Even the IT icon Infosys only spends 1 per cent of its sales revenue on R&D.

Business R&D growth is limited to a few sectors

Yet, heightened competition in the liberalising sectors of the economy has led to a seven-fold increase in R&D spending by companies in 2004 since 1999.²⁰² But this is more pronounced in some sectors than others – for example R&D spending in pharmaceuticals increased by 300 per cent between 2000 and 2004 from two to eight billion Rupees.²⁰³ Automobile design and parts of the IT sector are also investing more in R&D.

The investment environment is improving but still faces significant challenges

A recent World Bank report, 'Unleashing India's Innovation', recommends increased competition within its investment climate, whilst also supporting a stronger skills base, building a better information infrastructure and facilitating more public and private finance. The report also recommends that India needs to strengthen efforts to create, share and commercialise knowledge and innovation from its diaspora to private enterprise and smaller entrepreneurs.²⁰⁴ In a country as diverse and complex as India, however, such changes are difficult to implement. They will require significantly more resources and dedication by the Indian Government, the private sector, universities and the general population. Achieving this level of co-ordination is one of the biggest challenges facing the country.

Performing below its potential

Though much has been achieved, India is underperforming relative to its innovative potential, which has direct implications for the country's long-term competitiveness and economic performance.²⁰⁵ The United Nations currently ranks India only 63rd out of 162 countries for technological achievement.

That there is still room for improvement can be seen in the southern city of Bengaluru (Bangalore), which has played a starring role in India's story of innovation, and is home to the headquarters of top technology success stories like Infosys and Wipro as well as multinational R&D hubs like that of GE. But even here, the pains of growth are visible as the city's infrastructure has failed to keep pace.

Competing for talent retention

A particular challenge remains India's reputation as the 'world's talent factory' which, despite the potential opportunities, implies that India has to compete with the rest of the world for its own talent. Talent retention and attraction continue to be a major challenge.

Internationalisation

Openness and integration in the world economy are recent to India

India has been open for global business for less than two decades, but its post-liberalisation economy has rapidly internationalised. Twenty years ago, only a few foreign companies were permitted to set up in India. Today, trade barriers have largely been removed and the highest tariffs significantly reduced from 350 per cent in 1991 to 20 per cent in 2005.²⁰⁶

Both inward and outward investments have grown very rapidly

Now, India is one of the largest recipients of foreign investment in the world and its attraction to overseas investors is rapidly growing. India received approximately US\$6.676 billion in inward investment in 2005, which then jumped to almost US\$17 billion in 2006.

India's outward investment is also impressive – growing at an average of over 50 per cent on a three-year moving average, between 1992 and 2004.²⁰⁷ From 2005 to 2006, outward investment jumped even more dramatically from US\$2.5 billion to US\$9.6 billion.²⁰⁸ With such growth, it is hardly surprising that India is ranked second in the 2007 Foreign Direct Investment Confidence Index by AT Kearney, behind China.²⁰⁹ Given that China boasted extraordinary inward investment inflows of almost US\$70 billion in 2006, and outward flows of US\$16 billion, there is clearly much scope for continued strong growth in foreign investment in India.²¹⁰

200. Ibid.

201. Ibid.

202. See www.blonnet.com/2003/03/20/stories/2003032001150200.htm

203. World Bank (2007) 'Unleashing India's Innovation.' World Bank Report. Washington DC: World Bank.

204. Ibid.

205. Ibid.

206. Ibid. pp.xv.

207. UKTI (2008) 'India Country Profile.' Available at: https://www.uktradeinvest.gov.uk/ukti/appmanager/ukti/countries?_nfs=false&_nfpb=true&_pageLabel=CountryType1&navigationPagelD=/india [Accessed: 26/3/08].

208. UNCTAD (2007) 'World Investment Report.' Geneva: UNCTAD.

209. Ibid.

210. AT Kearney (2007) 'Foreign Direct Investment Confidence Index: New Concerns in an Uncertain World.' AT Kearney.

Indian skilled and professional diaspora are acting as important channels of internationalisation for the Indian economy
But the liberalisation of India's economy is just one of the elements which have led to greater internationalisation. The increased flows of people, ideas and cultures between India and the world have also underpinned this trend. An influential slice of the 20 million Indians spread around the globe are scientists, technologists, engineers and entrepreneurs. Now, many of the thousands of graduates who left India's shores are returning to India for at least part of their time, bringing with them money, ideas, contacts and skills.

In the 1980s and 1990s, a number of high profile Indian entrepreneurs, particularly in Silicon Valley, used their positions in large high-tech firms to champion India as a low-cost investment location, though few returned home permanently. High profile success stories like HP-India, Oracle-India and Motorola's India Software Centre helped to build India's international reputation for technology, particularly in places like Bangalore, and they also played an important role in boosting the country's own confidence and global strategy. If these investment trends continue, they hold the promise of simultaneously stopping India's brain drain and maintaining its position as a talent factory.

In this scenario, instead of Indians going abroad, foreign investment and outsourcing will bring high-skill jobs home. Bangalore, for example, is now home to over 100 multinational development centres, a cluster unlikely to have occurred without the influence of Indian-born engineers from Silicon Valley and elsewhere.²¹¹ It's little wonder, therefore, that some of the housing developments around Bangalore are being dubbed 'little Americas', with 80 per cent of the residents Indian returnees.²¹²

Internationalisation is changing both old and new industrial sectors

Certain industries are setting examples of the flourishing growth that can result from embracing international trade and capital. For example, following the loosening of restrictions on joint ventures and the subsequent international competition, Indian automobile manufacturing has risen in value to around US\$5 billion. It is still increasing by 15 per cent a year, resulting in increased labour productivity, steady employment and higher wages, whilst also advancing India's reputation as an emerging international leader in highly

skilled manufacturing. Business-outsourcing, particularly in IT services, an industry in which India has built a global reputation, is now worth US\$1.5 billion; in 2002 it attracted 15 per cent of total foreign direct investment and was worth 10 per cent of all exports.²¹³ Pioneering multinationals such as Texas Instruments and GE trained thousands of local workers, many of whom transferred their newfound skills to new Indian-run smaller replicas.

Some cities are more internationally focused than others

Not everywhere in India has embraced internationalisation equally. Some states and regions have stood out. Mumbai in Maharashtra, New Delhi in Delhi, Chennai in Tamil Nadu and Hyderabad in Andhra Pradesh have all become global centres with international inflows and outflows of people, business, and capital and booming economies. There are also the second-tier cities mentioned previously, such as Ahmedabad, Pune and Chandigarh, that could become hotspots for innovation.

India-UK links and opportunities

Whilst India and the UK obviously share a strong, if chequered, historical bond, some fear that intellectual ties between the UK and India are withering. Young Indians increasingly look to the US and elsewhere in Asia for study and collaborations, taking advantage of the more 'visible' and top-down collaboration initiatives that these countries promote. The UK can ill afford to be complacent about its relationship with India. When the UK Prime Minister visited India in January 2008, he spoke of a confident 21st century India working with a confident 21st century UK "in an equal partnership and an alliance that is founded on shared values".²¹⁴

Business links

Both trade and investments between the two countries continue to grow

India is the UK's 18th largest export market, with the UK exporting £3.9 billion of goods and services to India in 2005.²¹⁵ Over the past five years, trade between India and the UK has doubled, rising by 20 per cent a year, and there are approximately US\$10 billion of contracts in the market for potential business opportunities between Indian and UK companies.²¹⁶ There have also been a number of strategic investments that have enabled both the UK and India to benefit and assist in strengthening key sectors and infrastructure within both countries respectively, such as

211. UNCTAD (2007) 'World Investment Report.' Geneva: UNCTAD.
212. Saxenian, A-L. (2006) 'The New Argonauts.' Cambridge, MA: Harvard University Press.
213. Bound, K. (2007) 'India: The Uneven Innovator.' London: Demos.
214. NASSCOM-McKinsey Report (2005) 'Extending India's Leadership of the Global IT and BPO Industries.'
215. UKTI (2008) 'India Country Profile.' Available at: https://www.uktradeinvest.gov.uk/ukti/appmanager/ukti/countries?_nfs=false&_nfpb=true&_pageLabel=CountryType1&navigationPagelD=/india [Accessed: 26/3/08].
216. UK Prime Minister Gordon Brown (2008) Speech at the Chamber of Commerce in Delhi, 20/1/2008. Available at: <http://www.number-10.gov.uk/output/Page14323.asp>, date accessed 29/5/08

India's investment in British Steel, and the UK's investment in India's telecommunications sector.

London is the number one location for Indian investments in Europe

According to a recent report by the Greater London Authority, London attracts 32 per cent of all Indian FDI into Europe, more than any other European location. This FDI attraction has been assisted by the commitment of London's key FDI agency, Think London, which has helped at least 50 Indian companies to set up in London over the past three years, including the Punjab National Bank and Orchid Pharma.²¹⁷

increasing marketing campaigns by other institutions. There are also concerns that some UK institutions may be undermining the UK's reputation by not providing teaching or support of sufficient quality.²¹⁸

The number of Indian students in the UK continues to grow, but the US remains ahead

Whilst the gap between the number of Indian students in the US and UK is widening in the US's favour, the UK is still experiencing a rapid growth in the number of Indian students. From 2005/06 to 2006/07, their number increased by a massive 24 per cent from over 19,000 to almost 24,000. This reflected the better marketing by UK universities and an increasing number of Indian students seeking tuition abroad.²¹⁹ India is consistently the UK's second highest source of international students behind China (which accounts for around 50,000 students). But the UK can ill afford to become complacent and must direct far more attention to proving its credentials as a leading force in science, innovation and entrepreneurship.

Academic links

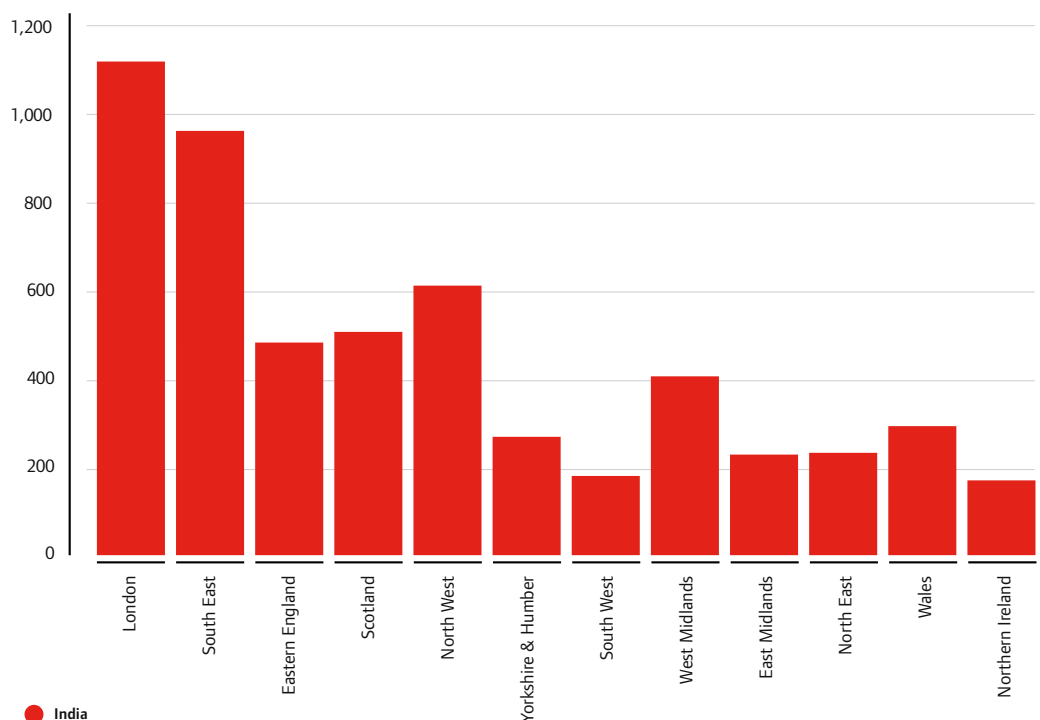
Student exchanges are also critical to collaboration. Given historical links, the UK was for long the natural destination for Indian students. But this has changed: today's young people are more likely to view the US as the place to go for entrepreneurship and innovation. Oxford, Cambridge and Imperial College are the only universities with strong reputations in India, despite

Academic research between the UK and India remains low

Another vital component of this relationship is academic collaboration. According to figures

- 217. GLA Economics and the London Chamber of Commerce and Industry Asian Business Association (2007) 'Spotlight on Asian Business: Their Contribution to London.' London: Greater London Authority.
- 218. Bound, K. (2007) 'India: The Uneven Innovator.' London: Demos.
- 219. HESA press release (19 March 2008) 'Students in Higher Education Institutions 2006/07'. Available at: <http://www.hesa.ac.uk/index.hp/content/view/1158/161>

Figure 4: Geographic distribution of co-authored academic papers between the UK and India



Source: Evidence Ltd, unpublished data (2008)

from the US National Science Foundation, the number of India's internationally co-authored papers rose from around 1,700 in 1996 to over 3,000 in 2003, as Indian scientists and institutions sought to become key players in the international science network. Despite this, research collaboration between the UK and India remains low, and is even declining (the US's share has also declined, although from a much higher base). Between 1996 and 2003, the UK's share of scientific co-authored papers with India fell from 10.2 per cent to 8.2 per cent.²²⁰

Medical sciences and physics researchers lead the collaboration between the two countries

According to data compiled by Evidence Ltd, there were over 4,600 UK-India co-authored papers between 1997 and 2006 with research in physics and medical sciences amongst the top disciplines.²²¹

Researchers from across the UK have collaborated with Indian researchers but researchers from London, the South East and the North West dominate

Significantly for regional absorptive capacity, there was an impressive spread of collaboration across the UK. Whilst London is the obvious beneficiary of the majority of co-authored work, the data demonstrates that over the period of 1997-2006, areas such as the South East, Eastern England, Scotland and the North West all boasted around 500 or above co-authored papers (with London just over 1,100).²²² Figure 4 provides an overview.

STI links

One often-cited obstacle to scientific collaboration with the UK is that its bottom-up model of scientific collaboration can be difficult to identify and navigate. Whilst this scientist-led approach has significant benefits and is producing strong results in terms of joint project and co-authorship, it also breeds considerable frustration among collaborators who criticise it for being too diffused. They contrast it with the top-down models of funding and decision-making in the US, China, France and Germany.

New initiatives to further support scientific collaboration

Through initiatives such as the UK India Education and Research Initiative (UKIERI), a £25 million fund to support collaborative

efforts, the UK has begun to address making life easier for potential partners – providing a new mechanism that can combine the best of both models. Bringing together significant government investment as well as contributions from major corporations such as BAE, BP, GlaxoSmithKline and Shell, this flagship programme focuses on strengthening collaboration at several levels: between higher education and researchers; between schools; and through developing professional and technical skills in both countries.²²³ The Initiative also provides an important avenue for engagement on issues of mutual policy interest such as quality assurance, international standards and credit recognition schemes – policy foundations that are integral to maximising collaborative opportunities.

But there is much pressure on the UKIERI to achieve its ambitious goals and there are many sceptics, given it took over two years to launch after Prime Ministers Blair and Singh announced its establishment in 2004. The tensions which surrounded its development exemplify the challenges of working across institutions within the UK, but also internationally, as the Indian Government were slow to match funding. However, despite these teething problems, UKIERI is extremely promising and should be a central plank of more radical efforts to scale up collaboration.²²⁴

British Council and Royal Society continue to create initiatives supporting collaboration between the scientific communities in the two countries

Key institutions such as the British Council and the Royal Society also fund exchanges that aim to create partnerships in science and technology between individuals and institutes. The British Council's focus is on biomedical sciences and genomics, climate change and environment, and pure sciences, in collaboration with the Royal Society, and more recently nanotechnology.²²⁵ These are key sectors where there is much scope for exciting and ground-breaking research if the British Council can stimulate and inspire commitment from both sides.

Increasing UK STI representation in India

Research Councils UK (RCUK) has announced that it will open an office in India in 2008, following the establishment of offices in the USA and China in 2007. With the aim of increasing the volume, range and durability of substantive research collaborations with the UK, this institution will open Indian researchers to the many diverse opportunities which exist

220. Bound K. (2007) 'India: The uneven innovator.' London: Demos.

221. Evidence Ltd (2008), unpublished data for NESTA.

222. Evidence Ltd (2008), unpublished data for NESTA.

223. See UK India Education and Research Initiative website at: <http://www.ukieri.org/> [Accessed 29/5/08].

224. Bound K. (2007) 'India: The uneven innovator.' London: Demos.

225. Ibid.

across all of the key research institutes in the UK.²²⁶ RCUK is also contributing £4 million, to be matched by India's Department of Science and Technology, to establish a Science Bridges Initiative which aspires to build partnerships between Indian and UK research institutes.²²⁷

The institutional infrastructure for India-UK STI collaboration continues to grow

In addition, there is an extensive array of existing initiatives and organisations dedicated to building relations between the two countries, providing much scope to build and extend upon existing foundations. Such collaborative efforts include the Indo/UK Science and Innovation Council, the OSI/Department of Science and Technology Networking Scheme, the JETCO (UK/India Joint Economic Trade Committee) and the UK/India Roundtable, just to name a few.

Inter-governmental collaboration around global issues such as climate change provides an additional dimension to India-UK collaborations in STI

There are also encouraging examples of the UK and Indian governments' collaborative efforts to tackle pressing global issues such as climate change. In 2006, both governments commissioned the University of Sussex, in partnership with the Energy and Resources Institute, India, to develop a comprehensive study to help inform intergovernmental discussions about the development and transfer of low-carbon energy technologies.²²⁸

More recently, during the Prime Minister's visit in January, both countries agreed to a second phase in the UK-India Climate Change Impacts and Adaptation Study, aimed at identifying the barriers to local carbon technology transfer. This is to be complemented by a number of collaborative pilot projects which will explore possibilities for encouraging more carbon market investment through cleaner more efficient technologies.²²⁹ More such initiatives should be encouraged if the UK/India relationship is to achieve its full potential, particularly in such important areas of global scientific need.

People links

The Indian diaspora in the UK continues to grow in numbers and significance

Migration presents significant opportunities to build understanding and networks between countries. India has a 22 million-strong

diaspora around the world, including a growing migrant population in the UK. Home Office Statistics suggest that the number of Indian migrants coming to the UK on work permits is a growing potential source of exchange and relationship building.

Work Permits and the Highly Skilled Migrant programme are contributing to the growth

In 1998, just over 8,700 Indians came to the UK on short to medium-term work permits. Those numbers had risen to 23,835 by 2007.²³⁰ Under the UK Government's highly skilled migration programme, the number of talented Indians coming to the UK is also increasing quite dramatically. In 2002, the number of approved Highly Skilled Migrants for Indian-born applicants was just 176, but by 2005, this had increased massively to 5,483 (3,827 above the second highest source of highly-skilled migrants: Pakistan).²³¹ The skilled immigration programme has been recently changed into a point-based system and it remains to be seen what the implications of the change will be on attracting immigrants from India.

The growth is also notable in impact and significance

The Indian diaspora has a significant presence in various business and high-skilled professions, such as IT and medicine. Of the 18,250 expatriate IT professionals who entered the UK in 2000, over 11,000 were from India, whilst 6 per cent of doctors in the UK National Health Service were of Indian origin in that same year.²³² A number of Indian immigrants have also assumed prominent roles with business, academia and government in the UK, enabling them to champion collaborations between India and the UK. In 2000, there were more than 300 influential, non-resident Indian businesspeople in the UK, as well as another 150 Indians who were considered very rich and prominent within key sectors. These include Gulu Lalvani of the electronics industry, Jasminder Singh of the hotel industry, and Lord Swaraj in manufacturing.²³³ On the political front, the Indian community has long been active. In 2000, there were four members of the House of Commons of Indian origin, and 11 members of the House of Lords.²³⁴

'Brain circulation' is also an important mode of networks-building

Whilst any attempts to lure talent from one country to another raises concerns about a 'brain-drain', it also raises the prospects of greater knowledge exchange. With increasing evidence that many Indians are returning

226. See FCO website, 'India-UK Strategic Partnership - Joint Declaration 2008.' Available at: <http://ukinindia.fco.gov.uk/en/new-pages/postin-bil-indiaukstrategicpartn>

227. Sussex Energy Group (2008) 'UK-India Collaboration to Identify the Barriers to the Transfer of Low Carbon Energy Technology.' Available at: <http://www.sussex.ac.uk/sussexenergygroup/1-2-9.html> [Accessed: 26/3/08].

228. UK-India Bilateral Relation, High Commission of India, London. Available at: <http://www.hcilondon.net/bilateral-relations.html> [Accessed 29/5/2008].

229. Home Office (2003) 'Statistical Bulletin, Control of Immigration Statistics 2003.' London: HMSO.

230. See http://www.hsmp-services.co.uk/hsmp_approval_statistics_total.html

231. Pandey, A., Aggarwal, A., Devance, R. and Kuznetsov, Y. (2006) 'The Indian Diaspora: A Unique Case. Diaspora Networks and the International Migration of Skills.' Washington, D.C: World Bank Institute.

232. Ibid.

233. Ibid.

234. Saxenian, A-L. (2005) From brain drain to brain circulation: Transnational communities and regional upgrading in India and China. 'Studies in Comparative International Development.' 40:2, pp.35-61.

home, this suggests a 'brain circulation' between India and the UK. These influential returnees start new companies or take up senior positions in academia or business while maintaining useful links and networks in the UK, as well as a deeper understanding of the opportunities that could be leveraged within their former homeland.

As AnnaLee Saxenian argues, the potential of these links and understandings is phenomenal. A survey of Chinese and Indian immigrant professionals in Silicon Valley found that 80 per cent of the Indian respondents exchanged information on American jobs or business opportunities with people in India, 67 per cent served as an advisor or helped to arrange business contracts, and 18 per cent invested their own money in start-ups or venture funds in India.²³⁵

UK government efforts

Attracting Indian entrepreneurs to the UK

The UK government is now also trying to inject a more personal, bottom-up approach to Indian talent attraction to the UK. The UK Global Entrepreneur Programme (GEP), which was launched in India, aims to help experienced Indian entrepreneurs and people with 'big ideas' set up shop in the UK.²³⁶ Whilst it is too early to measure the programme's success, it represents an encouragingly fresh approach to building connections between the UK and India.

Launching the UK India Business Angel Network

Building on GEP's work and existing networks of early-stage investors – or business angels – in the UK and India, Prime Minister Gordon Brown also launched the UK India Business Angel Network (UKIBAN) during his recent visit to India. The network is aimed at stimulating greater connections and synergies between angel networks and investor communities, whilst also raising the profile of entrepreneurs and investors in both countries. It is also promoting the UK's expertise in due diligence and fostering entrepreneurship. Between its launch in January to May 2008, the UKIBAN has assisted in the early stages of almost 30 deals – an impressive achievement in only four months.

The UK India Business Council was set up to foster bottom-up business relations between the two countries

The angel network (UKIBAN) is managed by one of the key institutions for the promotion of bilateral trade – the UK India Business Council (UKIBC). In 2008, the UKIBC identified life sciences as one of the priority markets for promotion of trade and investment, and as part of the Prime Minister's visit to India in January, facilitated the UK-India Entrepreneurs Summit focused on cross-border innovation, entrepreneurship, venture capital and knowledge transfer. The summit represented an important opportunity to stimulate collaboration and involved key influential players of politics in the UK and India, including Prime Minister Brown, India's Science and Technology Minister Kapil Sibal and UK Trade minister Lord Digby Jones, as well as senior business figures like Sir Richard Branson, Sunil Mittal and Lord Karan Bilimoria.²³⁷

4.3 China: the next innovation powerhouse?

Basic economic and S&T data

China became in 2006 the world's fourth largest economy, pushing the UK into fifth place. The growth of China's economy over the past 30 years, since the 'reform and opening up' of Deng Xiaoping in 1978, is an historically impressive story of economic development. With growth averaging close to an unprecedented 10 per cent per annum, the rise of China – or rather its re-emergence after some two centuries of extraordinary turmoil – is without doubt one of the most significant developments in global politics and economics.

In 2007, Gross Domestic Product grew by 11.9 per cent, the fifth year of double-digit growth, and some Chinese economists optimistically predict that China is set for 30 more years of similarly rapid growth.²³⁸ This growth has led to impressive increases in individual income, with corresponding reductions in poverty levels within a country that is home to one-fifth of the world's population. China's GDP per capita is still low compared to the OECD average, but its position as a leading global trading nation is strengthening, with exports surging from 20 per cent of GDP in 2001 to almost 40 per cent in 2007.²³⁹

After several decades of rapid growth, the challenge for China's economy now is ensuring

235. UKTI (2008) 'UK Goes all Out to Indian Biz Talent.' Available at: <http://www.entrepreneurs.uktradeinvest.gov.uk/content/current/news/IndianBizTalent.cfm> [Accessed: 14/04/2008].
236. UK-India Business Council Official Report, 'UK Business Delegation and State Visit of Prime Minister Gordon Brown and Minister for Trade and Investment, Lord Digby Jones of Birmingham', New Delhi, India, January 2008.
237. XinhuaNet (2008) 'Central Bank Economist: China set for 30 more years of fast growth.' Available at: www.xinhuanet.com. [Accessed 13/8/2008].
238. The Economist (2008) 'An old Chinese myth.' January 3rd 2008. Available at: www.economist.com/finance. [Accessed 13/8/2008].
239. OECD Reviews of Innovation Policy (2007) 'China – Synthesis Report'. August 2007. Paris: OECD.

Table 7: China's Key Country Indicators

Population 2005 ²⁴⁰	1,320,000,000	Life expectancy at birth (Women, Men), 2007 ²⁴²	72, 71
Area (sq km)	9,597,000	Total labour force 2007 ²⁴³	800,700,000
Currency	Yuan/ Renminbi	Government type	[One-Party] Republic
GDP (USD), 2006 ²⁴¹	\$3.28 trillion		

Source: CIA World Factbook

“that further progress – economic, social and environmental – will be both sustainable and comprehensive”.²⁴⁴ In January 2006, China's Science and Technology Congress approved a new Medium to Long Term Science and Technology Development Programme. This identifies priorities for the next 15 years and confirms the aim of boosting investment to 2 per cent of GDP by 2010 and 2.5 per cent by 2020. Reaching these targets will require investment in 2020 to be six times what it is today. The plan says that advances in science and technology should eventually account for 60 per cent of economic growth, and that China should aim to be among the top five countries worldwide in terms of patents and scientific citations. The plan starts by acknowledging that while manufacturing remains crucial, it will not be sufficient to carry China through the next stage in its development. These can be overcome only through a new focus on ‘indigenous innovation’ (zizhu chuangxin).

Certain slogans and concepts have defined different periods in China's history: ‘serve the people’ in Mao's time; ‘reform and opening up’ and ‘the four modernisations’ during the Deng Xiaoping period; ‘the three represents’ of Jiang Zemin; and under Hu Jintao phrases like ‘the peaceful rise’ and ‘the harmonious society’. Zizhu chuangxin looks set to become another era-defining mantra. Policymakers have decided that indigenous innovation is what China needs. It is no longer enough to import or copy high-end technologies from the US and Europe. If China is to find its rightful place in the world economy, it needs innovation that can support future waves of economic growth.

Chinese innovation performance

A country led by scientists and engineers

A century ago, at the 1908 London Olympics,

China failed even to field a team. Eighty years later, in Seoul, it finished in 11th place. In Athens, in 2004, it climbed to second, just behind the United States. And this summer, as Beijing played host to the most spectacular Olympics in history, China topped the table for the first time, with a staggering tally of 51 gold, 21 silver and 28 bronze medals.

But if this is what China can achieve in sport, how quickly will it become a global leader in science and innovation? There are some striking parallels between sport and innovation: in both areas, the Chinese government has set ambitious, long-term targets and then mobilised vast resources to achieve them. Just as the US\$40 billion spent on the Beijing Games dwarfed anything that had gone before, so China is now at an early stage in the most ambitious programme of research investment the world has ever seen. A technocracy, led by “scientists and engineers who believe in the power of new technologies to deliver social and economic progress”,²⁴⁵ China has set a determined course to become a powerhouse of science and engineering, and is taking unprecedented steps to achieve this. The OECD reported in 2006 that China had surpassed Japan as the second highest R&D investor in the world after the United States.²⁴⁶

China's R&D and innovation capabilities are improving rapidly

As a developing country, China was previously dependent on access to innovations and new technologies through FDI, multinational companies, international partnerships and imports. This picture is now starting to change and China's R&D and innovation capabilities are improving rapidly. Its expenditure on R&D as a percentage of GDP (itself a rapidly moving target) has grown from 0.6 per cent in 1996 to 1.3 per cent in 2005. It continues to grow at 19.2 per cent per annum and government targets project it to reach 2.5 per cent of GDP by 2020 (see below). Publications of papers by

240. Unicef. Available at: http://www.unicef.org/infobycountry/china_statistics.html

241. See World Bank website, ‘China at a glance.’ Available at: http://devdata.worldbank.org/AAG/chn_aag.pdf [Accessed 22 October 2008].

242. Ibid.

243. Ibid.

244. See CIA World Factbook website. Available at: <https://www.cia.gov/library/publications/the-world-factbook/geos/ch.html>

245. OECD, cited in Ibid.

246. Corbyn, Z. (2008) ‘China nears UK in brain games.’ *Times Higher Education*, 7 August 2008.

Chinese scientists have shot up from roughly 2.5 per cent of global publications in 1996 to 8.62 per cent in 2007 (only just behind the UK with 8.63 per cent). Citations have also improved dramatically, rising from a global ranking of 17th in 1996 to 8th in 2007 (with 5.6 per cent of citations, compared to 12 per cent for the UK). There have been particular improvements in the physical sciences and engineering, and in emerging fields such as nanotechnology.²⁴⁷

The Science and Technology base is expanding too

China now has six universities in the world's top 200. It has 7.9 million engineering and science undergraduates enrolled in its higher education system, and awards around 16,000 science PhDs each year. There are some 1,200 R&D centres for multinational companies, with around 100 of them performing cutting-edge innovative R&D. These are increasingly spread across China and not just in the innovation centres of Beijing, Shanghai and the Pearl River Delta. For instance, IBM now has set up an R&D centre in the central city of Xi'an in Sha'anxi Province. Domestic invention patent applications have grown at 23 per cent annually. Since 2000, according to the state intellectual property office, of which 18 per cent come from Chinese companies. US patents granted to Chinese companies have grown from 119 in 2000 to 661 in 2006, overtaking Belgium, Austria, Denmark and Spain. If Hong Kong is also counted, this figure rises to 969, more than Finland.

The number of researchers in China has grown rapidly too, from 695,000 in 2000 to 1.1 million in 2005. In absolute terms, China ranks third behind the United States (1.4 million) and the EU (1.2 million) but ahead of Japan (705,000) and Russia (465,000). However, when expressed as a proportion of total employment, China's 1.5 researchers per 1,000 lags the OECD average of 7.3.²⁴⁸

The Chinese innovation system is quickly developing a number of niches

Chinese policy remains wedded to central planning in some respects, though it is now managing to support a growing number of niches of excellence. In particular, China is a world leader in nanotechnology and telecommunications and is rapidly improving in highly technical fields such as biotechnology and genomics. In low-carbon innovation too, there are some striking advances being made. For instance, in fuel cell and electric vehicles, pioneering work is being done at a

number of research institutions, including the Dalian Institute for Chemical Physics, Wuhan University of Technology and Sun Yat-Sen University in Guangzhou, all of which also have strong links to assist commercialisation of their work.

Looking beyond the big centres, a next wave of innovative cities is emerging

Much of the innovation spotlight is directed to the three most innovative regions in China – the Yangtze River Delta (which includes Shanghai and 14 other cities), the Pearl River Delta (which includes Guangzhou, Shenzhen and Hong Kong), and the BoHai Rim (which includes Beijing and Tianjin). It is not surprising that these regions get the lion's share of attention, given that together they generate 45 per cent of GDP and over 70 per cent of international trade and investment. But the Chinese government increasingly emphasises the need to bridge the growing divide between the cities and the countryside, and in turn, share the benefits of China's economic growth.²⁴⁹

In addition to central government initiatives, places like Chongqing, Chengdu and Xi'an are developing innovation ambitions of their own. Chongqing boasts a rising science budget, an R&D workforce of over 60,000 and over 70 research institutes. In Chengdu, R&D spending has increased by 13 per cent each year since 2001, the fastest growth in western China, whilst Xi'an is home to one of China's largest software parks and technical universities which produce over 30,000 software engineers per annum.²⁵⁰

Main government policies, initiative and strategies

The Medium to Long Term Plan

The centrepiece of China's innovation policy is the Medium to Long Term Plan of 2006.²⁵¹ This has three main aims: to increase the proportion of GDP spent on R&D; to improve China's domestic innovation capacity; and to deepen the leadership of the business sector within the innovation system. The plan also lists priority sectors – biotechnology, aviation, aerospace and marine technologies – and a further 11 fields of basic research that merit targeted investment: energy resources; IT; water and mineral resources; health care; environment; urban development; agriculture; public securities; production technology; national defence; and transportation. Finally,

247. OECD (2007) 'Science, Technology and Industry scoreboard 2007.' Section B10. Paris: OECD.

248. Wilsdon, J. and Keeley, J. (2007) 'China: The next science superpower?' London: Demos.

249. Ibid.

250. Officially titled 'The National Program 2006-2020 for the Development of Science and Technology in the Medium and Long Term' (Guojia zhong changqi kexue he jishu fazhan guihua gangyao 2006-2020).

251. Wilsdon, J. and Keeley, J. (2007) 'China: The next science superpower?' London: Demos; UKTI (2008) 'UK Goes all Out to Indian Biz Talent.' Available at: <http://www.entrepreneurs.uktradeinvest.gov.uk/content/currentnews/IndianBizTalent.cfm> [Accessed: 14/04/2008].

Box 3: Case study – Science parks in China

Science and technology parks are another important feature of Chinese innovation. The scale and speed of investment in these parks is unprecedented. There are now 53 parks across China, with 30 more planned by 2010.²⁵² Data from the Chinese Ministry of Science and Technology shows that the turnover of the parks grew by almost 50 per cent year on year throughout the 1990s, to reach US\$187 billion by 2002. In the same period, the number of people employed rose from 140,000 to almost 3.5 million.²⁵³

One of the most successful of these experiments is Zhongguncun Science Park (known as ZGC), sometimes called the ‘Silicon Valley of China’. Spread across a large area of north-west Beijing, ZGC boasts the largest concentration of high-tech companies in China, and in 2002 generated revenues of US\$29 billion. Its firms account for 40 per cent of China’s software market and include the top internet portal Sina. It also houses a growing number of biotech and nanotech start-ups. The park benefits from its close proximity to Beijing and Tsinghua Universities, and a number of top research institutes, and is sustained by dense networks of scientists, engineers and entrepreneurs, with numerous links zig-zagging back to the US, Europe, Taiwan and Korea.

The parks are clearly successful at attracting investment, but how innovative are they? Science parks have become a key part of China’s development orthodoxy; they reflect a willingness to think big and make serious investments in infrastructure. Yet, for now, the majority of firms within them

still appear more focused on high-tech manufacturing than cutting-edge R&D, and there is little evidence of cross-fertilisation between sectors and industries. Talking to park managers and tenants, compelling examples of successful innovation remain surprisingly hard to pin down. This may gradually change as part of the new drive for independent innovation, but for now it is tempting to agree with one assessment that “conclusive empirical evidence of the advantages of a science park location has been elusive, and most findings suggest only marginal advantages at best”.²⁵⁴

Of course, getting the right chemistry in people, places and ideas is far from straightforward. Driving through Zhangjiang Hi-Tech Park, considered by many to be the most successful park in China, one is immediately struck by how walled in everything is. The physical layout of the park is not very inspiring, or human in scale: the roads are long and set at right angles, and it can be hard to find anybody walking. The walls around companies and research centres create an impression of exclusion and inaccessibility.

Can innovation flourish behind walls? Chinese walls are an enigma to foreign visitors. They suggest inwardness, secrecy and a lack of transparency, and imply that openness and accessibility are restricted. Does the physical geography of how spaces for innovation are planned hint at underlying attitudes which may be limiting in other ways? There is no easy answer to this question, but it is a dynamic that those within China and outside can find themselves struggling with as they try to build effective networks for collaboration.

16 large projects are highlighted for support, including space flight and fighting AIDS. This follows the pattern of innovation legislation to date, which is characterised by large research programmes such as the ‘Key Technologies’, ‘Spark’ and ‘Torch’ initiatives and the ‘863’ and ‘973’ programs (so-called because they were launched in March 1986 and 1997 respectively).

Challenges ahead

A supportive climate for innovation?

Whilst China’s innovation capacity is expanding on a steep trajectory, the country still faces many challenges. China’s ability to apply vast resources to a centrally defined goal may also be its greatest weakness. Unevenness exists alongside excellence: in some areas, China is now world class. But raising overall performance across the system will require sustained efforts to link the hardware of

252. Wilsdon, J. and Keeley, J. (2007) ‘China: The next science superpower?’ London: Demos.

253. Ibid.

254. Ibid.

investment and infrastructure to the software of culture, values and creativity. Debates over political freedom and human rights were never far from the surface of the Beijing Olympics, and innovation too is caught up in a bigger, unfolding debate about the pace and direction of reform. A recent editorial in *Nature* asked of China whether “a truly vibrant scientific culture is possible without a more widespread societal commitment to free expression”.²⁵⁵

Getting the framework right

If China is to capitalise on its own growing strength in science and technology, whilst also improving its ‘absorptive capacity’ to benefit from innovations generated elsewhere, it needs to ensure it has the appropriate policy frameworks in place. Whilst much has already been achieved, China must work to ensure “a modern system of corporate governance and finance, anti-trust law and effective intellectual property rights protection, and a modern, pro-competitive regulatory regime”.²⁵⁶ Such improvements would assist not only the national environment for innovation, but also act as a greater magnet for foreign investment in R&D-intensive sectors.

More home-grown heroes required

A big challenge for China is the persistent low level of business R&D. There are a number of reasons for this – government attention to date has focused on supporting high-class research institutes and boosting the university system without appreciating the important contribution the private sector can make to the national innovation system. Chinese firms are often very hierarchical so young talent is forced to defer to senior management. Investments are often rushed and lack strategic planning, whilst the boundaries between public and private ownership can be blurred.²⁵⁷ For China to reach its potential, firms of all sizes need to appreciate and foster innovation, and the government needs to encourage far more collaboration and exchange between the private and public sector.

Internationalisation

Several Chinese firms are already global players

But despite the relative lack of business R&D, several Chinese firms are making their way on to the global stage. While they may not yet be household names, China has six companies in the *Fortune* 200 Global companies (including the two oil giants Sinopec and China National

Petroleum) and a further 18 in the top 500. Brands like Haier, Huawei and Lenovo are also slowly gaining global recognition.

International trade and investment continue to grow

In 2003, Chinese exports amounted to US\$438 billion while imports were US\$413 billion. Both imports and exports have continued to grow, with the surplus rising to over US\$262 billion in 2007. China is also a major draw for foreign direct investment, which reached US\$60 billion in 2005, making it the third most popular destination for FDI after the United States and the UK.

Internationalisation is concentrated in the major urban centres, but is expanding to other places too

As one might expect, urban centres like Beijing, Shanghai and the Pearl River Delta are most closely integrated into the global economy. But other regions, including some inland cities, are becoming increasingly attractive locations for international business, such as the innovation drives of Chongqing, Chengdu and Xi’an mentioned above.

The ‘Sea Turtles’ returning home

In the 25 years after the Cultural Revolution, over 700,000 Chinese graduates headed abroad for further study. Faced with greater career opportunities, greater academic freedom and a higher quality of life, most decided to stay in either the US or Europe. But in the past eight years, this trend has reversed, with over 170,000 Chinese returning to their homeland to take advantage of the emerging economic and entrepreneurial opportunities, as well as for reasons of family ties and national loyalty.²⁵⁸ Those who come back to China are commonly nicknamed ‘sea turtles’, from the term ‘hai gui’, which in Mandarin means returnee but also sounds like ‘sea turtle’.

This innovation diaspora, many of whom worked in hubs like Silicon Valley, are “undermining the old pattern of one-way flows of technology and capital from the periphery, creating far more complex and decentralised two-way flows of skills, capital and technology”.²⁵⁹ There are many different types of returnee: entrepreneurs, multinational managers, academic researchers and investors. They can often transfer aspects of the US or European entrepreneurial system to the new knowledge centres of Shanghai, Beijing, Guangzhou and Shenzhen. When their ideas, management skills, contacts and access to venture capital are added to what is already

255. See *Nature* editorial here: <http://www.nature.com/nature/journal/v454/n7203/full/454367a.html>

256. OECD Reviews of Innovation Policy (2007). ‘China – Synthesis Report.’ August 2007. Paris: OECD.

257. Wilsdon, J. and Keeley, J. (2007) ‘China: The next science superpower?’ London: Demos.

258. Ibid.

259. Saxenian, A-L. (2006) ‘The New Argonauts: regional advantage in a global economy.’ Cambridge MA: Harvard University Press.

there, new business opportunities quickly emerge.

The benefits are also visible in an academic setting. For example, at the CAS Institute for Biomedicine and Health in Guangzhou, 17 of the 18 principal investigators are returnees from the US or Canada. There are gains to both sides from this process of brain circulation. One of the directors, Biliang Zhang, explains: "Having us back in China running an institute is actually very useful for our colleagues in the US. It means we have a bridge on which to build collaboration. I'm now setting up a joint venture with my former professor in Massachusetts, which will be headquartered in the US, but take advantage of the cheaper research costs here".²⁶⁰

Foreign skilled workers in China

China's re-emergence as a world powerhouse has also meant that foreign workers are increasingly looking east. The precise number is difficult to gauge – in 2008, some estimated that there were 250,000 foreigners in Beijing alone.²⁶¹ Japanese workers account for up to 30 per cent of them, and there are also significant numbers from South Korea and Singapore. But a growing number are also now coming from the United States, Europe and India.²⁶²

Shanghai offers an interesting case study. Statistics from the Shanghai Labour and Social Security Bureau (SLSS) show that in 2004 there were roughly 28,000 foreign workers in the city; they expect this number to grow steadily by over 20 per cent per annum for the next few years.²⁶³ The head of the SLSS, Sun Hande, is committed to making Shanghai "more friendly for foreign workers, as it is in great need of high-quality professionals with global perspectives".²⁶⁴ Concrete policies are intended to back up this commitment. Foreigners can apply for work permits in Shanghai online – the only city in China with this option – and if all paperwork is submitted correctly, workers from abroad can expect a permit from the Shanghai Foreigner Employment Office within five working days. Sun's efforts to simplify the application procedure and offer multiple means of application and collection are helping increase Shanghai's foreign worker population, including the proportion of those workers who are highly skilled. Over 60 per cent of the 28,000 foreigners are senior executives.²⁶⁵

China-UK links and opportunities

Business links

Business links between the UK and China have never been stronger

In December 2007, China rose to become the UK's 11th largest export market (1.73 per cent of total direct exports), rising from 14th in 2006. China is also the UK's fifth largest import market (6.1 per cent). Similarly, the UK is by far Europe's largest attractor of Chinese investment, with one third of it going to the capital. London's \$218.4 million of Chinese FDI in 2004 represented nearly four times as many projects as other major European cities like Paris or Hamburg. Conversely, the UK is also a major investor in China, investing approximately US\$1 billion per annum there since 2000.²⁶⁶ Agencies such as UK Trade and Investment and the China-Britain Business Council support businesses of all sizes looking to tap into the China market, by working to remove barriers to entry, and provide in-market assistance from a network of offices and business advisers in the UK and across China.²⁶⁷

Academic links

The UK is the second most popular destination for Chinese students

About 50,755 Chinese students were in the UK in 2006, by far the biggest cohort of overseas students. Indeed, the UK remains the second most popular destination for Chinese students after the US. After a slight dip in 2007, the latest figures from the Universities and Colleges Admissions Service show the number of Chinese students applying to UK universities is rising once again, up 22 per cent to 7,880 applications.²⁶⁸ At postgraduate level, China is also the largest source of non-EU students entering the UK system, providing 5,160 out of a total of 50,365 international postgraduate students in 2006–2007.²⁶⁹

The number of UK students in China is still relatively small, making links overwhelmingly one-way at present. Professors across China say how keen they are for their PhD students to have some time overseas, consistently mentioning the UK as a top preference. One major reason for this is not just the research excellence of the UK, but also that the Chinese system expects several publications in international journals from its PhD students. Time in a UK university is seen as a good way of equipping Chinese PhD students with the

260. Interviewed in Wilsdon, J. and Keeley, J. (2007) 'China: The next science superpower?' London: Demos.

261. International Herald Tribune (April 2008) Andrew Jacobs. Available at: <http://www.iht.com/articles/2008/04/23/news/23expats.php?page=2>

262. People's Daily Online (July 2005). Available at: http://english.peopledaily.com.cn/200507/25/eng20050725_198103.html; China Daily (May 16 2004). Available at: <http://www.10thnpc.org.cn/english/Life/95541.htm>

263. Ibid.

264. Ibid.

265. Ibid.

266. UNCTAD (2005) Available at: http://www.unctad.org/en/docs/wir2005_en.pdf

267. UKTI/China-British Business Council (2008) 'China Business Guide -2nd Edition.'

268. UK Higher Education International Unit (2008) 'UCAS reports increase in international applications.' International Focus, Newsletter of UK Higher Education International Unit, Issue 22, 30 July 2008.

269. UK Higher Education International Unit (2008) 'The UK's Competitive Advantage: The Market for International Research Students.' Newsletter of UK Higher Education International Unit, July 2008.

requisite language skills to be able to write in good scientific English. Yet while educational ties are currently strong, they cannot be taken for granted. There are growing expressions of concern about the rising cost of UK university fees, especially when compared to some other EU Member States which also work in English but don't charge fees to overseas students.

UK universities are active in China too

UK universities are also building a presence in China to strengthen networks, tap into the enormous student market and encourage international collaboration and research. The University of Nottingham, for example, has established a campus in Ningbo, whilst Liverpool University has partnered with the Xian Jiaotong University to establish a joint campus in Shanghai.²⁷⁰

The UK Department of Children, Schools and Families is also getting in on the action, recently becoming involved in an e-learning programme to provide courses in China to some 20 million students.

As part of the 2006 Quality Assurance Agency report, UK universities outlined over 350 individual links with 230 of their Chinese

counterparts. These include partnerships between Leeds Metropolitan University and the Zhejiang University of Technology; Queen Mary University of London and Beijing University of Posts and Telecommunications; The Queen's University of Belfast and Shenzhen University; and the University of Bedfordshire and the China Agricultural University – just to name a few.²⁷¹ Furthermore, the Quality Assurance report found that nearly half of all UK universities and higher education colleges were involved in some way in partnerships with China,²⁷² and as China's reputation for quality higher education and research improves and its economic dominance continues, the opportunities for collaboration and exchange will only become stronger.

After the US, the UK is China's second most collaborative nation in scientific publications

There has been a fourfold increase in China's collaborative authorship of research papers over the past ten years. The UK is now the second most prolific co-author with Chinese scientists and has particular collaborative strength in the life and medical sciences and engineering.²⁷³ This reflects the continuing international reputation of scientific research in

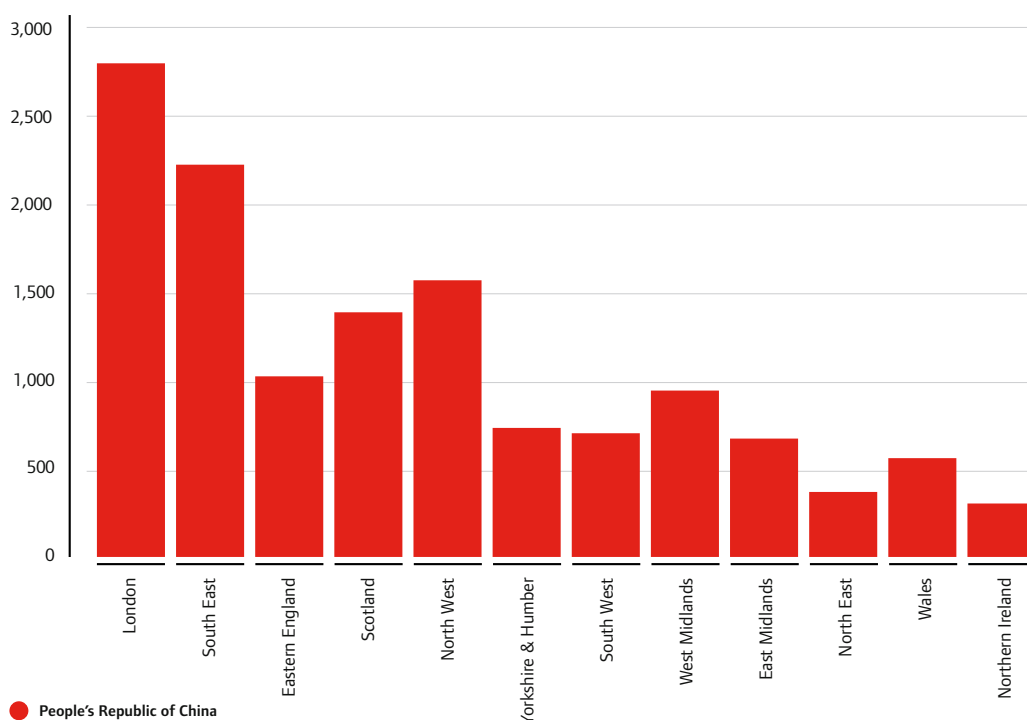
270. 'UK-China partnerships and collaborations in higher education.' 23 April 2008 by Johanna Waters for globalhighered. Available at: <http://globalhighered.wordpress.com/2008/04/23/uk-china-partnerships/>

271. Ibid.

272. Ibid.

273. Evidence Ltd (2006) 'Ethnic Minority Immigrants and their Children in Britain.' Available at: www.econ.ucl.ac.uk/cream/pages/CDP/CDP_10_06.pdf

Figure 5: Geographic distribution of co-authored academic papers between the UK and China



Source: Evidence Ltd, unpublished data (2008)

the UK, as well as the status of English as the international language of science and business.

Most research links between China and UK are built upon individual contacts and established shared research interests. One major way that such links are formed is by a Chinese researcher spending time in the UK as a PhD or post-doctoral scientist. The attractiveness of returning to China after such periods is increasing, leading to the rising numbers of returnees in China's research system. These personal contacts form the basis of many joint publications and other forms of international collaboration. Patterns of co-authorship and collaboration vary across the UK. Figure 5 below shows the number of joint papers by Chinese-UK authors by UK region.

People links

Another source of strong and longstanding links between China and the UK is the Chinese diaspora. There are about 30 million Chinese people living overseas. Indonesia and Thailand have the largest numbers – 7-9 million each – while Singapore has the highest concentration – 3 million, or three quarters of its population. In the UK, in the 1991 census, the number of Chinese was 156,938 (0.28 per cent of the UK population). By 2001, this number had increased to 247,403. Large scale migration of Chinese to the UK is a recent development, and Chinese still form the smallest ethnic minority group identified in the 2001 Census.²⁷⁴

Brightly coloured Chinatowns in the centres of cities like London and Liverpool are the most visible outward sign of the impact that Chinese migration has had on the UK. But Chinese in the UK today are among the highest-earning ethnic groups, and the most likely to do well at school. Around 50,000 UK Chinese – around a fifth of the total – now have jobs in law, medicine and other professions. The UK Chinese community has a number of active networks and associations, and websites such as www.dimsum.co.uk.

China's economic rise and the recent Olympics have helped to increase awareness and interest in China among the wider UK public. 2008 also saw the largest festival of Chinese culture ever in the UK – called China Now – which included over 1,200 events, performances and activities, designed to shine a spotlight on 21st century China.

Government links

In the past five years, the UK government has scaled up its science and innovation engagement with China. At the UK/China Summit in Beijing in January 2008, Prime Minister Gordon Brown announced £4 million for a Science Bridges scheme with China. Brown also said he wanted 100 new R&D partnerships between UK and Chinese firms over the next five years and the UK's output of joint papers with China to double.

UK government departments are working with China's Ministry of Science and Technology on priority projects, including a £3.5 million feasibility study for carbon capture and storage and a climate change impacts study led by the Department for the Environment, Food and Rural Affairs (Defra); and a £750,000 programme of clean fossil fuel projects led by the Department of Business Enterprise and Regulatory Reform (BERR). In addition, UK/China collaboration research programmes have recently been launched in three areas:

- Energy research collaboration (£6 million, led by the Engineering and Physical Sciences Research Council (EPSRC)).
- Research commercialisation and proof-of-concept collaboration (£5 million, Innovation China/UK-led).
- Science Bridges (£4 million, RCU-led).

The Scottish Government also published its own 'China Plan' in May 2008, which aims to strengthen economic, trade, innovation and research links.²⁷⁵

Other relevant instruments and partnership schemes include the UK/China Partners in Science initiative; the UK/China Focal Points scheme; a science partnership scheme run by the Royal Society and China Scholarship Council; the UK/China Sustainable Development Dialogue; and the UK/China Sustainable Agriculture Innovation Network. A number of collaborative studies are underway looking at various aspects of low-carbon technology transfer in the context of China. Tsinghua University is seeking to establish a low-carbon technology alliance with Cambridge University and the Massachusetts Institute of Technology (MIT).

Some of these schemes and programmes were formally recognised as central to bilateral science relations at the most recent UK/China

274. Ibid.

275. 'The Scottish Government's Plan for Engagement with China.' Scottish Government, 7 May 2008.

Joint Commission on Science and Technology in April 2008. In addition the commission agreed on the strategic importance to both countries of building a stronger partnership on innovation policy. Their full list of bilateral priorities is:

- Climate change, energy and environment.
- Infectious disease.
- Nanotechnology/and materials science.
- Stem cells and the modernisation of traditional medicines.
- Space technology.
- Innovation policy.

Yet despite these signs of growing collaboration, there is no room for complacency. The UK has much to offer as a partner to China, but certain difficulties arise from a mismatch between the two countries' funding systems. Unlike the UK's bottom-up approach, government in China is heavily involved in deciding which institutions get funding and for what areas of work. This

means that the science ministry, provincial and municipal policymakers and many research institutions themselves are well disposed to large, bilateral programmes (such as joint research centres), and tend to place less value on smaller, researcher-led activities. Inevitably, this puts the UK at a disadvantage compared with countries like France and Germany, which invest more readily in large, top-down projects. Working in this way guarantees political visibility and influence, and brings access to people and resources.

If the UK is to remain a leading partner for Chinese scientists and innovators, further reforms to the structures for collaboration will be required, to make larger and more sustained collaboration possible. A positive initiative in this regard was the opening of the Research Councils UK (RCUK) office in Beijing in October 2007. This office, sponsored by each of the UK's seven research councils, aims to make it easier for talented researchers in both countries to research collaboratively "on projects that advance knowledge, improve the quality of life and promote social and economic progress". The total value of live Research Council awards involving collaboration with China is now around \$93.3 million.²⁷⁶

276. Goldman Sachs (2005) 'How Solid are the BRICs?' Global Economics Paper No. 134. December 2005. Available at: http://www2.goldmansachs.com/hkchina/insight/research/pdf/BRICs_3_12-1-05.pdf

Box 4: Examples of China–UK collaboration

In September 2006, Leeds University and the Chinese Academy of Sciences announced a virtual joint laboratory, funded in part by the UK's Biotechnology and Biological Sciences Research Council (BBSRC). Plant scientists from Leeds and Chinese agricultural specialists will work on joint projects in the field of rice genomics, aiming to understand how plants react to environmental stress and high salt levels.

Around 1,000 students are now enrolled at Nottingham Ningbo University, the first foreign-run university campus in China. The aim is to have 4,000 undergraduates by 2008. Established as a partnership between Nottingham and China's Wani Education Group, this \$61 million campus is an innovative attempt by a UK university to win a share of China's expanding education market.

In September 2006, Tony Blair and Wen Jiabao launched Innovation China UK

(ICUK), which aims to help Chinese and UK universities commercialise joint research. With \$8.8 million from the UK Higher Education Innovation Fund, and equivalent support from the Chinese government, the project will finance the commercialisation of near-market technologies. "There are umpteen collaborations going on with China. What I'm interested in is getting a real return on that investment," says Caroline Quest, managing director of innovation and enterprise at Queen Mary, University of London, who is coordinating the project.

Around 3,000 plant species grow on the Jade Dragon Snow Mountain in China's Yunnan Province. Studying and preserving this biodiversity is the focus of The Lijiang Project, set up by the Royal Botanic Garden Edinburgh, the Kunming Institute of Botany and the Yunnan Academy of Agricultural Science. One of the project's main activities is the Jade Dragon Field Station, which opened in 2004 as the UK's first joint scientific laboratory in China.

Table 8: South Africa's Key Country Indicators

Population 2006 ²⁷⁷	43,786,115	Life expectancy at birth (Women, Men), 2003	52, 50
Area (sq km)	1,219,100	Total labour force 2005	20,100,000
Currency	Rand (ZAR)	Government type	Republic
GDP (USD), 2007 ²⁷⁹	\$468 billion		

277. World Bank Country Brief, South Africa. Available at: <http://web.worldbank.org/wbsite/external/countries/africaext/southafricaextn/>

278. South African Reserve Bank, International Monetary Fund, International Financial Statistics.

279. CIA Factbook: South Africa.

280. Goldman Sachs (2005) 'How Solid are the BRICs?' Goldman Sachs, Global Economics Paper No: 134. December 2005. Available at: http://www2.goldmansachs.com/hkchina/insight/research/pdf/BRICs_3_12-1-05.pdf

281. See <http://www.bloomberg.com/apps/news?pid=20601116&refer=afrika&sid=aegD3eTayzlw>

282. Dfid country profile: South Africa. Available at: <http://www.dfid.gov.uk/countries/afrika/southafrica.asp>

283. CIA World Factbook: South Africa. Available at: <https://www.cia.gov/library/publications/the-world-factbook/geos/sf.html>

284. OECD Reviews of Innovation Policy – South Africa. p.10.

285. South African Finance Minister, Trevor Manuel, Budget Speech, February 2008.

286. Department of Science and Technology (2008) 'The Ten Year Plan for Science and Technology, 2008.' Available at: <http://www.dst.gov.za/publications-policies/strategies-reports/The%20Ten-Year%20Plan%20for%20Science%20and%20Technology.pdf>

4.4 South Africa: innovation in transition

Basic relevant economic and science and technology data

When Goldman Sachs conducted their first analysis of Brazil, Russia, India and China (BRIC), they pointed out that it didn't ignore South Africa. They thought that its growth would be impressive, as would its capacity to innovate.²⁸⁰ But its smaller size and complexities make it a less obvious innovation power. South Africa is nevertheless interesting because of its transition to democracy, its position within Africa, and its relationship with Asia, America and Europe, and the place of its innovation system in these dynamics. As a result, the BRIC list of major emerging economies is sometimes presented as BRICS to include South Africa.

South Africa is the largest economy in Africa. Since establishing a democratic government in 1994, it has consistently implemented policies to build a single nation, eliminate poverty, expand the sphere of the formal economy, reduce unemployment and accelerate economic growth, largely by opening its economy to international trade and capital flows. On the back of these economic and political foundations, South Africa's economic growth has averaged 4.7 per cent in the past five years, compared with 2.7 per cent between 1998 and 2002.²⁸¹ South Africa's task has been to build a new innovation system from unique and chaotic foundations while maintaining the pockets of industrial and scientific excellence that survived under apartheid.

As with other emerging economies, South Africa is divided into a relatively affluent first-world economy with a large informal third-world economy running alongside. Thirty-five per cent of the country's population are very poor, according to the UK Department for International Development, and HIV/AIDS is rife.²⁸²

The country is now increasingly shifting the structure of its economy away from dependence on primary resource production. Unlike many other African countries, only a small proportion of the labour force is involved in agriculture or mining, with the majority working in the services sector.²⁸³ Consequently, the government aims to increase formal Research and Development (R&D) spending from 0.87 per cent of GDP to 1 per cent by 2012.²⁸⁴ This is an ambitious target, given that South Africa expects a 0.5 per cent drop in GDP growth in 2008/9.²⁸⁵

The national Department of Science and Technology recently published its ten-year vision, setting ambitious targets for South Africa's growth in R&D, research output and patents. This strategy presented five 'grand challenges' across biotechnology, space, energy, climate change and social needs.²⁸⁶ But whether these challenges are addressed or not depends on some structural factors that define much of South Africa's innovation.

South African Innovation Performance

Innovation in South Africa has roots

South Africa has a good historical basis of innovation and scientific excellence, particularly in the period between 1950 and 1970. It lays claim to inventing the CAT scan, the first oil-from-coal refinery, the speed gun used in cricket matches, and performing the first heart transplant. In Sir Aaron Klug and Sir David King, South Africa has given the UK a president of the Royal Society and Nobel Prize winner and a chief scientific adviser.

South Africa remains largely an adopter of technological innovation with low R&D investments

The United Nations currently ranks South Africa 39th out of 162 countries for technological achievement, and the country is seen more as an adopter of technology than

as an innovator. Domestic R&D efforts are low compared to international standards with South Africa's current 0.87 per cent average lower than the OECD average and lower than the Chinese 2005 level of 1.3 per cent. These numbers may be an underestimate because of the familiar difficulties measuring R&D in the services sector, which accounts for an estimated 69 per cent of South Africa's GDP.²⁸⁷

Business sector is behind 45 per cent or more of national R&D spending

However, a large chunk of R&D spending already comes from the business sector (45 per cent).²⁸⁸ Moreover, business funding accounts for a larger share of university R&D than in many other countries.²⁸⁹

Box 5: Regional profile: Cape Town – Africa's emerging science capital

Scientific innovation in Cape Town is grounded in the internationally-recognised University of Cape Town and the Cape Biotech Trust.

At the University of Cape Town, 42 per cent of total enrolment in 2006 was in science, engineering, and technology faculties. Home to two Centres of Excellence accredited by the Department of Science and Technology, UCT was also awarded 27 of the 71 new chairs on the South African Research Chair Initiative, a scheme administered by the National Research Foundation and the Department of Science and Technology to encourage research-capacity development.²⁹² High profile research in recent years has included catalysis and fuel technology, supramolecular chemistry, and sports medicine. The only African university in the top 200 of the Times Higher Education Supplement world university rankings,²⁹³ UCT is also currently engaged in a competitive international bid to host the Square Kilometre Array radio telescope in South Africa, largely on the strength of its scientific research tradition.²⁹⁴ UCT has also taken proactive steps since the end of apartheid to develop previously excluded human capital, and the student body has changed from 90 per cent white in 1979 to over 50 per cent black in 2008.²⁹⁵

Innovation outputs however, such as new products, services, and patents, are on the rise

Other innovation indicators are moving in a positive direction – in 2004 there were an average of 400 domestic new patent applications per month. Of the innovation performed by business itself, 10.1 per cent of innovation in goods and services were in products new to the market.²⁹⁰ Major progress has also been made in developing research activity in the health sector. The medical research community is addressing issues including HIV-AIDs, TB, malaria and non-infectious diseases prevalent in South Africa.²⁹¹

The Cape Biotech Trust (CBT) is a major initiative funded by the government Department of Science and Technology with the explicit aims of promoting the biotech industry, developing biotech businesses and investing in human capital in the Cape Town region. Begun in 2002, CBT is actively involved in promoting and investing in R&D, businesses, and new technologies to create an "effective functioning innovation value chain".²⁹⁶ So far, CBT appears to have been successful attracting talent and fostering innovation in the Cape region.

Cape Town also boasts three nearby universities – the University of the Western Cape, Cape Peninsula University of Technology, and the University of Stellenbosch. With the University of Cape Town they collaborate through the Cape Higher Education Consortium.²⁹⁷

Famed as a tourist destination for the spectacular Table Mountain, a Mediterranean climate, world-class beaches and nearby areas of natural beauty, Cape Town also easily attracts researchers and students looking for good weather and standard of living. Whilst it may not yet be renowned for its science and innovation capabilities, the combined effect of key institutions like the University and the Cape Biotech Trust will increasingly act as a magnet for further investment and innovation – making Cape Town the science capital of Africa.

- 287. Kahn, M. (2008) 'Understanding R&D and innovation in services: evidence from South Africa.' Brighton: Centre for Science, Technology and Innovation Indicators, SPRU, University of Sussex.
- 288. OECD Reviews of Innovation Policy – South Africa. p.10.
- 289. Ibid.
- 290. South African Centre for Science, Technology and Innovation Indicators (CeSTII), Human Sciences Research Council, The South African Innovation Survey 2005 Highlights.
- 291. Burton, S. (2002) Development of Biotechnology in South Africa. Department of Chemical Engineering, University of Capetown. 'Electronic Journal of Biotechnology.' Available at: <http://www.ejbiotechnology.info/content/vol5/issue1/issues/03/>
- 292. UCT (2008) 'About UCT 2008: A Brief Introduction to UCT.' Available at: http://www.uct.ac.za/downloads/uct.ac.za/about/about_uct.pdf
- 293. Times Higher Education Supplement (2007) Available at: http://www.topuniversities.com/worlduniversityrankings/results/2007/overall_rankings/top_400_universities/
- 294. See www.skatelescope.org
- 295. UCT (2008) 'About UCT 2008: A Brief Introduction to UCT.' Available at: http://www.uct.ac.za/downloads/uct.ac.za/about/about_uct.pdf
- 296. See www.capebiotech.co.za
- 297. Ibid.

Like Brazil, the natural resource sector is an important driver of local innovation

The most successful areas of innovation are linked to the country's history of primary resource production. The South African company Sasol is set to become the world's first operator of gas-to-liquids technology with plants strategically based in Nigeria and Qatar. However, this sector is also changing. The OECD has described South Africa as undergoing "premature de-industrialisation", as, in contrast to other developing middle-income countries, "output shares of both mining and manufacturing have fallen consistently, continuing a trend that started during the 1980s".²⁹⁸

Main government policies, initiatives and strategies for science technology, and innovation

The creation of a department for science and technology, an innovation strategy, and a strategic analysis unit

Since 1994 South Africa has made good progress in the governance of its innovation process. It created a government department for science and technology, which has been well-integrated in cross-departmental initiatives. Previously there was no one single body responsible for R&D and the process was highly fragmented. In 2002 it formalised its innovation strategy under the National Research and Development Strategy and complemented this in late 2005 with the 'Accelerated and Shared Growth Initiative for South Africa' (ASGISA).

South Africa has also developed a strong capability to provide strategic analysis to support policy. The Council for Scientific and Industrial Research (CSIR) conducts basic R&D and innovation surveys. CSIR has a lead role in forming innovation partnerships, joining up South Africa's innovation system and building the country's research capacity. One of its prominent achievements is collaboration with Boeing on satellite tracking technology.

Increased public funding for R&D

New initiatives for public funding of R&D have also been created. The Technology and Human Resources for Industry Programme (THRIP) has been effective in integrating the development of research-capable human resources and industry-university co-operation in R&D.²⁹⁹ The National Research Foundation has an income of \$106 million to support public research

and facilities, and much of this is allocated thematically according to social and economic priorities, in contrast with the responsive approach of the UK science budget.

The government has made the biotechnology sector a national priority

A key recent innovation priority for the South African government has been in the biotechnology sector. Biotechnology in South Africa used to focus on first-generation applications such as those in the food industry. More recently, activities geared towards the chemical, biochemical and pharmaceutical markets have progressed rapidly, particularly with the advent of the government prioritisation of biotechnology and the establishment of a number of national and international collaborative research programmes.³⁰⁰

Affirmative attempts to redress the racial imbalance are restructuring the South African economy

Former South African President Thabo Mbeki's 'Black Economic Empowerment' programme has been actively diverting funds towards companies with black ownership and ensuring that scientific and technical research has elements of capacity building among the black and minority communities. Politicians insist that this programme is not just a moral exercise; it is also a strategic growth plan aiming to make the most of previously wasted human capital. The South African higher education sector has expanded rapidly since the demise of apartheid which, accompanied by preferential access to historically disadvantaged groups, represents an attempt to develop human capital.³⁰¹

Fighting the 'brain drain' by attracting expatriates and foreign talent

According to the OECD, the major constraint to South Africa's transition into a fully-fledged knowledge economy is a lack of skills.³⁰² South Africa, as with the rest of the continent, has a problem of 'brain drain' with migrants staying abroad. Policies have tried to maintain links with a South African highly-skilled diaspora.³⁰³ The Global South Africans project and the South African Network of Skills Abroad (www.globalsouthafricans.org; sansa.nrf.ac.za) explicitly try to mobilise emigrants for the country's benefit. And there is some evidence that returnees from abroad are starting to bring new skills back to South Africa. Several civil society initiatives, such as Homecoming Revolution and the Come Back Home Campaign, have sprung up in recent years

298. Ibid.

299. OECD Reviews of Innovation Policy – South Africa, p.10.

300. Burton, S. (2002) Development of Biotechnology in South Africa. Department of Chemical Engineering, University of Capetown. 'Electronic Journal of Biotechnology.' Available at: <http://www.ejbiotechnology.info/content/vol5/issue1/issues/03/>

301. Further education expansion to improve diversity, 29 Jan 2008. University World News. Available at: <http://www.universityworldnews.com/article.php?story=2008012910024816php?story=2008012910024816>

302. OECD Reviews of Innovation Policy – South Africa, 2008.

303. Cervantes, M. and Guellec, D. (2002) 'The brain drain: Old myths, new realities.' OECD Observer No.230, January 2002.

Box 6: A complicated picture – Diaspora doing good

Mark Shuttleworth

Mark Shuttleworth is a technical and corporate innovator who has more recently turned his hand to social innovation. Having studied at the University of Cape Town, he created a highly specialised IT company, Thawte, addressing the exploding Internet's need for security and cryptography. The company took 40 per cent of the market for digital certificates, despite less than 1 per cent of the turnover coming from South Africa itself.³⁰⁴

In 1999, Shuttleworth became a billionaire by selling his firm to the US company, Verisign, and set off on his next journey, via Kazakhstan and space (he was the world's second space tourist and the first African in space) to London.³⁰⁵ In London, he began the Ubuntu project to create an open source free Linux platform for all computers.

Shuttleworth exemplifies a new breed of entrepreneur. They may live abroad but

they attempt to maximise their international links, wealth and knowledge to make positive change in their home countries. Shuttleworth founded and continues to actively invest in both a venture capital team, HBD, and a philanthropic organisation, the Shuttleworth Foundation.³⁰⁶ Investment in both ventures is directed back towards his homeland, trying to grow companies and social innovations that will benefit South Africa, particularly around education.

Like so many talented migrants, his connections to networks at home remain strong. His aim is to encourage risk-taking and entrepreneurship to help South Africa solve its social problems. In addition, he tries through his experience as entrepreneur and astronaut to encourage others to take up careers in science and innovation. For example, after his much-publicised trip to space, Shuttleworth created a roadshow of his experience highlighting science and technology aspects specifically aimed to encourage science and maths among South African students.³⁰⁷

providing career and other advice to draw the diaspora back home.³⁰⁸

The Department for Science and Technology has tried to compensate by attracting foreign talent, especially in universities.³⁰⁹ But the country is still losing net expertise. There remain bureaucratic obstacles in the immigration of skilled foreigners into South Africa, although the situation is improving.³¹⁰ Migrants from other African countries face the additional obstacle of widespread xenophobic sentiment.³¹¹

Internationalisation

South Africa's international image has improved rapidly since the 1990s. During apartheid, foreign investment was relatively low, largely due to economic sanctions. Since the implementation of democracy and Structural Adjustment Policies, South Africa's economy has opened up significantly and FDI has dramatically increased. Until 1993, inward FDI

was next to nothing; in 2003, it was up to 27.4 per cent and in 2006 was at 30 per cent.³¹² The US is South Africa's largest trading partner, although more total trade is done with the countries of the European Union, with the UK in the lead. China is the second largest importer to South Africa after the US, but it also buys 8 per cent of South Africa's exports.³¹³

FDI continues to flow, but international trust might be eroding

The Confidence Index by global management consulting firm AT Kearney says that South Africa faces serious threats to its ability to attract FDI. This is despite being ranked as the 18th most attractive investment destination. In the current investment climate, FDI tends to flow to knowledge-rich areas. South Africa's relatively limited human resource capability may dissuade foreign investors.

Relationship with Africa is strong and growing

South Africa plays a critical role in Africa's development due to its relative wealth.³¹⁴ In the last ten years, the country has been

304. 'South Africa's dot.com millionaire.' Mohammed Allie, BBC News, 20 April 2000. Available at: <http://news.bbc.co.uk/2/hi/africa/720735.stm>
305. See <http://www.africaninspace.com/>
306. From Mark Shuttleworth website: <http://www.markshuttleworth.com/biography>
307. Ibid.
308. 'More people returning to SA than leaving.' Devon Haynie, Mail & Guardian, 27 July 2008. Available at: <http://www.mg.co.za/article/2008-07-27-more-people-returning-to-sa-than-leaving>
309. Department of Science and Technology (2007) 'From brain drain to brain gain.' Department of Science and Technology press release, 20th September 2007.
310. 'Skills exodus is becoming a problem.' Eamonn Ryan, Mail & Guardian, 12 May 2008. Available at: <http://www.mg.co.za/article/2008-05-12-skills-exodus-is-becoming-a-problem>
311. 'What we feel, warts and all.' Mail & Guardian, 12 July 2008. Available at: <http://www.mg.co.za/article/2008-07-12-what-we-feel-warts-and-all>
312. UNCTAD World Investment Report 2007.
313. See www.southafrica.info
314. Department of International Development, South Africa Country Profile. Available at: <http://www.dfid.gov.uk/countries/africa/southafrica.asp> [Accessed: 19/03/2008].

an important player in the development of the African Union and NEPAD (the New Partnership for Africa's Development). Many South African corporations are investing and expanding aggressively into other African countries, especially in the telecommunications sector.³¹⁵ South African investment in the rest of the African continent rose threefold from 1996 to 2001, eclipsing China as the largest investor.³¹⁶

And so is the relationship with Brazil, China and India

South Africa's appetite for international engagement is growing. Since 2003, South Africa has a tripartite strategic agreement with Brazil and India.³¹⁷ This focuses on collaboration between southern hemisphere nations on issues of global concern, with science and innovation a priority area for collaboration. In June 2006, China and South Africa signed 13 agreements on cooperation in a range of fields including trade, national defence, agriculture, technology and science, with China also providing 20 million RMB (about \$US2.5 million) assistance to South Africa for training and skills improvement in South Africa.³¹⁸

South Africa-UK links and opportunities

Business links

The UK is one of South Africa's major trading and investment partners. A huge amount of foreign investment in South Africa comes from the UK – it accounted for about 76 per cent of total FDI in 2002.³¹⁹ South Africa is the UK's 22nd largest overseas market with exports (in goods only) totalling £2.2 billion in 2006.

Academic links

In 2007, according to the Universities and Colleges Admissions service, 331 South Africans applied to full-time undergraduate courses at UK universities. Although this figure is significantly smaller than application numbers from China and India, it is double the 2002 figure, suggesting that the UK and South Africa are starting to rebuild their higher education links. But academic research collaboration is much stronger with 5,206 co-authored papers between 1997 and 2006 compared with 6,758 papers with Brazil and 5,491 with India for the same period of time. Figure 6 below shows the regional distribution of co-authored papers with South Africa.³²⁰

315. 'MTN set to expand into Africa.' Shoks Mzolo, Mail & Guardian, 6 May 2005. Available at: <http://www.mg.co.za/article/2005-05-06-mtn-set-to-expand-into-africa>

316. 'Neo-colonialism or development?' Judi Hudson, Mail & Guardian, 18 Jun 2007. Available at: <http://www.mg.co.za/article/2007-06-18-neocolonialism-or-development>

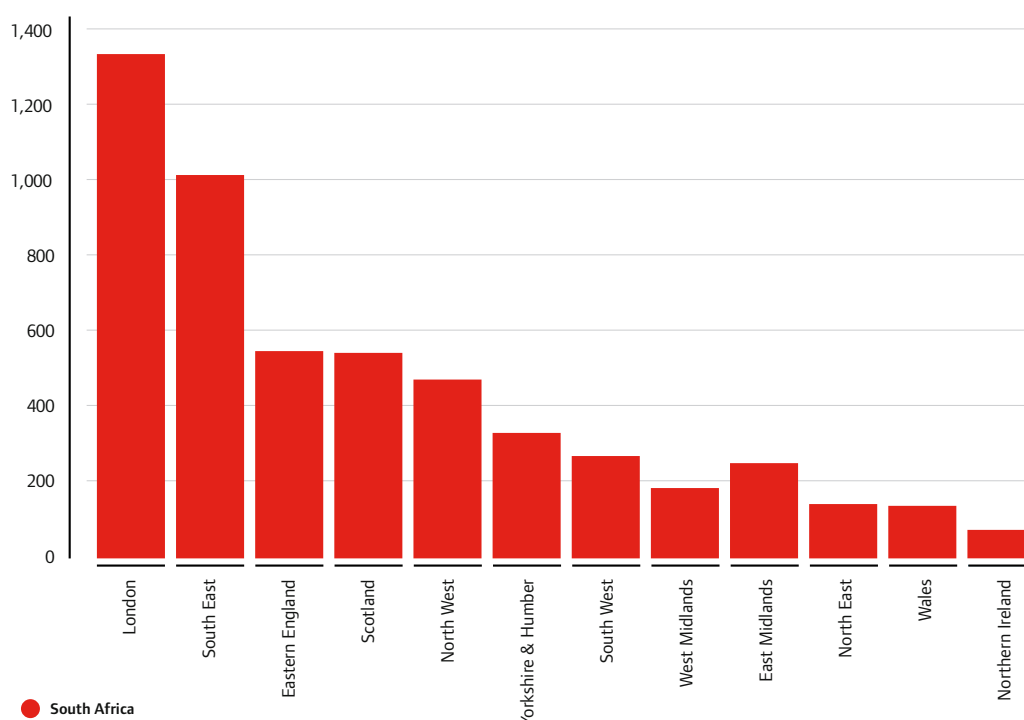
317. IBSA. Available at: <http://www.ibsa-trilateral.org>

318. China Daily, Xinhua News, 22nd June 2006.

319. OECD Reviews of Innovation Policy – South Africa. p.65.

320. Source: Unpublished data from Evidence Ltd.

Figure 6: Geographic distribution of co-authored academic papers between the UK and South Africa



Source: Evidence Ltd, unpublished data (2008)

Science and technology links

The Royal Society runs a successful networking scheme with South Africa, which has awarded grants to 67 South African scientists since 2003. These grants support meetings and long-term visits, providing a stepping stone to lasting collaboration. Much of the motivation for collaboration is linked to the availability of European Union funds. In the last round of EU Framework Programme 6, there were more than 150 collaborations between UK and South African researchers. With the latest round, this figure is set to grow as South Africans look for European partners to unlock funding and UK researchers collaborate with South Africans on projects looking specifically at issues of the developing world, from water quality to malaria treatments. The UK is consistently a leading partner for South African researchers on European projects.

In areas of shared scientific strength, such as bioscience, there is the potential for new forms of collaboration using these circulations. South Africa is understandably keen to attract back those highly skilled people who left the country to study or research, whether recently or in the apartheid era.

Where formal links have been established, organisations have been careful to include a strong element of capacity-building. South African scientists who have benefited from the Royal Society networking scheme are obliged to work with younger South African colleagues. And on the back of this, a new scheme has been set up to link universities in the two countries, particularly those South African universities who have been historically under-resourced.³²¹

At an informal level, scientific collaboration between the countries is strong. Bottom-up collaborations are hard to measure and hard for policymakers to build, but co-authorship of papers, led by institutions such as the University of Cape Town, reveals a picture of

rich collaboration. Such collaboration tends to be limited to those areas in which South Africa has had an historical strength, such as medicine and space science.³²² It takes place at the level of individual scientists as well as at an institutional level (take, for example, the SKADS project (www.skads-eu.org) involving, among others, Jodrell Bank observatory in the UK and the National Research Foundation in South Africa).

People links

The UK's well-established historical links with South Africa create opportunities for collaboration. The immigration of many South Africans to the UK has historically been facilitated by the fact that many have UK ancestry and passports. As part of the British Empire, South Africans did not face serious restrictions on entry to the UK until 1962. There is a large South African diaspora in the UK estimated to be around 550,000.³²³ According to a recent study³²⁴ of the South African community in the UK most immigrants from South Africa settle in the London area. Their presence in the UK goes back to the apartheid years and more recently reflects socio-economic factors. Emigrants from South Africa tend to be skilled professionals, with many finding employment in the finance and business sectors. This is reflected in the London labour market, where South Africans generally appear to fare well, on a par with migrants from high income countries rather than developing countries. The South African employment rate is amongst the highest in London, with a notable concentration in high paid sectors of employment.³²⁵ In 2007, the Rector of the University of Stellenbosch became a recent high-profile addition to this flow when he became Vice-Chancellor of the University of Newcastle.

There are a number of community and professional South African organisations and forums in the UK, such as the South African Business Club and the SA Times newspaper.

321. OECD Reviews of Innovation Policy – South Africa. p.65.
322. Source: Unpublished data from Evidence Ltd.
323. Interview notes, Thabisa Mbungwana, British High Commission in Pretoria.
324. SOURCE: Unpublished data from Evidence Limited.
325. The Runnymede Trust (2008) 'Understanding Diversity – South Africans in Multi-Ethnic Britain.' Available at: <http://www.runnymedetrust.org/uploads/publications/pdfs/UnderstandingDiversity-2008.pdf>
326. The Ministry of Culture in Estonia defines the creative industries as "an economic sector that is based on individual and collective creativity, skills and talent and is able to create welfare and jobs through creating and using intellectual property". The creative industries are classified as follows: architecture, audio-visual, design, performing arts, entertainment IT, publishing (incl. newspapers), fine arts, museums, music, advertisement, handicraft, cultural tourism. See Rosenblad, Y. (2007) Presentation in the seminar 'The cultural and creative sector – Lisbon Agenda.' Statistics Estonia. Available at: http://www.kul.ee/webeditor/files/loomemajandus/Lissaboni_ettekanne_final.doc

Table 9: Estonia's Key Country Indicators

Population 2006 ³²⁶	1,300,000	Life expectancy at birth (Women, Men), 2007	78.3, 67.27
Area (sq km)	45,226	Total labour force 2007	688,000
Currency	Estonian Kroon	Government type	Parliamentary democracy
GDP (USD PPP), 2007	\$29.35 billion		

Source: CIA World Factbook

327. Crawford, R. (2008) 'The Magical Million?: South Africans in the United Kingdom.' Paper presented at the 'South Africans in Britain' symposium, London, The Commonwealth Club.
328. European Commission (2006) 'European Trendchart on Innovation – Estonia country report.' Available at: http://www.proinno-europe.eu/docs/reports/documents/Country_Report_Estonia_2006.pdf
329. Koch P., Pukl B. and Wolters, B. (2007) 'OMC Policy Mix Review Report – Country report Estonia.'
330. See for instance Foreign Policy. Available at: http://www.foreignpolicy.com/story/cms.php?story_id=3995&page=6; Mitchell, D. (2007) Baltic Beacon. 'The Wall Street Journal Europe.' 20 June 2007. Available at: http://www.cato.org/pub_display.php?pub_id=8378
331. CIA World Factbook: Estonia.
332. Economist Intelligence Unit (2008) 'Country Briefing: Estonia'. Available at: <http://www.economist.com/countries/Estonia/profile.cfm?folder=Profile-FactSheet>
333. Praxis Centre for Policy Studies (2007) 'Estonian labour market: overview and new challenges.' Available at: <http://www.praxis.ee/data/Estonianlabourmarket.pps#436,1>
334. See European Industrial Relations Observatory (EIRO) website. 'Problem of acute labour shortage and migrant workers.' Available at: <http://www.eurofound.europa.eu/eiro/2006/12/articles/EE06120191.htm>
335. See European Industrial Relations Observatory (EIRO) website. 'Problem of acute labour shortage and migrant workers.' (2006).
336. See European Industrial Relations Observatory (EIRO) website
337. The Global Innovation Index is produced annually by INSEAD and World Business. World Business and INSEAD (17 January 2007) 'The World's Top Innovators.' Available at: <http://www.worldbusinesslive.com/article/610009/global-innovation-index-methodology/> and <http://www.worldbusinesslive.com/article/625441/>
338. Pro Inno Europe (2008) 'European innovation scoreboard 2007 – Comparative analysis of innovation performance.' Available at: http://www.proinno-europe.eu/admin/uploaded_documents/European_Innovation_Scoreboard_2007.pdf

UK government efforts

Collaboration at a government level with South Africa reflects the unique position of South Africa on its journey towards becoming a knowledge economy. Organisations such as the UK Department for International Development (DfID) see South Africa as a key collaborator for the use of science and innovation for development, as a facilitator of broad collaboration with Sub-Saharan Africa. At the same time, UKTI sees South Africa as an exciting growth economy. South Africa's future innovation capacity and its links with the UK are likely to depend upon the extent to which it can balance these two factors to produce innovation for economic growth that also takes into account the challenges of development faced by the country.

South Africa is designated as a priority market

South Africa is designated one of UKTI's 17 High Growth Markets, unlocking support for UK companies who are keen to move into the country but might not have the networks or local knowledge for success.³²⁷

4.5 Estonia: the innovator at a crossroads

Basic relevant science and technology data

Estonia is a small open economy in transition. Following independence from the Soviet Union in 1991 and membership to the European Union in 2004, the economy has grown rapidly. From 2000 to 2005, the average real GDP growth rate in Estonia was 7.7 per cent, compared to 2 per cent for the rest of the European Union.³²⁸

After the collapse of the USSR in the 1990s, many Central and Eastern European countries have undergone a process of intense social and economic transformation, which culminated for many of them with their admission to the European Union in 2004. Of all the former Soviet Union countries, Estonia has arguably made the most progress in building a liberal market economy. Many commentators have compared Estonia's dynamism to that of some Asian countries,³²⁹ and some have called Estonia a 'Baltic tiger'.³³⁰

This catching-up process has been driven by a liberal economic policy that aimed to promote low corporate tax rates, international trade and

foreign investment. Multinational corporations, mainly from Northern Europe (particularly neighbouring countries such as Sweden and Finland) have outsourced some of their activities to Estonia and have heavily invested in the country. According to Enterprise Estonia, Estonia has one of the highest shares of foreign direct investment (FDI) to GDP of the new EU Member States, with a cumulative stock of foreign investment amounting to US\$16.59 billion in 2007.³³¹ In 2007, Estonian exports of goods and services reached 80 per cent of GDP³³² (compared to 40 per cent in the rest of the EU-25). This allowed the transposition of know-how imported from more advanced economies and helped Estonia increase its capacities to innovate.

Nevertheless, decades of Soviet rule have left their mark on Estonia. In particular, labour productivity is still relatively low³³³ and the low- and low-medium tech sectors (e.g. forest sector, food, textiles) are still dominant sectors of the economy. Shortage of labour is also becoming an increasingly acute problem in attracting and retaining foreign companies.³³⁴ The Estonian Institute of Economic Research reveals that 44 per cent of enterprises cite labour shortage as the main problem hindering production growth.³³⁵ This has led to higher salaries which might affect Estonia's competitiveness in the future.³³⁶

Estonian innovation performance

According to the Global Innovation Index, Estonia is the world's 31st most innovative country.³³⁷ The European Innovation Scoreboard 2007 ranks Estonia first among all former Eastern Bloc economies and argues that within ten years Estonia will have closed the gap with the most innovative European nations.³³⁸

Estonia's performance against traditional innovation indicators shows positive signs of progress

R&D expenditure has expanded considerably in absolute terms. In 2004, Estonia's R&D intensity was still below the EU-25 average of 1.86 per cent at 1.14 per cent of GDP.³³⁹ In 2006, Estonia experienced a 40 per cent growth of private R&D spending, the highest growth in the EU.³⁴⁰ The latest Community Innovation Survey shows that Estonian firms in the service sector are innovative, revealing that 49 per cent of all Estonian firms have carried out innovation activities, above the

350. World Bank (2002) 'A Preliminary Strategy To Develop A Knowledge Economy In European Union Accession Countries.' Working Paper. Available at: <http://www.rec.org/REC/Programs/REReP/InformationSystems/PDF/KnowledgeStrategy.pdf>
351. Eurostat Press Release (8 February 2008) 'One person in eight in the EU27 avoids e-shopping because of security concerns.' Available at: http://epp.eurostat.ec.europa.eu/pls/portal/docs/page/pgp_prd_cat_prerel/pge_cat_prerel_year_2008/pge_cat_prerel_year_2008_month_02/4-08022008-en-ap.pdf
352. Eurostat (2007) Available at: http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1996,45323734&_dad=portal&_schema=PORTAL&screen=welcomeref&open=/&product=Yearlies_new_population&depth=3
353. Competitiveness (26 October 2006) 'Clusters, Clusters initiatives, and poles: Examples from the EU new member states.' TCI Annual Conference.
354. See www.competitiveness.org/filemanager/download/984/G3%20I%20Sagrario.pdf
355. EMCC (2006) 'Knowledge-intensive business services cluster in Helsinki and Tallinn.'
356. Archimedes (2001) 'Analysis of the Estonian ICT Sector Innovation System.' Tartu: Archimedes. Available at: http://www.esis.ee/eVikings/evaluation/eVikings_WP_Tarmo_Kalvet.pdf
357. Competitiveness (26 October 2006) 'Clusters, Clusters initiatives, and poles: Examples from the EU new member states.' TCI Annual Conference.
358. Ibid.
359. See http://www.praxis.ee/data/WP_15_2004ICT_Industry1.pdf
360. Tarmo Kalvet presentation at the e-governance Academy. 'Estonian ICT Cluster: The Current Status and Future Challenges.'
361. Hernesniemi, H. (2000) 'Evaluation of Estonian Innovation System.' PHARE Support to European Integration Process in Estonia.
362. See Regio website. Available at: <http://www.regio.ee/?setlang=eng>
363. See Skype website. Available at <http://about.skype.com/news.html>
364. See the European Monitoring Centre on Change (EMCC) website. Available at: <http://www.eurofound.europa.eu/emcc/content/source/eu06029a.htm>

Estonia is a model for e-Government

Estonia scores better than most Western European countries for the online availability of public services. According to the management consultancy company Cap Gemini, Estonia was ranked third in terms of online availability of public services in 2006, ahead of Sweden.³⁶⁵

This is all the more impressive since Estonia ranked 8th two years before.³⁶⁶ In total, 79 per cent of Estonia's public services were fully available online in 2006, compared to 71 per cent for the UK and 74 per cent for Sweden.³⁶⁷

Such achievements have been made possible through pro-active government support to bring the country into the digital age after the collapse of the Soviet Union.³⁶⁸ The Estonian government involved foreign businesses in the development of the its fixed communications network and liberalised the telecommunication market.³⁶⁹ The government also developed policies to support an information society. In 1994, it published a strategy, 'The Estonian way to the Information Society' and in 1998 the Parliament approved the 'Principles of Estonian Information Policy' which gave priority to the development of e-Government services. Other measures included the Digital Signatures Act approved in 2000, which gave the same legal status to a digital signature as to a hand-written signature. Finally, the role of "enthusiastic and visionary civil servants" in the development of e-Government in Estonia should not be neglected.³⁷⁰

All this has led to an explosion in ICT applications in banking, education, health, transport and public administration. Today, all Estonian schools are connected to the Internet; all Estonian towns and villages are covered by the network of public Internet access points; and there are more than 1,100 free wireless Internet zones around the country.³⁷¹ Examples of e-services available online include declaration of income taxes, social security benefits, personal documents such as passport and driver's license, declarations to the police (e.g. in case of theft) and health-related services (interactive advice on the availability of services in different hospitals or appointments for hospitals).³⁷² Such services are widely used. For instance, in 2007, the percentage of electronic tax declarations was over 80 per cent.³⁷³ The ID-card is central to the Estonian e-services. This card is much more than an identification document. It contains a personal data file and a certificate for authentication and digital signature.³⁷⁴ Citizens can even use it to vote.³⁷⁵ In Tartu and Tallinn, residents can purchase virtual transportation

tickets linked to their ID cards.³⁷⁶ Other public services innovations include the introduction of paperless meetings of government ministers and allowing expenditures made in the state budget followed on the Internet in real-time.³⁷⁷

Main government policies, initiatives and strategies for STI

Since 2000, the Estonian Government has launched a vast series of reforms to promote innovation. The impulse came from the desire to become a member of international organisations, such as the World Trade Organisation and the European Union. Estonia's innovation policies principally focus on triggering R&D investment in the private sector, developing science-industry linkages and encouraging innovative entrepreneurship. At first sight, the Estonian government's support for innovation seems comprehensive. However, closer scrutiny shows it to be more fragmented and focused on short-term measures.³⁷⁸

The Estonian government has developed a broad range of traditional innovation policies

Since 2000, the Estonian Government has launched many reforms to promote innovation,³⁷⁹ led in particular by the Ministry of Economic Affairs and Communications, which elaborates and implements innovation policy. At the beginning of 2002, the Research and Development Council was reformed and given more importance. It is now a permanent advisory body to the government and is chaired by the Prime Minister, which links it directly to the Cabinet. Enterprise Estonia is one of the most important institutions for funding R&D and innovation activities. In 2003, Enterprise Estonia was restructured into five main divisions: business start-up; business development; business and living environment; tourism; and investment and trade development.

Institutional reforms were also accompanied by strategies to support innovation. The government launched a new strategy for 2007-2013, Knowledge-based Estonia: Estonian Research and Development Strategy³⁸⁰ which sets three main goals: (1) better quality and increase of volume of R&D activities; (2) innovative entrepreneurship; and (3) a society that is more aware of the importance of innovation to economic development. The strategy also set ambitious goals, such as

raising the total investments in R&D to three per cent of GDP by 2014 and the proportion of upgraded and new R&D infrastructures by 80 per cent (compared to less than 20 per cent in 2004).³⁸¹ The strategy also singles out three main technology areas: user-friendly information society technologies, biomedicine, and material technologies.

This strategy is in line with other policy documents all directly or indirectly intended to increase Estonia's innovation capacity. The Estonian Enterprise Policy 2007–2013 aims to promote innovation and entrepreneurship through the development of a favourable legal environment, the better conditions for entrepreneurship in the regions, easier access to capital and support for the internationalisation of Estonian businesses. The Estonian Information Society Development Plan until 2013 establishes priorities for organising national information society activities. The plan would coordinate the implementation of ICT in all public institutions.

The Estonian government has also been particularly concerned about the supply of skilled labour. The Estonian Higher Education Strategy for 2006–2015 aims to increase the quality of higher education, improve academic cooperation with other EU Member States, and create better links between higher education and labour market demand.³⁸² Such objectives were also reflected in the Development Plan for Estonian Vocational Education and Training System 2005–2008.³⁸³

However, innovation policy lacks a strategic goal and is fragmented

Despite these strategic documents, there seems to be a lack of clear understanding of the importance of innovation to Estonia's future competitiveness amongst policymakers and a lack of common strategic vision of Estonia's main strengths in innovation.³⁸⁴ On the ground, the support for innovation is fragmented. Marek Tiits *et al.* (2006) have shown that governmental measures to support innovation are not sufficiently prioritised to have a practical impact and a lasting influence on innovation activities.³⁸⁵ In particular, the authors criticise the lack of any long-term perspective.³⁸⁶ Furthermore, government's support for innovation is fragmented. Businesses in Estonia complain about the lack of strategic and coherent support for innovation. One example is the disconnect between Innovation and Technology policy and general SME policy.³⁸⁷ The European Commission also argues that the long-term

development of Estonian innovation policy is obstructed by an insufficient awareness of the need for innovation policy among politicians and by the fact that various ministries have different understandings of innovation policy.³⁸⁸

Finland is an inspirational model, but Estonia needs to develop a model of its own

Estonian policymakers often try to replicate the Finnish model of innovation, without taking sufficient account of the major structural differences between the two countries. For instance, where commentators have welcomed the creation of the Estonian Development Fund as the equivalent of the Finnish Sitra,³⁸⁹ they have also questioned the usefulness of a fund for start-ups in the Estonian context. What works in Finland might not work in Estonia. Even if the Finnish model provides some important lessons for Estonia, it cannot simply be transposed. The Finnish innovation narrative is unique and this is one reason why it has proved so successful.³⁹⁰ Estonian policymakers might be too influenced by the Finnish model to create an innovation narrative that is specific to Estonia and that would provide the necessary ferment for a common long-term strategic vision for innovation.

The Estonian government seems to be increasingly aware of such shortcomings and is beginning to take action to ensure that Estonia moves up the value-chain and avoids being locked-in to low value-added activities. For instance, in 2006, the Estonian Development Fund was founded by Parliament. One of its objectives is to stimulate debates regarding the development of the economy.³⁹¹ The Development Fund also predicts future socio-economic and technological trends and supports Estonia's economy in moving towards more value-added activities in manufacturing, knowledge-intensive services (financial intermediation) and ICT use (in e-government and as a sector of the economy).

This attempt to adopt a longer-term view of Estonia's development is becoming more common in other public institutions. For instance, last year, Enterprise Estonia – the institution in charge of promoting the competitiveness of the Estonian entrepreneurial environment and companies – published a five-year strategy to provide a more coherent approach to business support across the Estonian society. The Estonian Ministry of Economic Affairs and Communication is also currently preparing a mobility scheme that aims to support Estonian businesses lacking skilled

365. Cap Gemini (2006) 'Online availability of public services: How is Europe progressing? Web Based Survey on Electronic Public Services Report of the 6th Measurement.'
366. Ibid.
367. Ibid.
368. Archimedes (2001) 'Analysis of the Estonian ICT Sector Innovation System.' Tartu: Archimedes. Available at: http://www.esis.ee/eVikings/evaluation/eVikings_WP_Tarmo_Kalvet.pdf
369. Kalvet, T. (2007) 'The Estonian Information Society Development since the 1990s.' PRAXIS Working Paper No 29.
370. Ibid.
371. Estonian Embassy in London.
372. IDACB, epractice.eu and European Commission (2007) 'eGovernment Factsheets : e-Government in Estonia.'
373. Estonian Embassy in London.
374. Estonian ID-Card website. See <http://www.id.ee/?lang=en>
375. Ibid.
376. Ibid.
377. Estonian Embassy in London.
378. Kattel, R. 'Governance of innovation policy: the case of Estonia.' Tallinn: Tallinn University of Technology and PRAXIS Center for Policy Studies.
379. European Commission (2006) 'European Trendchart on Innovation – Estonia country report.' Available at: http://www.proinno-europe.eu/docs/reports/documents/Country_Report_Estonia_2006.pdf
380. Estonian Ministry of Education and Research (2006) 'Knowledge-based Estonia – Estonian Research and Development and Innovation Strategy 2007–2013.' Tartu: Estonian Ministry of Education and Research. Available at: <http://www.hm.ee/index.php?0&popup=download&id=6175>
381. Ibid.
382. Estonian Ministry of Education and Research. 'Estonian Higher Education Strategy for 2006–2015.' Tartu: Ministry of Education and Research. Available at: <http://www.hm.ee/index>
383. Tekes (2008) 'Major challenges for the governance of national research and innovation policies in small European countries.' Helsinki: Tekes. Available at: http://www.tekes.fi/julkaisut/Major_challenges.pdf
384. Tiits, M. *et al.* (2006) 'Competitiveness and future outlooks of the Estonian Economy.' Tallinn: Research and Development Council.

385. Ibid.
386. Technopolis (2002) 'Competence Centre Programme Estonia Feasibility Study.' Tallinn: Foundation Enterprise Estonia. Available at: http://www.eas.ee/vfs/2126/Competence_Centre_Programme_Estonia_Feasibility_Study.pdf
387. INNO-Policy TrendChart (2007) 'INNO-Policy TrendChart – Policy Trends and Appraisal Report, Estonia.' Brussels: European Commission. Available at: <http://www.proinno-europe.eu/index.cfm?fuseaction=country.showCountry&topicID=263&parentID=52&ID=23>
388. Sitra is the Finnish Innovation Fund, which is an independent public fund that "promotes the welfare of Finnish society". Sitra's duty is to promote stable and balanced development in Finland, the qualitative and quantitative growth of its economy and its international competitiveness and co-operation.
389. Leadbeater, C. (2006) 'The Ten Habits of Mass Innovation.' London: NESTA.
390. See Estonia Development Fund website. Available at: http://www.eas.ee/vfs/3580/EASi%20strateegia%202007-13_eng.pdf
391. Enterprise Estonia (2007) 'Enterprise Estonia strategy 2007-2013.' Available at: http://www.eas.ee/vfs/3580/EASi%20strateegia%202007-13_eng.pdf
392. European Commission (2006) 'European Trendchart on Innovation – Estonia country report.' Available at: http://www.proinno-europe.eu/docs/reports/documents/Country_Report_Estonia_2006.pdf; and Pro-inno website, available at: <http://www.proinno-europe.eu/index.cfm?fuseaction=country.showCountry&topicID=263&parentID=52&ID=23>
393. Estonian Government (2007) 'Knowledge-based Estonia – Estonian Research and Development and Innovation Strategy 2007-2013.' Tallinn: Estonian Government. Available at: http://www.eas.ee/vfs/3152/EAS%20RAAMAT%202006_SISU%20ENG_LOPP.pdf
394. Enterprise Estonia (2006) 'Enterprise Estonia.' Tallinn: Enterprise Estonia. Available at: http://www.eas.ee/vfs/3152/EAS%20RAAMAT%202006_SISU%20ENG_LOPP.pdf

staff. Other forthcoming initiatives include schemes to encourage the repatriation of young people to tackle Estonia's looming skills shortage.

The European Commission has welcomed the recent focus of Estonian innovation policy on infrastructure development, in particular the launch in 2005 of an R&D infrastructure development programme.³⁹² Other examples of innovation include the establishment of the Technology Competence Centres Programme in 2004 to support the development of infrastructure for R&D and collaboration between enterprise and the research sector.³⁹³ The Estonian government is creating measures to develop Estonians' awareness of the importance of innovation for the country's economic and social welfare. In 2005 the government launched the Innoawareness Programme 'Good Estonian Idea'³⁹⁴ to develop Estonians' awareness of the importance of innovation to national competitiveness and to raise their skills to ease the implementation of innovation projects in the research and enterprise sectors.

Internationalisation

Openness has been central to Estonia's economic growth and to the development of its innovation capabilities. Estonia also successfully leveraged its geographical location to become a gateway to Russia and the Nordic countries for foreign businesses. However, until recently, the government has not developed internationalisation policies with long-term goals. Their absence would have hampered Estonia's ability to attract foreign capital and knowledge in the future which is why the government has intensified people exchanges between Estonia and other countries.

Openness has been central to Estonia's economic development

After the collapse of the Soviet Union, the Estonian government took radical steps to open up the economy to the rest of the world, particularly Western Europe. Estonia leveraged its proximity to the Nordic markets, its location between Eastern and Western Europe, its well-educated population and a competitive cost structure to attract foreign investment.³⁹⁵ Estonian policymakers also pursued a clear pro-trade policy culminating in WTO and EU membership. Joining the EU has helped create more favourable conditions for innovation.³⁹⁶ Openness has been central

to Estonia's impressive economic growth and growing innovative capabilities over the past decades. Estonia certainly performs better than its potential in attracting inward investment.³⁹⁷

Estonian exports have steadily increased since independence. In the 1990s, Estonia's neighbours, Finland and Sweden became the main export destination.³⁹⁸ But Estonia is developing trade relations with countries across the world. In 2006, exports to China increased by 527 per cent, and by 166 per cent to the USA.³⁹⁹

Such deliberate openness to the rest of the world resulted in Estonia being classified as the 10th most globalised country in the world in the Globalization Index produced by A.T. Kearney and Foreign Policy.⁴⁰⁰ This ranking assesses the nations' global connectivity and focuses on economic integration, personal contact, technological connectivity and political engagement. Estonia did not appear on this Index before 2006.

Estonia has successfully leveraged on its privileged geographic location

Estonia's Nordic and Baltic neighbours, particularly Finland, play an important role in Estonia's development. Estonian firms participate in global supply chains and international production networks.⁴⁰¹ There has been a rapid growth of intra-industry trade between the Nordic countries and Estonia, suggesting that Estonia is part of 'cross-border networks in the Baltic Sea region'.⁴⁰² As shown earlier, Estonian exports have steadily increased since the 1990s,⁴⁰³ and Estonia is part of strong cross-border economic clusters, including the ICT clusters in Tallinn and Helsinki.⁴⁰⁴

The Nordic links have helped Estonia improve its innovative capabilities, with particular initiatives helping to develop such links. For instance, in 1999 the organisation Euregio started to support the development of collaboration and exchanges between Estonia and Finland through cross-border and inter-regional co-operation projects that helped disseminate know-how and information.⁴⁰⁵ Examples of projects include the 'Helsinki-Tallinn Science Twin-City Programme' which aims to foster cooperation between players in science park environment in Helsinki region (Uusimaa) and Tallinn region (Harju). This includes the development of common curricula, graduate schools and research facilities, the exchange of students and scientists, and high-tech business development.

However, the government has no long-term strategy for internationalisation

The phenomenon and initiatives described above are not the result of a clear strategic internationalisation strategy by the Estonian government. If the government has adopted a liberal policy and opened the borders of the country, it does not mean it has established a clear strategy to attract FDI in strategic sectors of the economy. It has focused on broad macroeconomic objectives, rather than on how Estonia could increase its innovative capabilities through openness to the rest of the world.

The risk is that Estonia is seen as a low-cost manufacturing country rather than as a real value-adding partner. This lack of an internationalisation strategy may prevent Estonia from developing fruitful economic relationships with other emerging countries and from successfully exploiting the innovation that is happening in other countries. So far, one of the main reasons why Estonia has attracted so much foreign investment is because it has competitive advantages in relatively cheap, but highly skilled labour.⁴⁰⁶

But at the people level internationalisation continues to grow

Estonian researchers are well integrated within the global research community.⁴⁰⁷ For instance, they have submitted 809 project applications to the 5th Framework Programme, 195 of which (almost a quarter) have received funding. They also actively take part in the European Union research cooperation, and collaborate with prestigious international organisations such as the European Molecular Biology Conference and the European Organisation for Nuclear Research.

Estonia has developed many international linkages involving staff exchange and programmes to get international scholars to teach and research in Estonia. The Estonian Government has emphasised and actively promoted the importance of being active in international networking and opting for international careers.⁴⁰⁸ To support teacher and student mobility, the government has set up the Kristjan Jaak Scholarship Programme. Visits of foreign professors to Estonian universities are also supported. Estonian researchers participate in more than 40 international projects.⁴⁰⁹ According to a survey by the Archimedes Foundation,⁴¹⁰ Estonian academics have become increasingly aware that mobility is central to a successful career and to the quality of their research. Most Estonian researchers

have a positive approach to mobility and would not hesitate to spend some time abroad. Foreign researchers in Estonia have stressed the change of mindset that is underway in Estonia and assert that establishing contacts and integrating into the local environment was easier in the 2000s than it was in the 1990s.⁴¹¹

Universities are also developing strategies to attract foreign students. For instance, the Estonian Business School is developing a strategy to attract Chinese and Indian students. In 2005/06, 207 students and scholars benefited from this programme. The Estonian Business School has also opened a High School International Class that provides education in English, to prepare students to work abroad or with foreign pupils.⁴¹² Estonia has also participated since 1999 in the EU's Erasmus/Socrates programme.

Despite a slight decrease in 2007, Estonia has attracted an increasing number of foreign tourists, with 1.9 million staying overnight in 2007.⁴¹³ Estonia is also attracting an increasing number of tourists from non-neighbouring countries. For instance, a new air route between Tallinn and Barcelona saw the number of tourists from Spain grow by 1.5 per cent in 2007 and their overnight stays rise by 21 per cent.⁴¹⁴ Within the framework of the programme 'Marketing Estonia', the Estonian Tourist Board has identified five target markets, including France, Japan and the United States of America.⁴¹⁵

Finally, Estonia has developed its infrastructure to allow it to develop links with foreign countries. The total number of passengers in 2006 in Tallinn Airport increased by 10 per cent to reach 1.54 million, with the number of passengers on regular international services up by 10.3 per cent.⁴¹⁶ Furthermore, from Tallinn it is possible to travel to an increasingly broad number of countries. The most popular destinations in 2006 were Helsinki, London, Stockholm, Copenhagen and Frankfurt. Estonian Air operates scheduled services to 21 destinations in Europe. In 2007, it had charter services to 53 destinations.⁴¹⁷

Estonia/UK links and opportunities

Estonia's relationships with the UK are intensifying, as seen in better trade relations, cultural and academic exchanges, and the growing number of Estonians learning English.

395. Tiits, M. *et al.* (2006) 'Competitiveness and future outlooks of the Estonian Economy.' Tallinn: Research and Development Council.
396. Tekes (2008) 'Major challenges for the governance of national research and innovation policies in small European countries.' Helsinki: Tekes.
397. Bozkurt, B. and Ozdenli, O. 'Internationalisation and National Innovation Systems: An Investment Agency Perspective.' Available at: http://www.druid.dk/uploads/tx_picturedb/ds2005-1575.pdf
398. Ketels and Solvell (2006) 'State of the region report 2006.' Baltic Development Forum.
399. See Enterprise Estonia website. Available at: <http://www.investinestonia.com/pdf/ForeignTrade2007.pdf>
400. The Globalisation Index is an annual study produced by AT Kearney and 'Foreign Policy' which assesses the extent to which nations are becoming more or less globally connected. Available at: http://www.foreignpolicy.com/story/cms.php?story_id=3995
401. Tiits, M. (2008) 'Estonia's economic integration into cross-border production networks of the Baltic Sea region.' To be published.
402. Ibid.
403. See Enterprise Estonia website. Available at: <http://www.investinestonia.com/pdf/ForeignTrade2007.pdf>
404. EMCC (2006) 'Knowledge-intensive business services cluster in Helsinki and Tallinn.'
405. See Euregio website. Available at: <http://www.euregio.nrw.de/>
406. Research and Development Council (2004) 'Competitiveness and Future Outlooks of the Estonian Economy – R&D and Innovation Policy Review.' Tallinn: Research and Development Council.
407. OECD (2007) 'Reviews of Tertiary Education: Estonia.' Available at: <http://www.oecd.org/dataoecd/44/0/39261460.pdf>
408. Estonian Ministry of Education and Research (2006) 'Knowledge-based Estonia – Estonian Research and Development and Innovation Strategy 2007-2013.' Tartu: Estonian Ministry of Education and Research. Available at: <http://www.hm.ee/index.php?O&popup=download&id=6175>
409. Archimedes Foundation Press Release (26 May 2008) 'Estonia launches support scheme for covering project preparation and VAT costs in EU research programmes.'

410. The Archimedes Foundation is an independent body established by the Estonian government in 1997 with the objective to coordinate and implement different EU programmes in the field of training, education, research, technological development and innovation.
411. Archimedes Foundation (2007) 'Researcher Mobility in Estonia and Factors that Influence Mobility.' Triip: Archimedes Foundation.
412. See Estonia Business School website. Available at: <http://www.ebs.ee/ebs-high-school-admission-international-class>
413. Enterprise Estonia and Estonian Tourist Board (2006) 'Tourism in Estonia 1993-2005: Key Indicators.' <http://www2.ehrl.ee/files/Estonian%20Tourism%20Statistics%201993-2005.pdf>
414. Enterprise Estonia (2008) 'Marketing of Destination Estonia. Target markets and co-operation opportunities 2008-2010.' Available at: <http://www.visitestonia.com/public/files/2008-06-16%20ETB%20marketing%20cooperation%202008-2010.pdf>
415. See Estonian Tourist Board website. Available at: <http://www.visitestonia.com/index.php?page=360>
416. See Invest in Estonia website. Available at: <http://www.investinestonia.com/pdf/transportation2007.pdf>
417. Estonian Air (2007) 'Annual Report 2006.' Available at: http://www.estonian-air.ee/public/Annual_Report_2006_English_final.pdf
418. See Estonian Ministry of Foreign Affairs website. Available at: http://www.vm.ee/eng/kat_176/1200.html#economy
419. See Estonian Embassy in London website. Available at: <http://www.estonia.gov.uk/estonia/economy>
420. Ibid.
421. See UK Trade and Investment website. Available at: https://www.uktradeinvest.gov.uk/ukti/appmanager/ukti/countries?_nffs=false&_nfpb=true&_pageLabel=CountryType1&navigationPageId=/estonia
422. See British Council Estonia website.
423. See The Wellcome Trust website. Available at: <http://www.wellcome.ac.uk/News/News-archive/Browse-by-date/2004/Features/WTD004660.htm>

Business links

Business links between the two countries have been developing fast over the past decade. The UK is now a significant investor in Estonia. While Estonia's trade balance with the UK was in deficit by US\$29 million in 1997, the trade balance was in surplus by US\$39 million in 2005.⁴¹⁸ In 2005, the UK was Estonia's 8th largest trade partner.⁴¹⁹ According to the Bank of Estonia, the UK has the third largest foreign investment stock in Estonia, after Sweden and Finland.⁴²⁰ UKTI has identified six sectors in which links between the UK and Estonia are important and should be deepened: biotechnology; tourism, heritage and leisure; financial services; EU funded business; and education.⁴²¹

Science and technology links

Links in the field of science and technology and academic links between Estonia and the UK are also developing fast. In June 2008, the Estonian Genome Foundation, the Estonian Biocentre, and University of Tartu together hosted and organised the seventh annual Gene Forum to foster medical innovation in biotechnology. This is also a good example of collaboration between UK and Estonian scholars.

Academic links between the UK and Estonia are developing. UK universities are co-authoring an increasing number of academic articles with Estonian Universities, and in particular with the University of Tartu, Tallinn University of Technology and Estonian Institute of Experimental and Clinical Medicine. Organisations such as the British Council offer various programmes aimed at promoting academic links between Estonia and the UK.

The British Council's Researcher Exchange Programme (RXP) promotes bilateral exchanges between postdoctoral researchers in the UK and Estonia by providing between two weeks' and three months' funding.⁴²² The Wellcome Trust, specialising in medical research, opened its Senior Research Fellowships (SRFs) programme to Estonian scientists in 2002 to enable scientists to establish a career in their home country. It has proved very successful – Estonia now has the highest density of active Wellcome Trust senior fellows in any country, with six international senior fellows out of a population of only 1.3 million.⁴²³

People links

Culturally, the UK has a high profile, particularly among Estonia's young population.⁴²⁴ Increased spending power and

the development of budget airlines (such as Ryanair and Easyjet) have given many Estonians the opportunity to travel to the UK – London is in the top-ten flight destinations (with 13 flights a day leaving Tallinn for London in 2007⁴²⁵) and Estonian Air is now flying to Manchester several times a week. Even if the number of workers that have moved to the UK relative to the size of the population is lower than for other former Eastern bloc countries,⁴²⁶ links between the UK and Estonia have intensified.

Governments are actively seeking to foster links too through bilateral links. For instance, the British-Estonian Association (BEST) was established in 2002 with the support of the Estonian Embassy in London. Its objective was to bring together residents of the UK that have developed links with Estonia, and to use its members' social connections to promote collaborations between the UK and Estonia. In 2003 and 2004, the Scottish and the Welsh governments organised a series of business and cultural events to tighten their links with Estonia.⁴²⁷

Other links between the two countries are also emerging. Exchanges are becoming increasingly numerous in various fields, ranging from research collaboration to trade. This might allow the UK, and in particular a UK region, to replicate Estonia's most innovative initiatives, such as innovative use of ICT in the public sector or programmes to increase broadband penetration across the country. Finally, Estonia can be seen as a laboratory for the UK, and as a source of good practices that could be replicated in the UK.

Of all the Central and Eastern European countries, Estonia is probably the best positioned to develop its innovative capabilities. Its innovative and bold use of ICT in the public sector and openness to the rest of the world constitute its main strengths. However, the Estonian government has not developed a clear and strategic innovation and internationalisation strategy, something which might hamper Estonia's long-term ability to develop its innovative capabilities. Estonia is now at a turning point, and it will need to design and implement new strategies if it is to successfully move-up the value-chain.

4.6 Summary

An increasing number of places are playing an active role in the globalisation process. Developing countries in particular, despite pockets of poverty, are emerging as innovation leaders and actively looking to exploit external ideas to translate them into new ideas.

China and India's biggest cities have attracted a lot of attention in the UK, but second-tier Chinese and Indian cities as well as other smaller players such as Estonia, Dubai or Singapore should not be overlooked by UK policymakers and businesses. In these countries, governments at both the Federal and the Regional levels are developing strategies to promote innovation, while individuals and businesses are actively seeking to develop links outside their home-countries.

As the world innovation map continues to change, UK policymakers' understanding of changing places and the implications of such change on UK businesses will become more critical. The changes might affect the UK position as one of the most globally engaged countries if new links are not forged and established ones are not continuously revived.

424. See British Council website. Available at: <http://www.britishcouncil.org/eumd-information-background-estonia.htm>
425. See Enterprise Estonia website. Available at: <http://www.investinestonia.com/pdf/uldpreskoduleheleAug07.pdf>
426. Between May 2004 and September 2005, 3,855 Estonians moved to the UK to find work, compared to 37,275 Lithuanians. See Workpermit.com website (09 February 2006) 'UK economy helped by workers from eastern Europe.' Available at: http://www.workpermit.com/news/2006_02_09/uk/eastern_europeans_help_economy.htm
427. See Estonian Embassy in London website. Available at: <http://www.estonia.gov.uk/estonia/economy>

Part 5: Policy implications

5.1 Introduction

The nature of globalisation is changing, with the spread of ICT connectivity, the growing role of diaspora and transnational communities and the rise of new countries as global economic players opening new channels of global interaction. These drivers are transforming globalisation, which is often understood as involving primarily multinational enterprises and trade.

The old concentration of global exchanges in the Triad regions of Europe, Japan and North America is rapidly giving way to wider North-South and South-South exchanges. The five countries highlighted in this report are by no means the only emerging innovation hotspots; they represent good examples of the breadth and depth of changes around the world. The rise of new countries as hubs for innovation brings new opportunities and challenges for the UK. As they continue to grow economically and demographically, these countries will seek to strengthen their links to sources of knowledge and markets across the world. In this respect the UK could benefit from their growth.

In Chapter 1, we highlighted three main dimensions of this global transformation, namely the growth of transnational communities, the pervasiveness of ICT, and the entry of new players in the world economy. In Chapters 2 and 3 we showed that while the UK generally appears as a highly globalised country, globalisation seems to be largely contained within two or three regions. In Chapter 4 we provided a survey of five countries that we considered as prominent new players in the global innovation scene. In this chapter we explore the policy implications

for these changes and what role governments at central, regional and national levels can play to meet the challenges and exploit the opportunities they present.

5.2 The broader policy framework

5.2.1 Central government vs. sub-central governments

Foreign policy is normally the domain of central governments all over the world. However, sub-national jurisdictions such as US states, Canadian Provinces, and German Landers have all developed their own international trade missions, tourism offices and business representations to better serve their jurisdictions. Though such international activities are often co-ordinated with central governments and their representations overseas, the sub-national administrations are often the prime players in developing such links.

More importantly, this tendency is being strengthened by the federal nature of governments in emerging innovation hotspots such as Brazil, China and India. Federalism in these countries means that many of their policies are being made at the sub-national level where most key players exist. For a highly centralised country (albeit increasingly less so) like the UK this may sometimes create obstacles in the way of working with the most effective level of government internationally. While the UK already has federal country partners like the US, Canada and Germany, the regional disparities between the different regions and states in emerging innovation countries make it a different experience. As we have seen in the country reports, only a

few regions within Brazil, India, China or South Africa hold the promise of high value added exchanges and these tend to have international agendas that do not always correspond to the national agenda.

While the onus falls largely on the international partner to decide and organise their international agenda, the UK Government should develop a strategy to deal with an increasingly decentralised and fragmented international policy environment.

The UK government could respond in two ways

It could decentralise some aspects of international policymaking (e.g. cultural aspects, tourism, knowledge exchanges, etc.) to the Devolved Administrations (DAs) and to the Regional Development Agencies (RDAs) at a level that would correspond to what is happening internationally. Its role would then be to co-ordinate horizontally across sectors and regions various aspects of international business policy.

Alternatively, it might work more closely with the Devolved Administrations (in Scotland, Wales and Northern Ireland) and RDAs to deliver a more vertically integrated international policymaking capacity in specific sectors. The latter would require Central Government to become more involved in regional and devolved administrations' business policy.

Some changes have already taken place. Though foreign policy remains the preserve of the Foreign and Commonwealth Office (FCO), its trade and investment arm, the UKTI, works closely with RDAs and DAs. The FCO has also maintained a Science and Innovation Network (SIN), which it now coordinates jointly with DIUS, which aims to boost knowledge transfer and investment in knowledge in both directions.

5.3 Engaging with the new drivers of globalisation locally

This shift towards smaller players, shared-interest communities and distributed global supply chains (including through outsourcing) calls for policymakers to think differently about globalisation.

They need at all levels to 'think global and act local', as the former Norwegian Prime Minister Gro Harlem Brundtland said.

This means that local policymakers – including RDAs – must harness local 'agents of globalisation' such as foreign firms, international students, migrants and ethnic communities. They should also recognise the growing role of small firms, NGOs, and communities of shared interest in the making of global exchanges.

5.3.1 Transnational communities as global channels for innovation and enterprise

Ethnic and immigrant communities

Ethnic and immigrant communities have the potential to become links between local and international economies, and to help small businesses in building such links.⁴²⁸ Some research has already shown a clear link between immigration and trade, where ethnic communities are targeted to support trade links.⁴²⁹ Ethnic and immigrant networks can cut transaction costs related to obtaining foreign market information and the establishing of trade relationships.

This is particularly important for small businesses that often lack the resources to gather information about international markets. In fact, such ethnic business networks are prominent in places with high levels of entrepreneurship like the Silicon Valley, which reportedly has more than 14 ethnic chambers of commerce including those representing African-Americans, Chinese, Indo-Americans, Japanese, Koreans, Portuguese, Vietnamese and Hispanics.

The UK already has a number of programmes and initiatives aimed at harnessing such links; a recent initiative is the UK India Business Council (UKIBC). The UKIBC has programmes that support bi-lateral trade, business, and investment (see Box 1).

More could be done through government-supported programmes to develop these links:

- 'Minority Ethnic Enterprise' programmes, which exist in some UK regions and nations, should be supported to make use of extended social networks beyond the UK.
- Success stories should be showcased to inspire other potential ethnic or transnational entrepreneurs of what is possible through

428. Iyer, G.R. and Shapiro, J.M. (1999) Ethnic entrepreneurial and marketing systems: implications for global economy. *Journal of International Marketing*, Vol. 7, No.4, pp.83-110.

429. Harcourt, T. (2000) 'Why Australia Needs Exports: The Economic Case for Exporting, A Discussion Paper of the Australian Trade Commission and the Centre for Applied Economic Research.' Sydney: University of New South Wales.

Box 7: The UK India Business Council's 'Next Generation India' programme

In 2007, UKIBC launched 'Next Generation India', a programme of activities that aims to attract young Indian talent to the UK. Its objective is to change the perception of the UK in India, which is often seen as an old-fashioned and archaic country.

'Next Generation' is divided in three main programmes of activities that will engage young people in both the UK and India.

Its first programme, the 'Next Generation Network' aims to bring together young people with an interest in India to share work experience and ideas. This network brings together young professionals working in India, young Indian professionals working in the UK, Indian MBA students studying in the UK and second generation Indians wishing to reconnect to India. This

networking facility already has chapters throughout the UK and virtual links.

The second programme, 'UK India Scholarship', provides business placements in India for UK university students. In a pilot in June 2008, ten students gained paid work experience with firms in major cities in India. The pilot involved the Saïd and Cardiff Business Schools. Businesses participating in the programme to date include KPMG, ICICI, HSBC, Boudoir London, Get Through Guides, Origin Wave, JCB, PWC India.

The third programme is a 'UK India Business Angels Network' which was launched by the Prime Minister in January 2008. This network aims to connect Angel (early investors) and Venture Capitalists networks in India and the UK to increase the number of Indian early-stage businesses setting up headquarters in the UK.

430. Bakalis, S. and Joiner, T. (2006) The role of ethnic networks in export activities: the case of Australia. 'International Business and Entrepreneurship Development.' Vol. 3, No. 1/2, 2006, p.85.

linking one's intimate knowledge of the two trading environments.

- Central government should do more to harness the 'social capital' of new immigrants through its immigration programmes. New immigrants (arriving on skilled migrant visas or work permits) could be linked with their relevant business or industrial associations.
- But Government should resist the temptation to create one-size-fits-all initiatives for fostering trade links through ethnic communities, and rather should engage directly with chambers of commerce, community/diaspora organisations etc. to tailor programmes to a country's particular characteristics and culture.
- Internships should be created for international students at trade and business associations or with small companies.
- Ethnic communities should be helped to organise around business and trade issues, with some resources and prizes or awards to recognise best practice.
- UKTI should work more closely with RDAs and DAs to tap into local resources embodied in such communities, with training opportunities and exchanges. The

experiences of other countries may provide useful lessons. Australia and Singapore do this well. And the Italian Ministry of Foreign Trade works with 60 Italian Foreign Chambers of Commerce and Industry to harness Italian expatriate communities around the world.

Other transnational communities

But ethnic and immigrant communities are not the only transnational communities. Many civil society organisations, NGOs and so-called 'Communities of Shared Interest' span national boundaries in their activities, membership and influence.

Environmental groups and aid groups have long transcended national boundaries. More recently, they have been joined by communities using the Internet and open source technologies (see Chapter 1).

Government should help create an environment and an infrastructure that allows for more such groups and communities to emerge. They can then function as platforms for knowledge exchange and innovation between the UK and the world.⁴³⁰

This is particularly important for open source products, but it is also crucial to environmental and social innovations in health, community development, and fighting poverty. For

example, micro-finance is a social innovation that was popularised by Nobel Peace Prize winner Muhammad Yunus, and the Grameen Bank in Bangladesh.

There is a growing drive towards greater 'south-south' and global collaboration between countries at both the inter-governmental, NGOs, and individual levels. The diversity of UK society means that the UK is well-positioned to embrace a larger number of such exchanges and to act as a platform for them. Incentives and rewards are needed for both providing material support but also for recognising the importance of such activities for enriching the UK innovation scene.

5.3.2 Integrating foreign firms locally and linking small local firms globally

Integrating foreign firms locally

Research has shown that local learning activities are crucial if FDI and other external investments are to improve local knowledge and innovation (see Chapter 1). So, it is important that firms with foreign origins are integrated in the local supply chain.

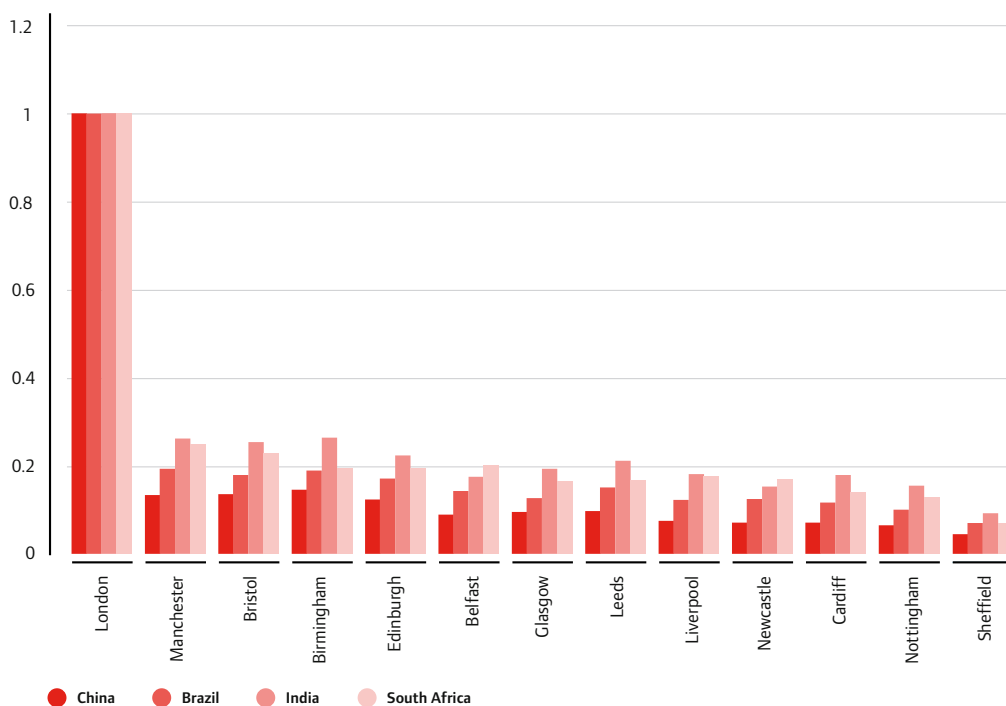
There are already a number of 'Investor Development' programmes across the UK coordinated by the UKTI and RDAs. These programmes help foreign firms achieve higher and longer term returns on their investment by plugging them into local supply chains, universities, as well as into the relevant Knowledge Transfer Networks (KTNs)⁴³¹ and Knowledge Transfer Partnerships (KTPs).⁴³²

Linking small local firms globally

Increasingly, UK firms are pursuing international opportunities. According to a survey by the Institute of Chartered Accountants in England and Wales (ICAEW),⁴³³ nearly three-quarters of the 1,000 firms surveyed are engaged globally: selling to customers, running operations, outsourcing, or securing goods or services abroad. The same survey has shown that fewer small businesses are involved in international business and those who are often lack an internationalisation strategy. A number of programmes already exist to help small firms develop international business strategies, ranging from 'Meet the Buyer' international trips to 'internationalisation strategies'.

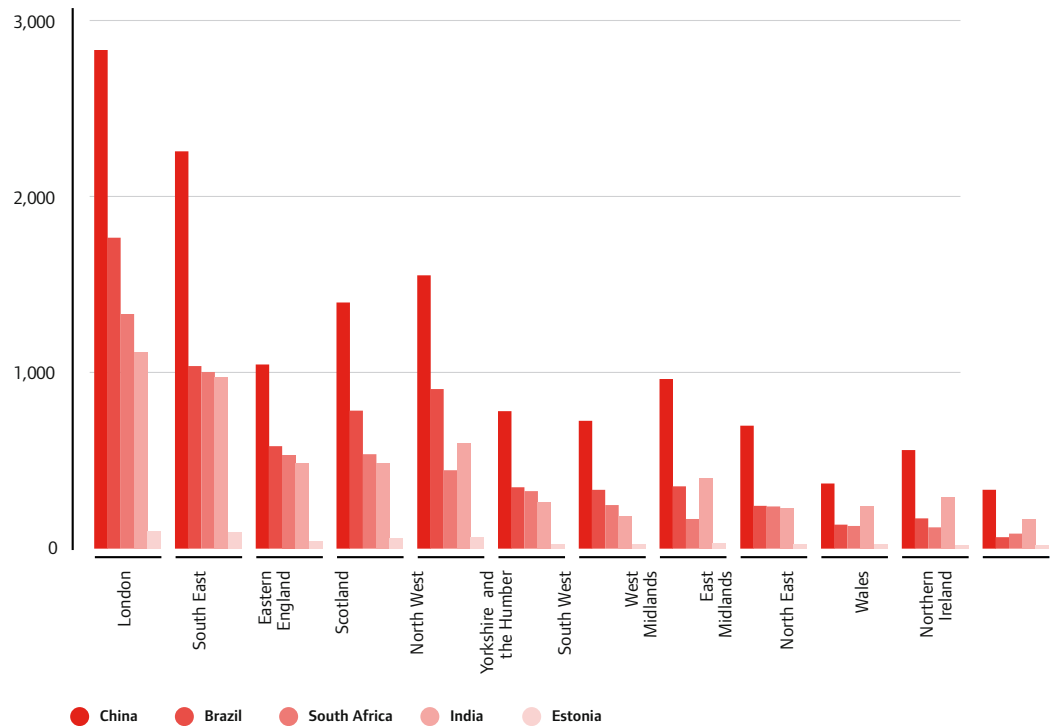
431. See www.ktnetworks.co.uk
 432. See www.ktponline.org.uk
 433. Institute of Chartered Accountants in England and Wales (2007) 'Enterprise Survey Report, 2007.' London: Institute of Chartered Accountants in England and Wales.

Figure 7: UK core cities' business links to the major world globalisation regions



Source: Globalization and World City (GaWC) Study Group, Loughborough University

Figure 8: Articles co-authored with selected countries, by region



Source: Evidence Ltd, unpublished data (2008)

5.3.3 Engaging with the new players

Businesses

In Chapter 4 we surveyed some of the main new players in the global innovation scene, their performance, and their government strategies. UK foreign trade and investment relations may remain skewed towards traditional trade partners in the EU and North

America. But the Evidence Ltd data (Figure 8) on research collaboration and the data from Loughborough University (Figure 7) on business networks show that UK cities and regions are increasingly developing relationships with other parts of the world, most notably the four BRICS countries we surveyed (see Box 3).

Box 8: Advantage West Midlands' network of overseas offices

The Regional Development Agency Advantage West Midlands manages inward investment activity for the West Midlands with various regional, national and international partners.

The RDA promotes the specific strengths of the West Midlands region in order to attract inward investment. This includes assisting potential investors to ensure that their projects are successfully developed and implemented: helping with staff recruitment and training; land and property search; and brokerage with universities.

The RDA has identified eight main priority sectors: Automotive; Aerospace; Building Technologies; ICT; Medical Technologies; Food and Drink; Business and Professional Services; and Environmental Technologies.

Together with the East Midlands Development Agency, Advantage West Midlands is also responsible for a wide network of overseas offices in the United States, India, Australia, Japan, and across Europe.

The RDA now claims to be home to around 2,300 foreign companies originating from about 40 countries which employ around one-fifth of the region's workforce.

Box 9: The East Midlands China Business Bureau

The East Midlands China Business Bureau aims to promote links between regional businesses and Chinese businesses. In particular, the Bureau provides assistance to regional businesses willing to enter the Chinese market.

Information is provided on the Chinese market and businesses are given access to specialist language providers. The Bureau helps build links between research institutions in China and the East Midlands. It also organises networking events in China for regional businesses to showcase their products: a market visit to Shanghai and Ningbo was being arranged for October 2008.

The Bureau has identified priority sectors and locations. The Sichuan Province/Chongqing Municipality and Zhejiang Province/Ningbo are its two priority locations. These have strong pre-existing political and civic links with the region. The Bureau has also chosen to target a few sectors, including transport, environmental technologies, construction, healthcare and food and drink.

Its website, which is available in both Chinese and English, is a gateway to a broad range of information on the Chinese economy, and is aimed to be an interface between Chinese and regional businesses. The Bureau plays a central role in linking up Chinese and East Midlands businesses, namely through networking and events both in the RDA and China.

Figure 7 shows the extent advanced producer services⁴³⁴ (APS) firms in core UK cities are linked to emerging economies. The values for UK core cities are calculated as a proportion of London's links to these countries. Interestingly it is India and Brazil that have the strongest links to these cities and not China. This could be because we are looking at the services sector and not the manufacturing sector.

The ICAEW survey adds further support to these trends. Over 40 per cent of businesses with overseas customers have customers in more than 25 countries.⁴³⁵ The survey also indicates that while the EU-15 remains the primary market for UK businesses, they are assertively seizing opportunities in the new EU Member States, China, the Far East, Central and South America and India.

There are programmes responding to the changing global scene such as the 'International Trade Teams' run by UKTI and RDAs across 40 local offices around the UK. UKTI also promotes and 'sells' the UK science and innovation system as a place to turn to for innovation, capacity-building and partnerships.

But there is a need for a more coherent response from UK government and the various RDAs and DAs. It is important that UK innovation, business, and foreign policies recognise how different aspects of global exchanges are linked to each other.

For instance, university fees policies for non-EU students can affect innovation and trade. There are still relatively few Brazilian students at UK universities, for example.

Government should help support growing links with the countries like Brazil and South Africa by providing studentships, or universities should charge the lower level of fees charged to EU residents to students from these countries. The UK might also increase the number of scholarships available for UK students interested in studying in these countries and could negotiate preferential arrangements for UK students wanting to study there.

Likewise, research collaboration with India seems to be below expectation. So, more support should be given to boost academic exchanges between UK and Indian institutions.

Business, science, and people links are all important channels of knowledge transfer and learning and thus they are important conduits of innovation. Government policies in all these three areas need to be better coordinated under a more coherent strategy.

UK universities and HEIs

UK universities and higher education colleges also need to broaden and intensify their relationships with the new global players. In

434. Includes finance, banking, law and accountancy.

435. Ibid.

Box 10: The Daresbury Science & Innovation Campus (Daresbury SIC)

Daresbury SIC near Warrington has developed a successful scheme to help develop UK businesses' international trade capabilities.

In 2006, an international trade pilot project led by Daresbury SIC with funding from UKTI was set up to help the most innovative SMEs in the Daresbury Innovation Centre identify the main reasons hampering their internationalisation. UKTI

provides supports such as on-site advice through its advisers, website consultancy, market intelligence, and events aimed at providing support for UK businesses willing to export their products overseas.

Since 2006, more than fifteen high-tech businesses participated in the programme, and nearly half of the companies in the Innovation Centre at Daresbury have an International Trade Advisor assigned to them. The scheme has been expanded to other R&D intensive SMEs in the North West.

most of the countries we surveyed there was a fast-growing demand for advanced training.

Some UK universities have already expanded overseas by opening campuses in China and the Middle East. We have seen how nearly half are already involved in providing higher education to Chinese students. This has not been replicated for other parts of the world. The number of Brazilian students, for example, remains very small despite the big demand for university education in that country.

UK universities need to deepen their links in other emerging countries with a thirst for higher education with as much zeal as they have devoted to China, as such links will help foster innovation and improve trade links for the future.

The current offer from UK Government, RDAs and Devolved Administrations could be better co-ordinated. Under a now discontinued programme, the top 50 UK MBA programmes were sold in an integrated way overseas, with an offer including the possibility to stay and work in the UK after the successful completion of the programme. Such offer helps the international student, supports UK firms in need of international talent, and boosts UK academia. Unfortunately this scheme is now discontinued with educational attainment becoming part of a broader point system.

UKTI and the British Council (on behalf of universities) should work together to promote trade and UK science and innovation capacities as part of the overall UK offer. They should develop 'integrated offerings' similar to those successfully used to market MBAs across other sectors and other domains of international exchanges.

5.4 Call to action

What should government do?

Government should create a globalisation advisory council: Globalisation is a multifaceted and multi-channelled activity that involves local businesses, foreign students, migrants and local universities as well as large corporations. Government needs to take a fresh look at the role of the state in an increasingly globalised world. New forms of globalisation have evolved and the broad range of stakeholders involved should be recognised in any consultation about globalisation and its impact on the UK innovation capacity. The UK government should consider the creation of a Globalisation Council, similar to that set up by Denmark in April 2005,⁴³⁶ comprising representatives of all sections of society, with the task of advising the government on globalisation.

Mind the opening gaps: The UK's relationship with the rest of the world is changing very fast and many gaps are emerging. Scientific collaboration with China and India remains below potential, and student exchange with Brazil is far below expectation. Other countries and regions within countries are also growing in importance, such as the Middle East Gulf region, Eastern Europe, Thailand, Malaysia, and Turkey.

The UK Government and Devolved Administrations, working where appropriate through the UKTI, its embassies, the British Council and RDAs should monitor these developments around the world. The Government and the Devolved Administrations need to identify emerging gaps in all spheres of international exchanges, recognise them

436. See <http://www.globalisering.dk/page.dsp?area=52>

and create strategies that respond to them, drawing on the RDAs regional expertise. The UK Government is in the process of creating an internationalisation strategy and this should be the moment and the opportunity to address these challenges.

Recognise the full extent of the change:

DIUS' forthcoming international science and innovation strategy should recognise the full extent of the change. The new innovation hotspots are emerging not only in China, India and other BRICs, but in many smaller innovative countries too. Small countries are sometimes pioneers of large scale innovations (and laboratories for government interventions) such as in public services innovation. Estonia for instance, despite its small size, is a rich source of good practices that could be used as inspirational models for UK regions. E-government in Estonia, to take one example, could act as a model at the regional level. The Estonian government's active support measures to bring the country into the digital age should inspire UK regional policymakers. Initiatives such as the public internet access points and free wireless Internet zones across the country could be replicated in the UK's remote rural areas. Other emerging small innovative countries are Dubai, Israel, Singapore, and Slovenia.

Pay attention to international changes at the sub-national level and in smaller countries:

Not only are new countries joining the club of big global players,⁴³⁷ but small players within countries are becoming more influential internationally. When trying to develop links with big and complex countries such as India and China, policymakers in Government should consider the variety within these countries too. For instance, cities such as Pune in India, Chongqing or Dalian in China provide good platforms for collaboration and carry the advantage of being smaller and less solicited by foreign players than big cities such as Shanghai or Mumbai.

What should the Devolved Administrations and Regional Development Agencies do?

Think global and act local: The potential of existing 'global' resources at the local level should be recognised, particularly international students, and immigrant and ethnic communities. Sub-national and Devolved Administrations are critical to the success of locally-delivered, globally-focused policies.

RDAs should build on their existing capabilities to provide financial and organisational support to help create professional and effective internationally-oriented business and enterprise ethnic networks within their regions.

What should the universities do?

Universities have an important role to play here too. Most UK regions and nations have growing numbers of international students at all levels of education which represent an important resource for the UK, as bridges with their home countries. Universities should consider using tuition fees more strategically to increase their share of international students from specific countries like Brazil. Furthermore, both Devolved Administrations and RDAs should engage with local universities to find ways to link local firms with international students. The onus is on universities, RDAs and local businesses to create such opportunities. The Government has put an attractive immigration system in place which allows such students to stay on after the completion of their training and seek work in the local labour market. It remains to be seen how this immigration channel will change in the ongoing changes to the immigration system.

What should the UKTI do?

Promote access to capacities, not to markets – UK Trade and Investment (UKTI) should develop a more coherent 'trade offer' for the UK. The marketing of UK firms, universities and places should emphasise the UK offer as an innovation system and the benefits of gaining access to it. UKTI's current marketing of the UK innovation system is one good example of such an offer. Likewise, when assessing international opportunities, UKTI (together with the Devolved Administrations and RDAs) needs to assess their international activities in terms of not only size of markets overseas, but also in terms of the overall benefit gained from accessing knowledge, skills, talent, and networks abroad.

437. Goldman Sachs speaks now of the 'Next Eleven'. See http://www2.goldmansachs.com/hkchina/insight/research/pdf/BRICs_3_12-1-05.pdf

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