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Maintaining Europe's Innovative Advantage: EU Policy Responses to the Asian Challenge in Pharmaceutics and Software

By

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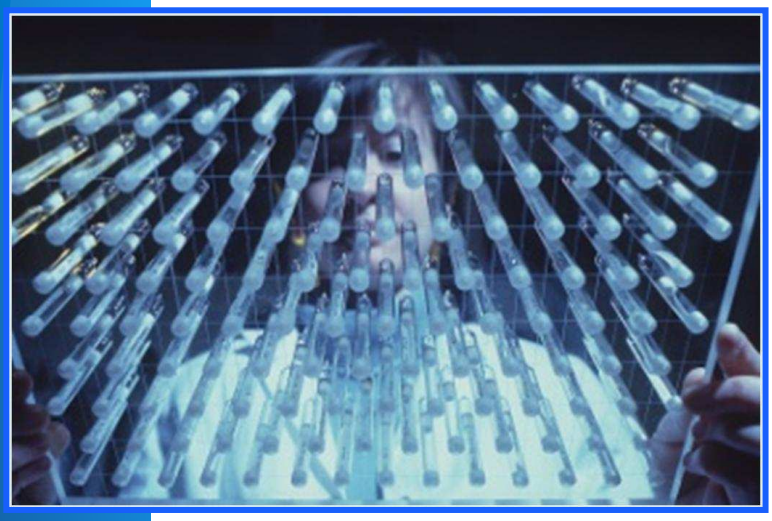

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List of Abbreviations

BPO	Business Process Outsourcing
CCP	Chinese Communist Party
CEAC	Copyright Enforcement Advisory Council (India)
CMM	Capability Maturity Model
EPC	European Patent Convention
EPO	European Patent Office
ERM	Enterprise Resource Management
EU	European Union
FDI	Foreign Direct Investment
FTA	Free Trade Agreement
GATS	General Agreement on Trade in Services
GATT	General Agreement on Tariffs and Trade
ICT	Information and Communication Technologies
IDC	International Data Group
IDMA	Indian Drug Manufacturers Association
IIPA	International Intellectual Property Alliance
IPA	Indian Pharmaceutical Alliance
ITES	Information Technology Enabled Services
ITO	Information Technology Outsourcing
NASSCOM	National Association of Software Service Companies (India)
OECD	Organisation for Economic Cooperation and Development
OPPI	Organisation of Pharmaceutical Producers of India
PCT	Patent Cooperation Treaty
RDBMS	Relational Database Management System
RMB	Renminbi (lit. People's Money – Chinese currency)
SIPO	State Intellectual Property Office (China)
SME	Small and Medium Sized Enterprise
TRIPS	Trade Related Aspects of Intellectual Property
UNCTAD	United Nations Conference on Trade and Development
USPTO	United States Patent and Trademark Office
USTR	United States Trade Representative
WCT	WIPO Copyright Treaty
WFOE	Wholly Foreign Owned Enterprise (China)
WIPO	World Intellectual Property Organisation
WITSA	World Information Technology and Services Alliance
WPPT	WIPO Performances and Phonograms Treaty
WTO	World Trade Organisation

Executive Summary

This paper examines the extent of competitive challenge faced by European enterprises in the knowledge economy from the emergence of Asian technology powerhouses, and in particular by the major economic adjustments in priority and funding now taking place in China and India, as both nations seek to raise the extent of their innovative capabilities and the quality of their innovation outputs. Key sectors such as those of software development, IT services and pharmaceuticals are explored and it will be shown that European politicians and business leaders should become more aware of the current and future innovative capacity that industries such as these are beginning to accumulate in Asia today.

The propensity to innovate by Asia has been explored in some detail and it is concluded that no longer can countries like China and India be ignored and written off as incapable of achieving either market scale or product novelty. Whilst Europe continues to enjoy singular competitive advantages in the sophistication of its knowledge industries, an outward facing strategy is increasingly required in order to grasp opportunities for partnership, market development and tacit knowledge exchange *with* Asia, but also to recognise and respond to threats to Europe's advantage in innovation *from* Asia.

Overview of the sector-based potential challenges from China and India outlined in this paper:

Emerging Sector	Characteristics of Asia's Potential Challenge
Chinese Software Product Development.	i) Direct competition with overseas product majors in China's domestic markets in software sales revenues. ii) Competitive potential to expand across East Asia and outwards to other regional markets that have growing integration with China such as Africa and Latin America. iii) Competitive potential to enter Europe with niche market innovative software / hardware product combinations to directly challenge majors on their home turf.
Chinese IT Outsourcing Industry	i) Competitive threat to Indian, European and US outsourcing firms in the Chinese domestic and regional Asian markets. ii) Competitive threat to near-shore Eastern European IT outsourcing suppliers based on cost *and* skills arbitraging, with local partners. ii) Competitive threat to *Indian* software majors in European (and US) outsourcing markets.
Indian Pharmaceuticals Manufacturers	i) Increase market share of generics and authorised generics revenues within western healthcare sectors. ii) Compete in cost effective drug discovery and development work in global shift of medicament creation sector.

It will be argued that these challenges require multiple level policy and strategy responses from key actors in Europe, at both a political and a business level. Such priorities need to include:

- Sustaining knowledge creation through R&D promotion and firm clustering.
- Creating innovation policy drivers using a legal, fiscal and investment culture that can stimulate individuals and enterprises to take ideas forward.
- Promoting entrepreneurial dynamism to commercialise these ideas across member states and into global markets.

The current economic downturn is severe, but it should not be permitted to detract attention from policies to maintain Europe's long-term competitive success, because new rivals from Asia are emerging with a singular purpose to embrace innovation. For example, China has created a long-term and well-funded strategy to upgrade its own innovative capability and to shift its industrial structure from being an assembly hub to being a knowledge creator. Indeed, its leaders continue to prioritise these economic objectives even despite serious demand downturns in some of its traditional export focused industries, with both national and provincial Chinese politicians seeing the creation of knowledge-intensive enterprises as a counter-balance to reduce the dependency on traditional manufacturing in their economy.

European platforms for nurturing its innovative advantage in knowledge sectors have both strengths and weaknesses as they shape up to respond to this challenge. Clustering, business collaboration networks and continuing education are important inputs in this context, but questions and concerns also arise about the quantity and sustainability of scientific skills, and the extent to which disruptive thinkers can connect with entrepreneurial doers to create commercially sustainable innovative outcomes. In particular, problems persist in the following areas:

- Human resource supply
- Human resource mobility
- Venture investment climate
- Socio-culture and entrepreneurialism
- Inconsistent Fiscal Stimulus

Policy responses need to focus on creating an effective innovation support system, promoting enterprises, nurturing knowledge creation and providing a proven and reliable legal infrastructure for intellectual property and researcher's free movement.

Specific proposals include:

1 *Invest* in initiatives to improve links between science and technology research and commercial business opportunities. Encourage spin-out support systems by providing a pre-seed and seed start-up funding pool. Use US initiatives as a useful template.

2 *Promote* entrepreneurial skills acquisition through continuous education and lifelong learning initiatives, prioritising e-learning-based business school / industry collaboration programmes, linked to second qualification and mature-age skills upgrading.

3 *Re-introduce* the Community Patent Directive and EPLA framework to support cost-effective community-wide patent grants and adopt a London Agreement style solution for language translation disputes.

4 *Create* a separate Software Patent Directive to clarify and coordinate a community-wide approach to categorising and recognising software-based IT innovations in Europe.

5 *Expand* the cluster support framework and design a best-practice strategy for cross-sector and cross-border collaborations within the EU by properly evaluating success factors and path dependency outcomes in existing successful clusters.

5 *Resolve* the complexity, inconsistency and confusion that persist due to disparate member state approaches to R&D tax credits. Tackle two steps in concert: first, prioritise the tax credit issue within wider discussions on the CCCTB, and second, enact proposals to create a Europe-wide special tax status for Young Innovative Companies.

6 *Implement* Researcher's Free Movement principles as part of rollout priorities for the European Blue Card scheme. Monitor implementations carefully to ensure that member states cannot dilute flexibilities to the point of rendering the initiative meaningless.

Europe certainly has the talent to succeed in an innovation driven world. It is now incumbent on EU policy makers at all levels to craft the framework that can ensure this outcome.

1 Introduction

This paper joins the debate about European competitiveness but adopts a new angle to address the potential competitive challenges now being posed by emerging Asian economies. It analyses whether the nature and character of nations such as China and India present a new challenge, or even a threat, to maintaining Europe's leadership in knowledge industries and innovation based growth. It is divided into a number of sections that cover the background to the debates and that present evidence of sector based upgrading upon which these key emerging economies in Asia are embarking, and outlines the arguments concerning the risks to Europe's position that such an evolution may involve. This introductory chapter briefly overviews the messages and conclusions discussed in the paper.

1.1 The Competitive Context of Emerging Asia

Asian countries are changing, and none more so that China and India. They are developing new capabilities and aggressively entering business sectors hitherto seen as the preserve of advanced western societies. Contextualising this change requires an appreciation of how technology upgrading and an embrace of innovation have been able to take root across Asia as a whole, and particularly in China and India, and what implications this may have for Europeans.

The paper presents a broad study of innovation trajectories in China, together with an assessment of the national and international drivers that have influenced these developments. Whilst the current economic slowdown clearly resonates as a major concern in Chinese policy thinking, the political leadership is also shown to be looking strategically at long-term innovation initiatives and the gains that could accrue with appropriate investment over the next 10 to 15 years. An ambitious investment framework is outlined and its implications for European decision-makers are discussed, but there is also an assessment of constraints that may inhibit China's ability to achieve its objectives.

This section concludes with a breakdown of the competitive character of both China and India as they currently compare in international assessments with other major European and global economies, as a precursor to a sector based evaluation of selected Chinese and Indian knowledge-based industries.

1.2 Sector Case Studies.

Two sectors present themselves as particularly compelling subjects for detailed review: the Chinese software product and IT services industry and the Indian pharmaceutical development and drug manufacturing industry.

A case study of China's software industry is useful for a number of reasons. First, far less information is known or appreciated internationally about the evolution and depth of talent in the Chinese software community versus those of its Indian neighbour. Second, demand for software products is growing as Chinese businesses enter a new phase in their development, even despite the economic downturn. The Chinese *domestic* enterprise market presents an expanding opportunity for revenue generation in both business software product development and IT services delivery, to a far greater degree than that currently exhibited by India. This distinctive products platform could impact on the market share advantages that overseas technology firms currently enjoy in the Chinese market. Third, an outward facing attitude is

emerging, with Chinese firms entering European markets directly, using their experience of selling services in the United States, and this is especially noticeable in software services. This trend could have compelling competitive messages for low-cost European near-shore destinations, such as parts of Eastern Europe.

The Indian pharmaceutical industry is shown to be developing at a remarkable pace, with some of its leading enterprises taking advantage from legal changes that have tightened the IP product patent landscape in India at exactly the time that cost pressures on pharmaceutical research and development activities are having far greater salience for even the largest western drugs multinational. Opportunities for India's firms are discussed in the context of both the current and future potential possibilities, with an evaluation of key changes in public health purchasing of drugs perhaps also favouring the value proposition of Indian drug discovery and development capabilities.

Contrasting developments in India's software market and China's pharmaceutical sector are briefly highlighted to provide a comparative framework of analysis.

1.3 Responses and Policy Implications

The threat assessment of China and India is linked to the drive by European governments to expand the region's capabilities in knowledge sector outputs and increase the innovation activities of European firms.

Initiated as part of the EU's Lisbon strategy in 2000 with the objective to create an engine of innovation across the continent, a number of important policy responses are explored and evaluated, based not only on their absolute effectiveness to promote innovation in Europe, but also on their relative impact to enable the region's firms to effectively compete with those from India and China. R&D intensity, investment in clusters and the promotion of knowledge networks are all shown to be part of Asian strategies as well as central to achieving improved outcomes across Europe.

In particular, a set of recommendations are structured around an innovation framework that can combine support for knowledge-sector enterprises on the one hand, and on the other can also address wider issues of knowledge creation, lifelong learning and the promotion of entrepreneurialism across Europe's innovation landscape.

1.4 Conclusion

This section has introduced the issues that are to be explored further in this paper, and has located the arguments about the emergence of Asia as a competitive challenge to European and American knowledge industry leadership with the rise of China and India in sector-specific areas of their own economic development. The globalised world of the early 21st Century is very different to that of the late 20th Century. Characterising this change and exploring responses to potential dislocations that such change can introduce are the central themes of this paper.

2 Understanding Emerging Asia's Propensity to Innovate

This section reviews the emergence of a commitment to innovation, science and technology in key states within emerging Asia, taking a *horizontal* view of national economic interactions across sectors, evaluating multiple factors of the research and development climate. The section focuses in particular on the evolving trends observable in China and India in the context of their embrace of innovation and their encouragement of their knowledge sectors.

2.1 Phases and Trends in Asian Innovation Policy

It is perhaps useful to first define what is meant by "innovation"? One useful definition, provided by Anthony Arundel and Hugo Hollanders, retains flexibility across industry sectors but equally instils the essence of invention and the importance of commercial as well as state actors in the process. Innovation, they outline, should be viewed as the creation, transmission and diffusion of *new* knowledge, measured in various ways, including through patents filed, papers published, venture investment committed, and R&D intensity calculated, and having as an outcome, the potential to generate *commercially sustainable* competitive advantage for an economy (Arundel, 2008: 37).

The emergence of Asia as "an important and competitive player in the knowledge-based world economy" can be best understood to have taken place as part of three overlapping and interlocking stages of development (Krishna and Turpin, 2007: 4). The first stage, which can be broadly defined as taking place from 1950's to 80's, acted as a platform for creating a science and technology policy and was a part of the thrust and enthusiasm for national plans and the state centred approach of picking winners across the economy. Perceived weaknesses in government bureaucrats' abilities to effectively gauge corporate competences and plan business strategy led to the emergence of a second stage in the 1990's that included the introduction of critical new aspects such as market feedback loops and objectives to increase the *application* of innovation in production techniques and product development.

The development of the second, more market-oriented, stage of innovation policy, led to a number of rapid successes in key sectors, and especially within the Asian Tigers of Korea and Taiwan, and in some ways drove the subsequent integration of China into the wider regional economic loop as part of a globalising trajectory (ibid). However, this evolution also led to duplication and inefficiencies across innovating actors, such that, in Korea for example, analysis has found that state institutions, enterprise *chaebols* and private research centres overlapped activities that wasted resources, even despite a vibrant private sector and increased venture capital formation (Kusnetsov, 2008). This may be due to the "group firm" culture that *chaebols* inculcated, promoting vertically integrated production systems and keeping similar R&D activities within a discrete corporate unit that inhibited knowledge dissipation and encouraged duplication of effort. To an extent, therefore, this second stage showed both the limits and limitations of what governments can and cannot do in promoting effective innovation.

The third stage in innovation policy evolution was framed by an acceleration of market and enterprise integration, and by an embrace by the key economies in the Asia region of what can be seen as the formulation of an effective national innovation *system* (NIS), linked to overall economic objectives and featuring a more sector-specific approach to investment, particularly favouring areas such as pharmaceuticals development, biotechnology and information technology advances. This third stage aims to prevent repetition of past mistakes in "picking winners", but instead looks to prioritise the creation of a supportive environment

from within which winners can emerge. Key to this stage's success, it is argued, is the establishment of linkages between research in pure science for absolute advancement, in places such as universities and research institutes, and the application of, and commercial potential for, innovation outputs.

Moreover, the emergence of an NIS approach included pan-Asian attempts to better secure co-ordination of innovation policies, encapsulated especially in the ASIALICS initiative, which is an informal network of scholars and policymakers that work to engender knowledge-based strategies to promote economic growth[1]. Annual conferences are held to explore issues in more depth and seek solutions form common regional problems, with the 2008 event being held in Bangalore, India, with a focus on the changing role of innovation systems in the move form manufacturing to services based economies.

Two Asian countries that have become, in most recent years, very active in the design, development and execution of far reaching innovation strategies are mainland China and India, as each pursues its own agenda to compete with western economies in achieving technology-led leadership in the 21st Century.

2.2 The Evolution of Competitive Innovation in China and India

Historically, in China, there has been the twin stimulus of *push – pull* to effect change in economic and industrial progress, which also looks set to impact the technological structure of domestic firms and their international competitiveness. The *push* element has come from proactive policies from central government, seeking to redress the overseas dominance in technology sectors and to stimulate *domestic* levels of innovation in ways that are designed to challenge those of western Europe and the US (OECD, 2007). The *pull* element has come from a further round of local enterprise integration with world markets coupled with an upgrading of overseas corporate involvement, especially in respect to China's emerging technology sectors. Knowledge industry multinationals have begun to engage with both China and India, in different ways and to different extents, that push both the elements of tacit knowledge and the potential for high value spillovers well beyond simple manufacturing techniques and productivity processes, instead engaging in the holy grail of research and development and creating "brain circulation" (Tung, 2008; Saxenien, 2007) within domestic technology spaces. This kind of knowledge can be exploited domestically by an increasingly entrepreneurial, innovative and internationally educated workforce to build competitive enterprises with global ambitions.

These two factors have been accompanied by a marked increase in Chinese outward facing investment activities, with sovereign fund holdings estimated at around US$2 trillion by 2008 (Subacchi, 2008) and high profile investments in Blackstone and Barclays Bank, complemented by local market activity by major telecoms players such as China Mobile's creation of an overseas subsidiary in London in early 2008, and China Netcom's similar move in 2007, representing the first significant entry by these Chinese behemoths into European markets[2]. At the other end of the corporate spectrum, events of similar importance have been taking place. Less well-known but equally significant enterprise engagement and subsidiary creation can be observed, especially in parts of western Europe, such as the newly announced Chinese incubation centre created in North East England, that aims to attract high tech clustering from innovation centres in the Shanghai region, as well as being able to provide

[1] See Asian Journal of Technology Innovation for further details of this group at http://www.asianjournal.org/asialics.asp accessed 21st November 2008.
[2] See UK Trade Invest website "Many Chinese ICT companies find base in UK" at http://www.ukinvest.gov.uk accessed 25th November 2008.

further support to the 35 Chinese companies already embedded into the that part of UK[3]. FDI outflows *from* mainland China alone have increased from US$2 billion in 2004 to an estimated US$20 billion by the end of 2008, creating what some commentators have termed "new poles in a multipolar economic system" that will likely reshape the economic and political landscape by the middle of the 21st Century (Subacchi, 2008: 492).

In India, there is a different character to the structure of the changes taking place: bottom-up enterprise driven rather than top-down policy driven, as is more evident in China. Whilst the Indian government seeks to respond to its various democratic constituencies, the country's enterprises in key industries are creating their own outward facing agenda, using a strategy that mixes partnerships and technology sharing by IT firms, with an aggressive acquisitions approach by leading pharmaceutical producers, linked to growing levels of specialisation within the Indian drugs industry, as it absorbs the now WTO-compliant aspects of the country's IP regulations and internally consolidates competences as the shape of international pharmaceuticals supply and demand factors change. Ironically, the takeover of Ranbaxy, the country's leading innovative drug manufacturer, by Japanese multinational Daiichi Sankyo for US$4.6 billion in June 2008, illustrates both the current success and potential continuing weaknesses of India's pharmaceutical sector.

In terms of global presence at the macroeconomic level, perhaps only China and India have the capability to sit alongside Europe, the United States and Japan, due not only to their economic size but also to their political, military and human resources that they can marshal as a support system to sustain wider strategic goals. This in particular should distinguish the emergence of these nations from other economies that have come before (Hong Kong, Taiwan, Korea, Singapore)[4]. Angus Maddison's assessments helping to illustrate the increased share of Asia over coming decades, using historical data and sample projections of capabilities in economic catch-up.

Table 1: The World's Largest Economies in 2030: A new G8?

Figures are in 1990 Purchase Power Parity (PPP) US Dollars

Country	GDP US$ Billion	Per Capita GDP US$
1. China	22,983	15,763
2. United States	16,662	45,774
3. India	10,662	7,089
4. Japan	3,488	30,072
5. Germany	2,406	30,179
6. France	2,171	34,462
7. United Kingdom	2,150	33,593
8. Russia	2,017	16,007

Source: Maddison, 2008, Rich and the Rest in the World Economy, Asian Economic Policy Review, page 79.

Moreover, in terms of enterprise-based activities at the microeconomic level, a recent survey of potential internationally competitive firms various characteristics and competences of 100

[3] See http://www.northeastengland.co.uk/home/other-news/north-east-england-hatches-wealth-from-far-east.aspx accessed 15th December 2008. The growth in the number of Chinese companies creating subsidiaries in Britain is further supported by author interviews with business consultants tasked with supporting inward development strategies for many of these firms and also through the author's own personal experience working with Chinese IT companies in the UK.

[4] Indeed, many economic historians point out that China and India are simply seeking to *retake* their place at the geopolitical top table, having lost it to a mix of colonialism, foreign occupation, internal strife and domestic economic mismanagement in the preceding 160 years (Bottelier, 2007; Scott, 2007; Madison, 2006).

firms from developing economies were assessed, with China and India being "disproportionately represented" and having "already produced an impressive set of companies with strong global ambitions" (Aguiar et al, BCG, 2006: 7 – 8). This would seem to promise strategic moves by businesses from both economies to embrace an outward-looking, innovation centric, knowledge-owning competitive enterprise model.

It is important to recognise that in seeking to adopt a more structured *systemic* approach to innovation, Asian countries are framing enterprise-oriented policies and implementing incentive driven frameworks in a similar way to that which the European Union's own member-state led policy development has taken place. As in Europe, there are differences in policy detail and government activism between countries like China and India, and some advantages and disadvantages persist in the efficacy of various policy instruments and their application to different industrial sectors. Nevertheless, the levels of investment, the human resources available and the broader globalising tendencies of R&D activities and new product development all mean the Europe must better understand these developments and should seek to ensure European responses are framed to take account of new international competition.

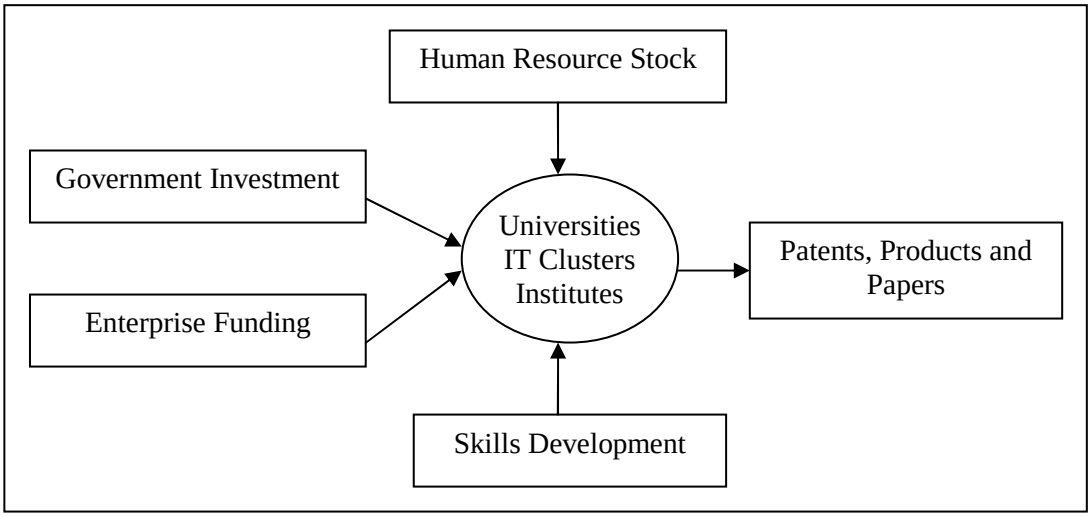
2.3 Sector Study: The Innovation System in China

China's national innovation landscape can be seen as being driven in the following way:

- *Increasing innovation solutions*, such as patents applications and grants.
- *Developing innovation productivity*, encapsulated in new product sales.
- *Building an innovation knowledge base*, such as papers and citations.

These outputs are created within national innovative infrastructure through combinations of government investment, private sector funding and the fusion between universities, sector specific enterprise clusters and state or non-state research institutes.

Diagram 1: Overview of National Innovation Activity Flows



Source: Adapted from Zhang Jing (2007), The Dynamics of China's National Innovation System, along with author's own assessments.

2.3.1 Measuring and Assessing Innovation Success Factors

China's production of innovation outputs has been consistently increasing over recent years, but there are ongoing issues in respect to the quality and influence of aspects of this acceleration, all of which can have negative impact on overall national innovation strategies.

In terms of outputs and activity, patent intensity is seen by many commentators as a useful proxy for increasing maturity, and some interesting contradictions in this respect do become clear on inspecting international reports. These include a number of important indicators from which both a better understanding of the Chinese achievement and a clearer realisation of the China's continuing weaknesses become apparent.

This analysis is based on figures released by the World Intellectual Property Organisation in its Patent Report of 2007:

i) China's State Intellectual Property Office is now the third busiest in the world for patent filings, with domestic residents filing more than non-residents.
ii) However, most *domestic resident* patent applications are still being made in the less innovative "utility model" category rather than the more advanced "invention patent" category.
iii) Over 60% of the patents actually *granted* in China were awarded to non-resident applicants, implying that, despite the application filing intensity, in terms of submission quality and innovative effect of an application, foreigners would appear to remain in a dominant position in terms of knowledge ownership.
iv) In terms of domestic resident patent filings per million inhabitants, China is ranked only 25th in the world, behind Belarus and the Ukraine.
v) The number of international patent applications made with China being the country of application origin under the Patent Cooperation Treaty (PCT) increased by 56% year-on-year in 2006, but in *absolute* terms, the number of international patents filed in China continues to be dwarfed by those of the United States, Japan and Germany.

Influences in character and construction of China's innovation network have, in fact, been from two main source groups. First, a national and internal impact, led by policy initiatives and enterprise intensity improvements; and second, international and foreign influences, anchored on technology transfer processes and the upgrading of R&D intensity within foreign affiliates.

2.3.2 National and Internal Influences

The Chinese government has been a key actor in promoting the importance of innovation activities and to providing both human resource inputs and institutional funding for generating outputs (Zhang Jing, 2007), and it would be fair to characterise the current framework as broadly state-coordinated, even if no longer predominantly state-owned. Business incubators, typically managed largely by civil servants, have also been growing in their visibility across China in recent years (Liu and Ren, 2007). Still largely anchored to the traditional locations Beijing, Shanghai, Suzhou, and Shenzhen, there has, nevertheless, been a noticeable expansion of what could be termed second stage cluster initiatives, moving out from more expensive locations to embrace second tier cities such as Wuxi and Nantong (near Nanjing), although not until relatively recently has their focus shifted from hardware dominance to the importance of services.

However, even within this state activist paradigm, there has been a gradual shift in China away from an emphasis on wholly government centric projects into industry funding, with the importance of smaller and medium sized enterprises being given greater recognition in policy planning and private sector lending, although ongoing issues remain in the way the domestic banking system reviews risk and evaluates SME value propositions, and there also persists a severe lack of private venture capital across domestic sectors (OECD, 2008a).

The National Program for Medium and Long-Term Scientific and Technological Development 2006 – 20 (hereinafter S&T Strategy) was launched by the Chinese government with the promise of substantial state-backed investment drives to bring China into the forefront of research led nations and to provide a platform for moving away from an assembly hub model of low-tech manufacturing-based development (Zhang Gang, 2008). In particular, the policy spells out explicitly that innovation is to be categorised upon three broad themes that should progress in harmony to bring about effective synergies, and that enterprises are to be seen as the core of nurturing successful nationwide strategies. The three themes to be embraced in this policy are:

i) Original scientific discovery and invention.
ii) Integration of related technologies for new products and services.
iii) Better absorption of available worldwide technological resources.

There now exists in China a determination to deploy its resource to create indigenous intellectual property and replace the perceived dependence that high value production centres continue to have on foreign funded enterprises and imported know-how (State Council, 2006; Wu, 2006).

Some of the China's S&T Strategy's key characteristics include:

- Qualitative increases in R&D intensity, from 1.43% in 2006 to 3% in 2020.
- Provide a challenge to the EU's R&D intensity average of 2%.
- Lift-off point for China of US$38 billion gross expenditure in R&D for 2006 at current exchange rates, making it 6th largest worldwide and equivalent to US$86.8 billion, in terms of current purchase power parity (OECD, 2008a: 11).
- Growth rates in Chinese R&D intensity of 19% year-on-year for period 2001 – 06.
- Drive SME innovation through expansion of clusters and incubators.

One example of an innovative success story in the domestic sector is telecoms company Huawei. Still privately owned and operating from its massive science park in Shenzhen, south China, its holds the largest number of invention and utility patents for any Chinese firm. It has sought imaginative ways to counter perceived shortfalls in management skills and lower than required propensities towards innovative thinking by creating its own "university" within the organisation, operating as more than simply a training base, it is led by overseas educated Chinese returnees and seeks to induce the key disruptive thinking characteristics and innovative risk taking that has led to American and European success in high technology markets. Moreover, the company has also recently established its own overseas research institutes, in Sweden, United States and India, and the firm is now seen as a genuinely global innovative Chinese enterprise, active in international markets. There is no reason to believe that such success cannot permeate elsewhere within the domestic economy, and that would certainly appear to be the objective of the Chinese government's radical policy framework.

2.3.3 International and Foreign Influences

The activities and interest in China as an overseas location for research and development by foreign technology firms and multinationals has also been an important feature in China's evolution along the spectrum of R&D competence. The country's platform of absorptive capacity, and a grounding in technological capability within indigenous firms, has been a critical feature of the effectiveness with which different parts of China have been able to exploit opportunities for knowledge acquisition under a spillover effect, which may explain why it is the more technologically sophisticated eastern seaboard regions that have achieved greatest success (Fu et al, 2008). By a process of integration into domestic partnerships and supply chain relationships, foreign know-how can be absorbed into domestic enterprises within an economy, especially when the transfer distance is relatively small, as in the case of clusters and enterprise zones that are a particular feature of China's innovation landscape (ibid).

Recent analysis has charted a number of different stages along the pathway of R&D engagement with China by foreign enterprises. The first stage could be characterised as being driven by politics under a "*knowledge export model*". Their association has been best described as one of intelligence gathering and market entry management, with the objective to create a domestic presence for the overseas brand whilst also responding to political pressures to transfer tacit knowledge to local firms in politically dictated relationships, such as through joint ventures and local sourcing restrictions. Research facilities thus created have been viewed as little more than "PR&D" centres, as part of wider public relations exercises (Jakobson, 2007: 15). The second stage was driven by cost savings under a *knowledge protection model*, linked to the phases of globalisation wherein products were developed in China for both export and domestic consumption under a control structures that limited the amount of genuinely new intellectual property was created in the Chinese entity, as opposed to being imported as an input into production. A third stage, however, is now underway, driven more by a skills partnership between Chinese and overseas staff working within genuinely innovating subsidiaries of overseas technology firms under a *knowledge creation model*.

In this third phase of knowledge creation, there can be seen to have been a rise in *domestic* capabilities that have been captured by overseas firms and put to their own exclusive use (albeit perhaps temporarily), so as to create genuine centres of global research excellence, operating as wholly foreign-owned subsidiaries. These foreign firms are taking advantage of the fact that as a percentage of overall R&D expenditure, labour costs in China account for a relatively smaller share, when compared to both European nations, such as, for example Norway and Hungary, and other East Asian economies, such as Korea (OECD 2008: 112).

In managing this third phase and offshored R&D, overseas multinationals are now seeing investment in Chinese R&D centres as an essential part of their global strategy, whereby products and service innovations are developed for both Chinese and international markets using an offshore centre (Walsh, 2008). This posits the potential for mutually increasing research expenditures from both foreign *and* domestic firms, the latter taking advantage of both the knowledge spillover effect and the rise in domestic gross expenditure prompted through the government's S&T Strategy. For example, one survey has highlighted the evolution of Microsoft's presence in China over recent years, characterising the recently opened Beijing research lab as a genuine Advanced Technology Centre (ATC) for the company, fusing the knowledge inputs of Chinese returnees, local staff and expatriate technical specialists (Chen, 2008). Flagship organisations such as Microsoft's ATC can help to spur innovation across enterprises within the Chinese IT sector, promoting productivity rises due to the intensity of competition that China exhibits in the creation and destruction dynamics of its domestic firms (Bell, 2007).

It is perhaps from initiatives such as these that there exists greatest potential for take-off in domestic R&D expertise, and subsequent locally inspired challenges to overseas knowledge-rich markets such as Europe and US.

2.3.4 Inhibitors and Constraints to China's Innovation Objectives

Despite the central government's objectives to create an innovation centred economy and even with the partnering spillover and network incentives offered by research led centres such as Microsoft's ATC, there are a number of ongoing problems that inhibit China's strategy and blunt its current capacity to seriously challenge world innovation centres such as Silicon Valley in the US, Cambridge in the UK, and the Eindhoven – Leuven – Aachen Triangle (ELAt) in northern continental Europe.

In China, according to a number of industry surveys, and reconfirmed by local political commentators[5], the penetration by overseas firms, which include wholly foreign owned enterprises (WFOE) and foreign dominated joint ventures, of all of China's export content reached 55% by 2007, with this extent being even higher in the ICT sector, where estimates put the foreign dominance at over 80% (Jakobson, 2007; OECD, 2007b). It has also being pointed out that the actual amount of knowledge-based *value-added* provided by China in any of its manufacturing processes was generally regarded as only quite "modest" (Tang and Zheng, 2008: 77), perhaps amounting to no more than an average of 15% across industries (Kroeber, 2007).

There are also a number of further factors that need to be considered to gain a broader view of innovation activity and its potential evolution pathway in China (Dobsen and Safarin, 2008; OECD, 2008a: 41).

i) Limited trust in partnership creation preventing genuinely useful horizontal networks from being created, even in the leading science parks in major hubs, with what effort that exists often expended on nurturing political connections under China's distinctive brand of *guanxi*[6] capitalism.

ii) Educational shortcomings in the way that problem solving and innovative thinking are encouraged in China. The context of most state education programs is largely rote-based and passive in its approach, promoting the accumulation of facts rather than the application of knowledge. This may call into question the premise that China's deep human resource pool is, of itself, an singular advantage over other nations, as, in qualitative terms, the majority may not have internationally competitive competences, reducing their value to domestic and overseas firms.

iii) A greater focus on new product development (category two of the S&T Strategy) than on pure science research (category one), linked to an over-emphasis on the immediate application of incremental innovation rather than an encouragement of "blue sky", disruptive thinking projects.

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[5] Speech by CCP politicians to the European People's Party delegates, Brussels, November 2007.

[6] A Chinese word literally meaning "connections". In practice, the phrase is often associated with the effort and utility of making and maintaining contacts into both local and national Chinese government departments. In a wider sense, its use can describe the way that trust relationships are built up between potential partners in broader Chinese business practices, starting at a social and human level prior to contract negotiation and formal agreement definition. This is rather the opposite of western processes, which typically use contracts and operational outcomes of a partnership as the basis for developing trust.

iv) Ongoing weaknesses in the enforcement capability of its intellectual property regime, although progress at national level, and grass-roots accumulation of IP principles at local levels, are improving, with a greater propensity for Chinese enterprises to defend their own IP in specialists courts.

v) Overbearing bureaucratic state institutions undermining the distribution of available funds to genuinely innovative firms, but perhaps less well-connected under the *guanxi* principles, especially in the SME sector. One analysis by the Finish Institute of International Affairs exposed a complex web of interconnecting government departments and agencies responsible for disseminating high tech funding (Jakobson, 2007: 10).

vi) A potential tension in the national government's policy of providing the platform for nurturing national champions rather than allowing firm-level decisions to govern the right time for mergers with foreign companies seeking a market-entry acquisitions strategy (Steinfeld, 2007). This could undermine the drive towards an *enterprise-led* innovation system rather than one driven by state centric priorities.

Yet, it is these very shortcomings that have now become the driving incentive for change in China's national technology policy, and an element of nationalism may well characterise their innovation strategy for the future. Indeed, whilst it is important to see China's S&T strategy as very much part of the country's overall top-down, government led policy framework, one particularly noteworthy aspect of China's innovation journey is the extent to which *businesses* (including foreign funded) have become the dominant actor in its R&D expenditure. The proportion of China's business expenditure in R&D as a percentage of total intensity has increased significantly over recent years, from representing less than 40% of the total invested in 1991 to being almost 70% of gross expenditure by 2005, matched by a commensurate reduction in percentage terms of the government's role, which itself still takes a more significant role than that of universities. In 2005, the proportion of business R&D investment in China as a percentage of the country's total broadly matched that of the United States and Germany, and was rather more than the proportion from business by the EU25 (OECD, 2008a: 100). Given the degree of increase in absolute value both of China's R&D expenditure and its GDP over recent years, and their projected ongoing growth, this would appear to represent a significant "coming of age" in the country's research and development framework.

These current trends do appear to represent a new role China in particular, in the evolution of research and development activity under the influence of globalisation, and concerns such as those highlighted about qualitative levels of innovation by domestic Chinese firms, and weaknesses in human resource stock of China's employment base, should not be seen as cause for undue complacency by foreign competitor nations. It therefore seems clear that China is determined to invest increasing amounts of its national product as part of a major upgrading of the country's economic direction, and that it is already exhibiting what the OECD has terms "accelerated catch-up" (OECD, 2008a: 111). Whatever shortfalls may exist at present, the singular determination with which Chinese authorities are seeking solutions cannot be ignored.

2.4 Comparisons and Contrasts: India's Innovation Strategy and Cooperative Context

India's R&D landscape can best be characterised as being less startling in its pace of change than China's, but also more sector-based, with most marked innovative activity rested within pharmaceuticals and IT services. Nationally, the country's R&D intensity has remained largely static over the past 10 years at around 0.7% - 0.8% of GDP, putting it on a relative par with Chile and Turkey (UNESCO, 2007:4; Mitra, 2007:30).

The acceleration in recent years of R&D activities within its domestic pharmaceutical industry, and the relatively higher importance of patents to drug companies in general, might help to explain why India is second only to China for *growth* in filing international (PCT) high technology patent applications between 1997 and 2004 (OECD, 2008b: 44), although the relatively low base in their activity from which both these countries started the period also needs to be considered. In terms of its share of world scientific articles published, India's share of 2.1% is around one third that of China's, and both nations are dwarfed by the United States with 28.9% and the EU27 with 33.1%.

Under the 10th Five Year Plan, India's Science and Technology Strategy looked in particular at human resource development, the application of S&T research for society, and international cooperation opportunities, especially in respect to the potential for participation in funding programmes open to all participants, such as the EU's own Framework Programme No. 7 (OECD, 2008b: 66 – 75). This policy was complemented by an industry group's exercise known as Vision 202, published in 2003 (Mitra, 2007: 33 – 34). By 2004, gross expenditure for research and development in India had reached US$23.7 billion in purchase power parity terms (OECD, 2008b: 11) that helped Asian economies take a growing share of expenditures worldwide.

India continues the Asian trend of playing host to overseas enterprises keen to diversity their R&D activities, with India in particular now hosting Big Pharma corporations such as AstraZeneca, as well as IT, telecommunications, robotics and automation enterprises, such as investments by Microsoft, Intel and Cisco, and the R&D centres of Ericsson and ABB, together with BT's research and development virtual education consortium, under the India-UK Advanced Technology Centre, launched in December 2007[7].

Despite the visibility of enterprises in shaping R&D outputs, India's government plays a leading role in providing funding and determining the interfaces between different actor participants in the national innovation system. By contrast with China, the proportion of gross expenditure on R&D that comes from business sources is only around 20%, with the remaining proportion dominated by government sources (UNESCO, 2007: 6). Nevertheless, the role of government is actually highlighted as a major weakness in India's upgrading of its S&T infrastructure and in its embrace of more active R&D trajectories. Like China, a network of national and state-level government agencies, autonomous research institutions, universities and private sector enterprises combine to comprise the R&D landscape in India, with primary policy responsibility being taken by the Department of Science and Technology (DST), whilst the primary public sector actor in the R&D space is the Council of Scientific and Industrial Research (CSIR).

Some important issues that arise in this context include a number of factors having singular resonance with China's growing pains (Mitra, 2007):

- Ineffective utilisation of government R&D expenditures on research labs with limited actual research activity.
- Institutional deficiencies in legal and regulatory framework, with inflexibilities in national labour markets and IPR enforcement timescales being particularly highlighted.
- Limited depth of quality in human resource stock, especially in PhDs and project managers.
- Poor national infrastructure constraining energy availability and capital investment expenditures.

[7] See UKTI for further details, at http://www.ukinvest.gov.uk/OurWorld/4018796/en-GB.html accessed 26th November 2008.

In the same way as China is evolving its private sector contribution to national R&D, so too is India, although typically focused more on specific sectors, in which pharmaceuticals and telecoms having especial resonance. It is useful to note that India's leadership in world offshoring for IT services does create a further vehicle for process and business service innovation, especially through the creation and delivery of multi-location services, but that the absence of significant software product development in the Indian market, and a general reliance on copyright assertion, and trademarking, in the software industry rather than patent protection (outside the United States), means that the observable trends in innovation activity are more difficult to ascertain in software service organisations as opposed to product development companies such as those in the pharmaceutical and chemicals sector. Of the top 20 companies in 2004, ranked by R&D intensity, eight were pharmaceutical firms and four were in electronics and software services (Mitra, 2007: 52).

In India, the sheer scale of domestic R&D investment activity and national level upgrading that appear to be characteristic of China's march towards R&D maturity would seem to be absent. Instead, there has been a marked pace of change over recent years that has sought to shift the predominantly government centred character of the R&D infrastructure, substituting in its place enterprise oriented collaboration, both nationally and internationally, seeking to build sector-specific opportunities for excellence. However, the role of central government may once again be set to grow, as the India's Union administration is proposing to introduce its own "India Innovation Act", designed to be a legislative boost to promote innovation and research across the country[8]. Still in the drafting and consultation stages, the Act is likely to bear close resemblance to the "America Competes Act" of 2007, which addressed issues connected with the promotion of increased research investment, the expansion of education in mathematics and sciences, whilst also giving an additional stimulus to America's innovation infrastructure[9].

To conclude this section, it may be useful to put China and India's innovation systems and policy trends into a wider, international competitive context, prior to looking at specific sectors in more detail.

2.5 The Competitive Context of China and India

The World Economic Forum's (WEF) latest World Competitiveness Report sets out 12 "pillars of competitiveness", including analysing aspects of a country's national institutions, macroeconomic stability, educational and physical infrastructure as well as making assessments about an economy's technological readiness and innovation capabilities (Schwab and Porter, WEF, 2008: 4 – 6). These drivers are interrelated and are linked into three overall categories whereby a country's per capita GDP indicates where they are factor driven markets, focusing on basic requirements such as institutional capacity, infrastructure development and healthcare, efficiency driven economies for whom educational services, technology readiness and market size become important, and lastly innovation driven economies, wherein business sophistication and innovation are of primary importance (ibid: 7).

However, China and India present some interesting dichotomies when making a value-based assessment of their development capability and sophistication. It is indeed the case that,

[8] For further details of India's National Innovation Act 2008, see the Indian government's draft at http://dst.gov.in/draftinnovationlaw.pdf accessed 3rd December 2008.
[9] For further details of the America Competes Act, see The White House website at http://www.whitehouse.gov/news/releases/2007/08/20070809-6.html accessed 3rd December 2008.

based only on per capita GDP, China is making a transition[10] from stage one (factor driven) to stage two (efficiency driven) in the WEF's assessment framework, whilst India is actually still firmly rooted in the lowest category of development[11].

And yet, China's overall ranking is 30, putting it just behind Spain and ahead of Portugal, Czech Republic, Slovakia and Slovenia. India's overall ranking is 50, just behind Italy, and ahead of Poland, Hungary and Greece. How can this be? From the data, it would seem to be clear that both China and India do have some advantages over some countries that would otherwise be well ahead of them in simple per capita assessments.

Table 2: Select Competitiveness Indicators and Country Rankings

Indicator Country	**Overall**	**Institutions**	**Macroeconomic Stability**	**Business Sophistication**	**Innovation**
United States	1	29	66	4	1
Denmark	3	3	12	5	10
Sweden	4	4	15	7	5
Germany	7	14	40	1	8
United Kingdom	12	25	58	17	17
China	30	56	11	43	28
Czech Republic	33	72	42	29	25
India	50	53	109	27	32
Poland	53	88	50	62	64

Source: World Competitiveness Report, 2008, pages 12 – 18. Selected rankings from a list of 134 countries.

In terms of these advantages, they move beyond factors such as determination and imagination, and the report makes the case that both these merging countries possess significant internal strengths that should not go unnoticed by western observers. For example, India's quality of scientists and engineers, its business cluster endowments and its business sophistication are seen as prized assets, although, of course, such views were expressed before the Satyam computer services scandal, which will have somewhat tarnished its corporate governance image. China's economic stability and market size are singled out as providing strong factors for potential future development, and both countries score relatively highly in their innovative competences – indeed, well above the average for their WEF categorisation based on per capita levels alone. In terms of reviewing China's impact in international economics, the report could not have been clearer by characterising the country as an "emerging giant in global competitiveness" (Schwab and Porter, WEF, 2008: 27).

Nevertheless, significant challenges remain for both countries and there continues to be marked contradictions and tensions in how these countries chart their way forward. Some compelling questions beg to be answered:

- Have their innovative capacities been affected by the global economic downturn?
- Can their ambitions be achieved in any meaningful timescale?
- What about the qualitative levels of innovation outputs from these two countries?
- What are the implications for knowledge sector firms and governments in the EU?

[10] The transition economies from stage one to stage two are assessed on the basis as having per capita incomes at US$2,000 to US$3,000 based current exchange rates.
[11] Indicating a per capita GDP level of less than US$2,000.

2.6 Coping with Recession: The New Context of Innovation

In China today, any idea that the country could somehow remain wholly decoupled from the chill winds of contracted demand and decelerating growth have been shown to be overly optimistic. Estimates of GDP growth for China's third quarter entered single figures for the first time in years, together with a fall in China's Business Climate Index and its Entrepreneurs Confidence Index (NBS China, 2008). Industry forecasts for 2009 put the economy on track for growth at around 8%, marking a significant reduction on 2007's value of 12% (Schuman, Time Magazine, 2008), but even that figure may now be in doubt. But more disturbingly for Chinese policy makers, the export hubs of Guangdong have shown a sharp slowdown in activity over recent months that has precipitated factory closures, lay-offs and some associated social strife (China Briefing, 2008a).

In a speech to an academic audience at Cambridge University in February 2009, Chinese Premier Wen Jiabao recognised the unprecedented nature of this "once in a century crisis" now afflicting the world's economies, including those of China, Britain and other member states of the European Union[12]. As part of China's coordinated macroeconomic response, Premier Wen reiterated the government's determination to make energetic efforts for progress in technological innovation to achieve economic recovery, maintaining that science and technology were policy issues of "fundamental importance in overcoming the financial crisis"[13]. His statement presciently captures the transition taking place in China today, as the country seeks to upgrade its productive capabilities away from low value-added manufactures into high-technology, knowledge-led sectors.

However, the government also faces pressures to preserve social stability in the face of mass redundancies and firm closures in hard-pressed exporting zones, as well as ensuring the continuation of sector-based shifts into high-tech, knowledge-driven industries as a platform for long-term structural change. These twin concerns could explain why, on the one hand, technological innovation will be amongst the top 10 recipient sectors of China's US$586 economic stimulus package that was announced in November 2008, whilst on the other hand, a majority of the funding will nevertheless go towards traditional supply-side infrastructure stimulus (China Briefing, 2008b).

In India there has been a realisation by policy makers across industry and politics that a marked dislocation was emerging between export and domestic sectors. On the one hand, there can be clearly seen the consolidation of a vibrant and increasingly cutting edge export sector in software technology and IT services, together with the beginnings of outward facing and innovative elements in the pharmaceutical industry, but on the other, a domestic market dominated by traditional low-tech industries and ongoing high levels of poverty (Sridharan, 2004). Moreover, whilst an evolving Indian middle class has certainly become became discernable in recent years, average per capita incomes have remained stubbornly low (less than those of China), making market seeking FDI less attractive in comparison to the potential of its East Asian neighbour, thus limiting knowledge spillovers and hindering the potential for wider indigenous innovative growth. At a speech in Cambridge in 2007, Indian Prime Minister Manmohan Singh pledged his government's determination to support and sustain India's technology led success[14], but these ambitions have been brought into sharper relief by the current economic slowdown afflicting Indian IT exports.

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[12] The author attended this speech, but a full transcript is also available through China's official news agency, Xinhua, at http://news.xinhuanet.com/english/2009-02/03/content_10753336_2.htm accessed 5th February 2009.
[13] Ibid.
[14] Speech by Prime Minister Singh at the award of an Honorary Degree, University of Cambridge, 12th October 2006, attended by the author as a guest.

The Indian economy was reviewed earlier in 2008 by the Asia Development Bank and was seen as being potentially exposed to international slowdown predominately in its low-tech sectors of textiles and handicrafts, whilst outputs from its high value-added sectors such as technology and business services were expected to grow steadily, if not spectacularly, causing growth to ease. In September, the Bank reviewed these forecasts and published an update that indicated a sharper slowdown and greater stresses for India than previously forecast, highlighting falls in the composite business optimism index for Indian enterprises and constraints on the international investment climate that cold hurt India's future growth (Asia Development Bank, 2008).

Some analysts have posited that India's interconnections with China, which have grown markedly over recent years as part of the increased intra-Asia trade integration observed regionally, will help to prevent the wider malaise from inflicting significant damage (Basu, BBC, 2008). In this changing climate, maintaining revenue streams and competitive business value propositions from within India's high technology services and research oriented pharmaceutical sectors could become an even greater contributor to national economic advantage. But the absence of a meaningful profile in consumption patterns for high value knowledge products within India's domestic economy stands is sharp contrast to China's appetites, which, whilst slowed by recessionary waves, still provide a significant engine for local enterprise growth and competence building.

Before a more detailed sector analysis of innovative development in IT and pharmaceuticals in both countries is presented, it might be useful to conclude this section by summarising their characteristics in terms their respective strengths and weaknesses.

China's Characteristics

Strength

- Considerable state-directed financial and political resources available to industry.
- Deep human resources pool and ongoing stream of computer and engineering skills.
- Substantial domestic market stimulates local demand and may mitigate export downturn.
- High tech clusters attractive to local and overseas firms promote knowledge spillover.
- Skilled Diaspora's willingness to return is increasing due to opportunities & incentives.
- Emerging visibility in western markets for IT services and pharmaceutical production.
- Growing brand identities in key knowledge sectors such as Lenovo, Founder, Huawei.

Weakness

- Top-down drivers may not meet needs of smaller and innovating enterprises.
- Educational framework based on rote learning and ill-suited to modern needs.
- Significant and ongoing inequality across domestic consumer base skews demand.
- High tech sectors still dominated by overseas know-how and WFOE strength.
- Local management skills and corporate governance not globally competitive.
- Insufficient English language skills and project leadership shortfalls.
- Ongoing weaknesses in IP enforcement despite real progress in legal landscape.

India's Characteristics

Strength

- Enterprise driven sophistication in some sectors drives business centric growth.
- Government commitment to nurture and sustain knowledge sectors driven from leadership.
- World class IT software services skills and global resource depth in business processes.
- World class pharmaceutical process research in generics manufacture, sales and exports.

Weakness

- Bottom-up approach needs strong industry lobby groups for govt dialogue.
- Constraints exist in national and state-level bureaucracy: company formation & growth.
- Dislocation with weak domestic market demand and few software products.
- Limited depth of research and development into new medical entities.

- World class Indian Institutes of Technology sustaining elite post-grad skills base.
- World class technology clusters driving export facing knowledge sector firms.
- Too few IITs with mediocre second and third tier educational infrastructure.
- Poor physical infrastructure inhibiting manufacturing and logistics networks.

Source: Author's assessments.

2.7 Conclusion

This section has introduced the characteristics and extent of current innovation capabilities in China and India, locating them in the context of historical trends in Asia's knowledge upgrading, but also highlighting the special character of these two giants that may make their emergence on the world stage more of a challenge than those of smaller East Asian nations in the past. The ambitions of both countries to upgrade competences as a platform for wider international engagement has been explored to paint a clearer picture of trends, opportunities and challenges, both for "the Rich" and for "the Rest". It is important to review sector specific competences in the selected knowledge industries of emerging Asia and attention will now be turned to analyse the structure of software and pharmaceutical sectors.

3 Emerging Asia's Competitive Challenge in the Knowledge Economy

This section provides an analysis of distinctive national industries and their importance in the knowledge economy, and will present a detailed review of key operational factors at a *vertical market*, sector-specific level.

An evaluation of capabilities and an assessment of the outward challenge to western enterprises in high technology and knowledge-rich fields is important, as it is in this part of the world's economic sphere that US and EU economies seek to operate as leaders and in which they have significant interest in maintaining their own comparative advantage in products and services innovation. Moreover, in the cases of software and pharmaceuticals, there are equally important evolutions taking place in market structure and revenue potentials, which make for growing competitive opportunities for new market entrants, and help to illustrate the scope of the challenge.

Answers will be sought to a number of important questions:

- What is the industrial structure of software and pharmaceuticals in emerging Asia?
- Just how important are these sectors to the economies of China and India?
- What implications are there for western enterprises now operating within them?

3.1 Sector Study: China's Software and IT Services Industry

3.1.1 Identifying China's Domestic Software Industry

The Chinese IT sector as a whole has had a variety of market size assessments attached to it over recent years, based in no small part by its emerging importance on the world stage as a source of potential IT products *consumption* (OECD, 2006)[15]. There have been a number of estimates carried out by various sources into the size and trajectory of China's IT and software services sector, including some by independent monitoring companies (IDC-China, 2008), the Chinese government themselves (CSIP, 2008), and also one recently undertaken by India's own IT trade association, NASSCOM[16], which tried to assess the potential challenge to its own home-grown industry (NASSCOM, 2007). This latter report puts the aggregate revenues for the country's IT sector at around US$150 billion in 2006, of which around 90% was from hardware based revenues, indicating a much smaller base for software revenues of approximately US$12 billion for the same year, with the majority of these anchored on software services and on providing outsourced software development to the *domestic* market, with the remaining smaller amount derived from international customers, at present predominantly from Korea and Japan, putting overseas earnings at around US$2 billion of the total, although the point is well made that this export sub-element is actually the most rapidly

[15] The international software industry is broadly divided into three parts, comprising: i) Software Products and Packages that are either enterprise or shrink-wrapped, such as Oracle Financials or Microsoft Word. ii) Software services such as traditional systems integration coupled with new era internet delivered innovations such as software-as-a-service. iii) Software project development, carried out on behalf of the client by service suppliers. Parts ii) and iii) are now often outsourced to suppliers who use their own teams to deliver solutions, where this outsourcing can either be *offshored* to a remote location, such as from the UK to India or China, *near-shored* to a regional supplier such as UK to Czech Republic, Romania or Ireland or *in-shored* to a supplier resident in the client's host country who may use overseas skills, perhaps from the supplier's own overseas HQ, effectively imported into the project – a modern-day refinement of traditional body-shopping.

[16] India's National Association of Software Service Companies, headquartered in New Delhi.

growing, with an estimated CAGR of 41% to 2010. Software products and application packages as a segment of the Chinese software industry total accounted for around US$3.6 billion in 2006 (ibid: 8).

Whilst these figures at first sight make software very much the second sibling to the IT hardware market in China, the sector is of potentially increasing importance and growing interest to overseas observers, for a number of reasons.

First, with hardware production relatively dominated by foreign know-how and supply chain production, the software industry could give market leverage for the emergence of *local* firms to more easily compete with the global giants of Microsoft, Oracle and SAP, using the significant potential of the in-shore market as a base line.

This is not to say that similar challenges of foreign dominance in the Chinese software market do not also permeate the sector as well, as some studies have concluded that up to 90% of system software and 60% of applications software have foreign vendor dominance (Yang et al, 2005). Instead, however, it is perhaps appropriate to take a wider perspective and to imply that there *could* be a greater likelihood of domestic industry success to challenge established players, through the exploitation of local loyalties and through taking advantage of engagement by the Chinese in their own brand development and the identity association that Chinese businessmen have with *Chinese-made* solutions. Thus, things could change for the larger players, especially in sectors such as open source operating systems and enterprise application software packages. Moreover, local firms may be able to generate greater traction in rapidly deregulating business and social sectors, such as banking, insurance and healthcare IT, to capture revenues in specialisations and to use this base as take-off for more aggressive competitive business models, which could subsequently link to overseas expansion plans.

Domestic product company names such as Kingdee and UFIDA already have aggressive plans within their strategy to look outwards from their base of loyal local customers (McManus et al, 2007: 127 – 29). Meanwhile, emerging forces in Chinese software outsourcing services, and outsourced software development, have also been growing healthily to take account of domestic demand, and competing with multinationals such as IBM and EDS-HP, for both domestic and overseas revenue streams, such as ChinaSoft, HiSoft, BeyondSoft, VanceInfo, iSoftStone and Founder, all of which have already entered the US market for services outsourcing and many of whom are now using that base as a platform from which to launch the next stage of their outward facing strategy plans – entry into the European market.

Whilst none of these organisations can yet directly compare in size and scope with Indian majors, let alone western giants such as Microsoft, Oracle and SAP, neither are they minnows to be completely ignored, and nor should they be yet written-off as an insufficiently mature challenge.

Table 3: Selected Chinese software vendors and market focus.

Company Name	Primary Sector Focus and Technology Expertise	Approx. Employees	Est. Revenues (approx. US$*)
Neusoft	Medical software-based products and IT software services.	13,400	US$420 million (2006)
Kingdee	Enterprise Resource Planning software products (ERP) for SME; Java middleware.	3,200	US$100 million (2007)
UFIDA	ERP software products and some IT and outsourcing services.	4,400	US$200 million (2007)

ChinaSoft	IT services and outsourcing, and software overseas development centres.	4,600	US$100 million (2007)
VanceInfo	IT services outsourcing, and software overseas development centres.	3,500	US$100 million (2008 expectations)
iSoftStone	IT services, outsourcing, software overseas development centres and IT consulting.	4,500	Undisclosed (Private company)

* Taken from public sources and/or company announcements and converted at current exchange rates.

Source: Public information, company websites, author's estimates and interviews.

For sure, these are early days, but it might be overly optimistic to bet against an increase in competitive capabilities taking place across the domestic software and software services sector in China, even despite the strains of an economic downturn.

Second, it is important for western analysts to remember that China's software and IT services sector is not actually as new a phenomenon as it first may seem, despite its relatively recent emergence on to the corporate radar screens of US and European enterprises, which is itself perhaps an illustration of the rather limited appreciation by some corporate actors in western circles over the pace of change that has been taking place across the middle kingdom in recent years. In fact, China has been a favoured destination for software services outsourcing and offshore software development from locations across East Asia for much of the last decade, and especially from Korea and Japan, where linguistic and cultural familiarities have made early market traction easier.

The expansion of domestic in-shore opportunity, coupled to a shift from supplying clients in near-shore locations to servicing needs in offshore locations such as from United States and Europe, is what is now characterising the current trends. Moreover, this domestic confidence has also been associated with impressive estimates for future growth, with China's Ministry of Industry and Information Technology (MIIT) predicting a year-on-year growth rate (CAGR[17]) for the 2007 – 10 period of 34.9% (CSIP, 2008), which may, in fact, not be unreasonable, given an actual CAGR of 31% for China's software and services market from 2000 to 2006 (NASSCOM, 2007: 9).

Third, the political commitment for software as a strategic industry in China is significant, and the importance of this fact should not be underestimated, with the sector already being designated as a "pillar industry" in both the Tenth (2001 – 05) and Eleventh (2006 – 10) Five Year Plans. Furthermore, the sector has had major national funding projects such as Torch associated with it, which, together with provincial initiatives, have injected capital to create software development parks that have become home to thousands of software start-up firms and established payers alike. Whilst for sure, these parks enthusiastically attract foreign investment from western firms keen to get a foothold in China and to exploit local labour force capabilities for their own software development purposes, there is also a very important domestic dimension to the operation of Chinese software parks[18].

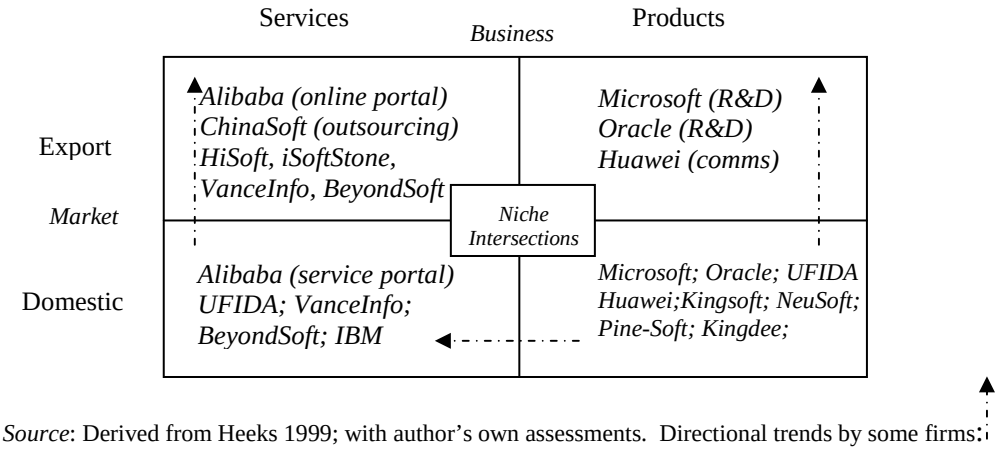
The country's major commitment to clustering can be observed by the fact that it is not only in Beijing's landmark Zhongguancun Software Development Park (Z-Park) that construction and expansion is taking place. In addition to the capital's Z-Park, that has seen enterprise occupancy approach 20,000 firms with accumulated revenues of around US$80 billion[19],

[17] Compound Aggregate Growth Rate.
[18] Author interviews with software park officials, Nanjing, Wuxi and Nantong, China, September 2008.
[19] See "Z-Park in Brief" at http://www.zgc.gov.cn/english/AboutZPark/Z-ParkProfile/34441.htm accessed 12th December 2008.

other regions are evolving at considerable pace as well: in Dalian there is a thriving software development and offshore centre serving Japan and Korea. Meanwhile, in the south of the country, software parks are taking shape around the city of Nanjing, about which provincial politicians have ambitious hopes to create China's version of Bangalore[20], with high tech software firms building on locally derived market experience and technical competences to create outward facing strategies inclined to securing new customers from, and a subsidiary presence in, Europe and the United States[21].

A number of academic and practitioner analyses have been carried out to try and better understand the strength, weaknesses and potential trajectory of the Chinese software market, and many characterise particular strengths coming from domestic market growth potential driven especially by local SME opportunities as potential customers (McManus et al, 2007) and a position that denotes outward facing ambition prior to moving offshore into overseas markets (Kumar et al, 2005). This grid builds on a framework originally created to explore the phenomenon of the Indian software industry during the 1990's, but it is one that can be usefully adapted[22].

Diagram 2: Chinese Software Industry Business Matrix: Example Firms



Source: Derived from Heeks 1999; with author's own assessments. Directional trends by some firms:

Nevertheless, there are still weaknesses for this sector in China that need to be overcome in order for it to achieve take-off internationally and challenge the foreign firms that still compete head-on in the domestic market.

- Many Chinese firms (especially SMEs) lack CMM[23] and CMMi competence above 3.
- English language competence remains a perennial problem, especially writing skills.

[20] Speech by First Secretary of CCP, Nanjing Municipal Party, Nanjing, September 2008.
[21] The author has visited many firms in Beijing, Shanghai, Nanjing and Wuxi and met a number of political leaders and company executives in software firms across China who all exhibit great confidence and determination to make an impact outside the domestic and East Asian heartlands. Indeed, one local firm based in Wuxi, near Nanjing, reported that the municipal government had responded to particular skills shortages experienced by his firm by creating and funding a new technology course at the local university geared to producing graduates of the required calibre to fill the firm's HR shortfalls. Author interview, September 2008, Wuxi, China.
[22] The firms indicated are purely representative of those active in different industry segments and should not be seen as a definitive or exhaustive list.
[23] The Capability Maturity Models (CMM and CMMi) were developed out of the Software Engineering Institute of Carnegie Mellon University with independent appraisers trained and authorised by the SEI making inspection assessments of application companies, similar to the way that Quality Management kitemarks are assessed across the EU. CMM is concerned primarily with advanced software programming capabilities, whilst CMMi assesses process and project skills.

- There persists significant structural immaturity with great need for market consolidation to reinforce strengths in a few firms rather than dissipate capabilities over numerous enterprises of various sizes.
- Many Chinese firms must fill significant gaps in middle tier management and project leadership, especially in respect to large-scale international project delivery skills.
- The industry lacks a coherent national lobby group with effective political leverage and the creation of a body along the lines of India's NASSCOM is a much needed next step.

3.1.2 Challenges and Opportunities for Chinese Software Enterprises

This analysis has shown is that the Chinese software industry should not be ignored and has, despite its problems, both market presence and core capabilities from which to grow, and credibly challenge the operations of major industry-leading firms, especially in China's home markets.

Whilst they have formidable opponents in the shape of Indian majors, as well as highly capable multinationals, potential challenges to some European sectors in the medium term could also be envisaged. In particular, the rise in Europe of near-shoring to less costly parts of the Union – i.e. the use of overseas outsourced services that are still close to a company's home market – may come under increasing pressure, as cost reduction demands begin to accelerate during an economic slowdown that is expected to last at least until 2010. This could directly challenge the value proposition of firms from countries such as Czech Republic and Romania, who, over the last few years, have become visible on the outsourcing radar of industry groups in both India and China as a clear competitor market for harvesting EU outsourcing customers (Gopalan and Herring, 2005, NASSCOM, 2006).

Some threats that may be facing emerging EU outsource suppliers from China over coming years, independent of costs issues and resource pool arguments, include:

- Increased compliance with information security standards ISO27001 and BS7799 by Chinese firms coupled to anticipated changes in China's data privacy laws to better reflect international norms.
- Growing awareness amongst Chinese business and political elites of the importance of intellectual property enforcement efficiencies coupled to progress in IP regime institutional capacity.
- Returning EU-educated Chinese bringing direct cultural and business experience of European countries, their operating needs, cost expectations and language diversities.

Moreover, the opportunities may also be greater than they first appear due to developments in both software industry *structure*, as well as the wider, ongoing implications of the international economic downturn.

i) Changing Structure and Nature of Software

The nature and structure of software may be changing fundamentally which could work in favour of emerging, cost-competitive and internet oriented enterprises such as those in China's software parks. The development of more fragmented software delivery frameworks, such as internet delivered software-as-a-service (SaaS), where software such as accounting systems, resource management and customer relationships coordination can be fragmented and used within an on-demand environment, using a high-speed, "always connected" internet delivered model. Furthermore, there is growing enthusiasm for the process and efficiency gains that are promised from another new software based solutions portfolio, the Service

Oriented Architecture (SOA) model, whereby business units and software supporting tem can be broken into manageable constituent parts and re-used in ways that lends itself perfectly for outsourced and remote development and delivery.

These initiatives could radically change both buying and building habits of even the largest corporate consumer of software, which could mitigate large product oriented firms continuing to dominate in the way that they have to date. No doubt, successful cash-rich ventures such as western software multinationals will respond and re-enervate their own product offerings, but such movements in the tectonic plates of an industry create risks and challenges, and, perhaps for the first time, competence in service delivery exhibited by Chinese firms may be intersecting with industry demand trajectories.

ii) Recession-driven increase in skills-based cost-reducing outsourcing

In terms of weathering the wider economic ills now facing the world, some software and service firms will fair better than others. Indeed, economic downturns can actually encourage more offshore activity in order both to streamline project delivery and further reduce operating costs: HR in particular for international software firms is the major cost element as the outputs are so dependent on individual skills. It is particularly important to understand this kind of offshoring as being valuable so long as it is *skills-based* and not simply premised on cost reductions, and China's deep human resources pool and growing numbers of IT graduates could set the country in good stead to exploit the downturn afflicting overseas customer, whilst also being able to respond to demand from local firms, who undoubtedly will not be immune from the wider economic cycle, and for whom language issues such as English are much less of a concern.

iii) Rise of "Out-tasking" challenges enterprise-wide contracts

Observable industry trends towards smaller scale "out-tasking" may yet prove to be an advantage for Chinese enterprises which are nimble, customer responsive and tuned into the leading edge of computer services (Davies et al, 2008). In this sense, out-tasking could replace some of the "big ticket" outsourcing deals that have dominated headlines and secured revenue streams for western majors, providing instead a finer level of granularity in the nature and extent of what exactly is being outsourced[24]. Whilst these trends have first been observed as a response to cost constraints and risk aversion during the height of the economic recession, such operational flexibilities may prove to have lasting attractions and could be a useful differentiator for smaller and medium-sized software service enterprises such as those that characterise the Chinese domestic sector.

3.2 Comparisons and Contrasts: Summarising India's IT Services Sector

In India, the software and IT services industry has iconic status as a sunrise sector and, in terms of current size and reach, it dwarfs that of China, with projected accumulated revenues for its entire IT-BPO market (including hardware) of US$64 billion in 2008, with the predominant export markets being United States (61% of total) and the Britain (18%)[25]. Within this overall figure, a useful comparative value with earlier Chinese estimates puts the Indian IT Services outsourcing industry (*including* business process outsourcing (BPO) and software products and packages) of US$52 billion for 2008, of which over US$40 billion was

[24] See article "Megadeals on the Wane" by Outsource Magazine which serves the UK's business process and IT services outsourcing industry with news and analysis of potential trends. Accessed 9th December 2008 at http://www.outsourcemagazine.co.uk/index.php?page=article&article=1131.
[25] See NASSCOM website enumerating current and past revenues: "IT-BPO Sector Overview" at http://www.nasscom.in/Nasscom/templates/NormalPage.aspx?id=54612 accessed 19th November 2008.

exported. Indian brands in IT have now become global brands: Tata Consulting Services, Wipro, and InfoSys, for example, have become well-known international corporate names.

Interestingly, in percentage terms, there is a sharp split between domestic and export revenue streams, with a strong emphasis on exports, and is in opposite proportions to the profile offered by China's industry. This export bias is especially significant when analysing the more narrowly defined segment for IT services and outsourced software development (excluding BPO) which has estimates for domestic revenue sources put at US$7.9 billion for 2008, as opposed to export sales for the same segment of US$23 billion. This shows that India is far more dependent on export revenues than China at present, and has considerable market exposure to two markets most likely to enter deep recessions in 2009, the US and UK. Moreover, their ability to shift focus swiftly into domestic penetration is largely controlled by the readiness with which local enterprises can embrace sophisticated IT solutions.

In effect, this confirms two aspects of India's IT sector: first, its current success eclipses competitors, but does not of itself prevent the emergence of challengers. Second, the difficulties – the dislocation – that Indian firms continue to face when extending their undoubted export leadership into the domestic market place remains in place, and could continue to be a source of underlying weakness in building a base for software product sales and domestically generated intellectual property, which could prevent Indian's firms challenging the main international software product companies, many of whom are in fact their key customers (D'Costa, 2004).

Finally, whilst some of the larger Indian enterprises continue to evolve their China entry strategy, and the Indian industry continues to look with confidence at its current hegemony in international low-cost offshore outsourcing (NASSCOM, 2008), even despite the economic downturn, there are some clouds on the horizon. In particular, Chinese commentators point out that expansion by Indian firms into the mainland has been less swift than the publicity surrounding the original announcements of Chinese subsidiaries back in mid decade[26], and there is now at least some serious questioning as to the future potential for mutual complementarities under the "Chindia" paradigm, increasingly replaced instead with a realisation that China and India are more competitors than they will ever be partners.

It can therefore be argued with some confidence that the China challenge, in IT at least, extends across the Asian continent, as well as potentially into the European domain.

3.3 Sector Study: India's Pharmaceuticals Industry

3.3.1 Locating Indian Pharma on a World Scale

The takeover through acquisition of a majority stake in Ranbaxy, India's pharmaceutical jewel in the industry's crown, by Japanese multinational Daiichi Sankyo in June 2008 for US$4.6 billion, illustrates both the strength and weakness of Indian pharma, and points to both opportunities and threats to its future as a collection of independent operators. Nevertheless, it also shows the extent to which Asia, and India in particular, have become important centres of gravity for the global pharmaceutical sector.

The global pharmaceutical industry is estimated to be a business with worldwide revenues at US$700 billion (Bellot, 2008), with the Indian industry ranked 4th in the world by volume of drugs produced and 13th by sales revenues in US dollar terms (Chaturvedi et al, 2007). Nevertheless, the worldwide market for pharmaceutical production and sales remains dominated by Europe and the United States, in terms all the key indicators:

[26] Author's interview with Chinese software industry senior representative, Beijing, May 2008.

i) Regional Market Share: United States: 45%; Europe: 31%.[27]
ii) Enterprise market share: the top 10 firms are all from either from Europe or the US.
iii) Enterprise revenues: the same 10 firms lead the industry field.
iv) Market demand: Europe and North American residents dominate consumption.
v) Global procurement: both regions have highly sophisticated health insurance markets.

Table 4: The Pharmaceutical Global Top 5 2007.

Company	Country	Sales (Billion £)	Market Share
Pfizer	USA	22,292	6.7%
GlaxoSmithKline	UK	18,847	5.6%
Novartis	Switzerland	17,154	5.1%
Sanofi Aventis	France	16,788	5.0%
Astrazeneca	UK	15,010	4.5%

Source: Association of the British Pharmaceutical Industry (ABPI) website at http://www.abpi.org.uk/statistics/section.asp?sect=1 accessed 29th November 2008.

In terms of India's pharmaceutical presence in a global context, one industry report has estimated that the domestic market for pharmaceutical outputs in India could triple by 2015 to over US$50 billion (OPPI[28], 2008), driven in particular by income growth and the expansion of a prosperous middle class, whose interest in, and ability to pay for, healthcare insurance and related products could be expected to converge with those of developed economy consumers. In this sense, therefore, the industry appears to be much more balanced than India's software and services sector, with consequent greater potential to seek rapid engagement with a growing domestic market for medicament consumption.

Table 5: Structure and Revenues of Indian Pharmaceutical Industry

Category	2007 – 08 Estimates	2002 – 08E CAGR
Domestic Formulations	US$8.4 billion	14%
Bulk Drug Exports	US$4.2 billion	11%
Formulation Exports	US$4.0 billion	23%
Contract Research	US$0.4 billion	75%
Total	**US$17 billion**	**20%**

Source: Indian Pharmaceutical Industry. Vision 2015. OPPI (2008), pages 8 – 18.

Table 6: India's Leading Pharmaceutical Firms

Company	2007 Revenues
Ranbaxy	Rs41.9 billion
Dr Reddy's	Rs41.6 billion
Cipla	Rs37.6 billion
Sun Pharma	Rs24.6 billion
Lupin Labs	Rs22.1 billion

Source: Industry and company websites.

[27] See IMS Health research and market intelligence website, accessed 29th November 2008, at http://www.imshealth.com/deployedfiles/imshealth/Global/Content/StaticFile/Top_Line_Data/GlobalSalesbyRegion.pdf.

[28] Organisation of Pharmaceutical Producers of India. This is one of three principal industry lobby groups and its membership contains mainly overseas multinationals along with two leading domestic firms – Ranbaxy and Nicholas Piramal. The others are: The Indian Drug Manufacturers Association (IDMA), which represents a majority of domestic firms and took a broadly hostile stance against TRIPS compliance, and the Indian Pharmaceutical Alliance (IPA), which took a largely neutral stances in the TRIPS debates on India' intellectual property regulation reforms.

3.3.2 The TRIPS Bifurcation

The domestic market has grown and evolved through three stages, within a classic push-pull paradigm, led by the benevolent push of nurturing government policies under an import substitution model and by the subsequent pull of international market opportunities when local competences had reached critical mass. Each one of these phases has in effect been defined by the intellectual property regulations that have been in place during the period, which have either encouraged or discouraged particular domestic and multinational corporate activity (Chaturvedi, 2008). In the industry's first stage of evolution, after independence in 1947, but prior to the Patent Act of 1970, India's market was characterised by limited local productive capability and dominance by the overseas multinationals of "Big Pharma".

Over the subsequent 35 years of the second stage of the industry's history, once the 1970 Patent Act had abolished product patents and had made the creation of patentable processes to copy the design of existing medicaments wholly legal under Indian law, the absence of product patent enforcement and the development of distinctive creativity in medicament processes by domestic Indian firms led to the creation of world class production facilities in the manufacture of generic drug formulations, which are non-branded versions of medicines that may or may not enjoy patent protection outside India. Indeed, it is important to note that much success in Indian drugs manufacturing has actually been based on creating generic versions from off-patent formulations of compounds that have lost patent protection globally. During this second period of evolution to 2005, many MNCs exited the market and it has been estimated that local firms had control of over 75% of the India's pharmaceutical market share by the time that product patent enforcement was re-introduced (OPPI, 2008).

The industry is now embarking on a new third phase of development and expansion, defined in large part by the 2005 changes to India's patent regulations, which now, for the first time since 1970, recognise and enforce product patents on pharmaceutical medicaments. Foreign multinationals are now re-entering the domestic space, with Daiichi-Sankyo's move for Ranbaxy a particularly bold example.

In terms of domestic corporations, Ranbaxy continues to be India's largest domestic drugmaker and one of its most innovative and aggressive firms, having itself embarked on a series of international acquisitions as early as the middle 1990's, to grow its own market presence in Europe and the US, concentrating on its leadership in the generics sector, beginning with Ohm Labs in the American market in 1995 before looking to European firms for market entry platforms, buying Veratide and Basics in Germany in 2000 and Aventis in France in 2004. The company's investments in R&D have typically led the industry in India, and although at a relatively early stage, entry into the highly competitive but potentially rewarding field of new medical entity research puts it into a leadership position in the domestic market and may help explain Daiichi-Sankyo's purchase enthusiasm.

By turning Ranbaxy into a subsidiary of Daiichi, there has been speculation as to whether this presages a more active multinational engagement with India and its pharmaceutical enterprises, in order perhaps to pre-empt future competitive stresses and at the same time, position foreign firm capabilities to exploit the growing domestic demand base for different kinds of drugs that the sub-continent may present in years to come. It remains to be seen what the future holds for other local Indian firms, many of whom have in recent years pursued similar outward facing acquisition-centred strategies similar to those of Ranbaxy. This behaviour has included even smaller and lesser-known names, such as Nicholas Piramal, who acquired Rhodia and Avecia in the UK, in 2004 and 2005 respectively, and Wockhardt, who acquired the UK's CP Pharmaceuticals in 2003 and Germany's Esparma in 2004.

3.3.3 Generics Skills as Anchor Points in Firm Strategy

Indian firm capabilities should be seen in the context of an evolution along the research and development spectrum, engaging in ever more complex aspects of drug formulation. The journey can be encapsulated as:

i) Research, create and sell generics versions in India.
ii) Obtain approval for marketing these drugs in EU/US.
iii) Acquire EU/US generics firms to build local market share.
iv) Develop competences in R&D for drug discovery in new medicament entities.
v) Compete globally for government healthcare procurement contracts.

In this journey, the basic skills gained during the generics production phase of the industry can now be seen as providing excellent base points for moving up the value chain. Such competences include:

- New chemicals evaluation
- Reverse engineering analysis
- Advanced process research
- Drug marketing know-how
- Export engagement capability

Even within higher value activities, some firms have concentrated more on "research" than "development", with drug discovery being particularly important aspect of some firms' strategic direction (Bower and Sulej, 2007). It is, however, conceded by many observers that the move by a majority of Indian companies to a genuine R&D centric business model that can effectively compete with western established firms remains "very challenging due to the differences of knowledge base and organisational capability" (Kale and Little, 2007: 603).

Moreover, many of the leading innovative firms, such as Ranbaxy, had already been investing heavily in R&D prior to the 2005 new legislations, which may reflect some directional adjustments observable over recent years. For example, the sharp fall in Ranbaxy's R&D expenditure from 2005 to 2006 is almost all accounted for by a reduction in clinical trials expenditure over the year, and the absolute amount still reflects an important commitment R&D by the company's senior executives (Ranbaxy Financial Report, 2006).

Table 7: India's Pharmaceutical Top 5 R&D Activity

	Research & Development				**US Patent Grants Since 2000**
Company	2005 / 06 Rs. Billion	2006 / 07 Rs. Billion	2006/07 % Approx. Intensity	05/06 – 06/07 Year Change	
Ranbaxy	6.39	4.83	11% of Rs41.9bn	-155	62
Dr. Reddy'S	2.97	2.53	6% of Rs41.6bn	-43	64
Sun Pharma	1.15	1.61	4% of Rs37.6bn	+45	1
Cipla	0.98	1.55	6% of Rs24.6bn	+57	3
Lupin	0.83	1.08	4% of Rs22.1bn	+24	8

Sources: R&D India, Newsletter June 2007; R&D India, "Pharmaceuticals Sector Analysis" at http://www.rndindia.info/sectfinal.aspn accessed 20th November 2008; Author's calculations.

3.3.4 Cost Advantages and R&D Trends

India actually competes in the international pharma space both as a competitor and as a supplier to multinational firms, drawing on its costs advantages as an outsource destination for both research and development activities and in the support of clinical trials, both processes being important and costly stages in the overall process of new medicament creation. Industry estimates put the cost advantage of developing an active pharmaceutical ingredient in India versus the same process in the EU or US as over 30%, and given estimates of overall costs for new medicament entities of up to US$1 billion, that represents a significant saving (Bower and Sulej, 2007). Furthermore, even despite the ever increasing costs, the output productivity of pharmaceutical innovation is declining, putting further pressure on costs bases and revenue future pipeline revenue streams. Particular leverage is made possible by Indian firms due to their human capital, both in the depth of the HR resource pool and in salary flexibilities, whereby compensation levels for Indian science PhD holders fluctuates at around an equivalent US$15,000, versus the developed economy level of equivalent US$100,000 (ibid).

In this sense there is the emergence of strong regional clusters with India in the centre of skills-based development outsourcing, including the creation of marketing and sales partnerships, co-targeting leads (Bellott, 2008). Moreover, trends towards Indian Diaspora members returning to lead projects in the innovation and research space of India's economy may be accelerating (Bower and Sulej, 2007) and could be further prompted by the overall slowdown and economic contraction afflicting European and American markets. Additionally, development agreements for producing "authorised generic products" between Indian and western firms are increasing, involving the production of generic versions of drugs whose compounds are still under patent protection and are thus subject to the licensing approval of the patent owner.

These developments posit a more benign role and imply a limited scope for India's capability to challenge international firms' core competence and market dominance. However, there are actually a number of ongoing aspects of sector evolution that may premise additional leverage for disrupting the status quo.

3.3.5 Disruptive Potential of India's Pharmaceutical Industry

India has opportunities to strengthen its position in the international market by exploiting the side-effects of two important structural and financial developments:

i) Supply Side Disruption: Growth in Off-Patent drugs

It is estimated that over the next 10 years, up to US$100 billion worth of drugs will go off-patent with a particular concentration of patent expirations taking place in 2011 (OPPI, 2008), meaning that even under India's TRIPS compliant regulations, it will be possible for generic versions to be mass produced and exported from Indian pharmaceutical manufacturing centres in direct competition to the previous patent owners, using their pre-existing generics capabilities and cost advantages. To be sure, alliances and exclusive marketing arrangements with multinational in the context of "authorised generics" will undoubtedly take place to mitigate some of the financial risks, but nevertheless, such patent trends pose a potent challenge to future revenue streams, especially given the paucity of pipeline replacements in the form of limited new blockbuster drugs from the research labs the market leaders.

ii) Demand Side Changes: Procurement policies of national healthcare systems

India already has experience working within the US market under the market pressures introduced by the Hatch Waxman Act, which sought to introduce legislative initiatives to reduce drug prices in the US healthcare market as far back as 1984. Recent rulings in American courts may have helped Indian enterprises by allowing tem earlier and easier access to explore medicament molecules even during the investigation phase of a multinational's research procedures. In this way, the requirement to embrace the route of an authorised generic may be diminishing, perhaps prompting Indian firms to review their current strategy in what is still, by far, their most important market (Sahay, 2008).

Moreover, change is taking place not just in the US, with price pressures and a growing concern in reducing spiralling healthcare budgets gaining ground on the political agenda in Europe as well, with demand for generics expected to grow across Europe by at least 10% in the years to 2011 (OPPI, 2008). India already having the largest number of FDA approved manufacturing development centres outside the continental United States, and has a growing number of UKMCA approved centres as well, giving its industry both the credibility and confidence to enter these highly regulated markets in ways not easily replicated by other developing economies.

iii) Sector Evolution: Increase in Outsourcing of Entire Development Value Chain

The costs, timelines and risks of new medicament entity research are considerable, and one area of growing expertise for India's pharmaceutical industry in is reducing that burden through an effective outsourcing and offshore supply of skills for existing drugs multinationals. Growing trends across the industry include the separation and outsourcing of all parts of the medicament entity value chain, including R&D and clinical trial phases, which could offer Indian firms both the attraction of revenue streams and the opportunity to build on in-house capabilities through closer synergy with leading international corporations. Whilst an increase in outsourcing could not be interpreted as an immediate threat to Big Pharma *per se*, as they would at least in the first instance be customers rather than competitors, it does present the prospect of skills upgrade and of building a niche competitive capability from which more aggressive domestic Indian competences could be evolved in due course (Zinnov, 2008).

These cost and competence advantages offered by India could encompass the entire value chain of drug discovery and development, a process which current can take up to 15 years or more, and which certainly helps to explains the billion-dollar R&D investments of western multinationals.

Table 8: Linking different phases of the pharmaceutical lifecycle and Indian capability.

Phase	**Success Rate**	**Duration In Years**	**Cumulative Timeline**	***India's Capability and Future Potential?***
Research & Discovery	< 1%	4 – 6 yrs	4 – 6 yrs	*Low but growing*
Pre-clinical development	< 1%	1 year	5 – 7 yrs	*Moderate & growing*
Clinical Trials Phase 1	70%	1 – 1½ yrs	6 – 8½ yrs	*Moderate & growing*
Clinical Trials Phase 1	50%	1 – 2 yrs	7 – 10½ yrs	*Good*
Clinical Trials Phase 1	50%	2 – 3 yrs	9 – 13½ yrs	*Excellent*
Registration	90%	1 – 2 yrs	10–15½ yrs	*Good*
Post-marketing studies	Not applicable	Several years	Several years	*Good*

Source: IFPMA, 2007: The Pharmaceutical Innovation Platform, page 18. Author's assessments added.

However, global success for India's pharmaceutical firms is by no means assured, and recent setbacks in America indicate the fragility of India's competitive advantage: 30 generic drugs sold by Ranbaxy were recently banned from the US after an investigation into production quality was initiated by the FDA (Pharmaceutical Law Insight, 2008). Moreover, strategies by MNCs for neutering the threat posed by Indian enterprises, through takeovers and lock-in partnerships, will likely form a feature of future industry consolidation and vertical integration and it would be premature to write-off the competitive response capabilities of Big Pharma just yet. Additional Indian domestic weaknesses, in terms of R&D intensity commitments, the sustainability of continued HR skills availability, and the attractiveness of simply selling up to an international suitor in the vane of Ranbaxy, could also add negative influences from an internal direction.

Nevertheless, the potential strength and established competences of India's drugs manufacturing industry should not be ignored, and evidence presented here indicates that in time, and for a variety of reasons, Indian enterprises could represent a serious thrust at the comparative industrial strength of European and American enterprises over the coming years.

3.4 Comparisons and Contrasts: Summarising China's Pharmaceutical Sector

The Chinese pharmaceutical sector is smaller, more fragmented and far less internationally integrated than that of its Indian neighbour. It has been characterised as "extremely regionalised and fractured" but yet still ripe for "dramatic restructuring", growing on the potential for evolution of a national health insurance and clinical care system that the Chinese authorities need to introduce to sustain social stability under the "harmonious society" concept and correct "an almost total absence of conventional primary care" across the country since the abolition of the iron rice bowl principles during the 1980's (Backman: 2008: 142 – 46).

In clinical terms, there has also been a history of concentration on Chinese traditional medicine, and a skills development n the manufacture of medical equipment for export rather than drug development and R&D driven medicament discovery. Nevertheless, whilst the sector in enterprise terms is still relatively weak, the market potential for growth and profitability is potentially huge, with estimates of a $1 trillion domestic healthcare budget spend in China by 2030, based on an estimate of 8% of GDP year-on-year spent on healthcare that reflects typical values for developing countries (ibid: 146).

But the industry at enterprise levels has a number of formidable challenges to overcome, linked to a number of policy and behaviour concerns. First, there are ongoing quality control fears that permeate many aspects of China manufacturing and that have most startlingly been revealed in the baby milk scandals of mid 2008; second, national and provincial intellectual property regime and enforcement shortfalls have, at least in the past, mitigated against heavy drug discovery investment; and third, there is anecdotal evidence of a drug sales philosophy in hospitals that has at times appeared to reflect a cash-raising objective rather than a deep respect for core clinical decision making which can undermine sector credibility in the hearts and minds of local, middle-class consumers[29].

Its market potential, however, is seen as being considerable, not least because of the possibility of increases in state-provided healthcare provisions and private sector health insurance evolution promoting growing demand for pharma outputs. Moreover, China can also be seen to be emerging as a major supplier of active base ingredients and core chemicals, with growing capabilities in finished pharmaceutical goods. The Chinese drugs industry does

[29] Feedback and opinions given directly to the author by numerous Chinese professional colleagues and family friends, at different points whilst living for extended periods in Beijing from 2003 onwards.

not appear to be presenting the same direct competitive character now being displayed by India, and the large pharmaceutical multinationals current seem to view China as a major potential growth opportunity for themselves, rather than as a potential challenger to their own hegemony.

3.5 Assessing the Innovative Threat from China and India

How can the threat from China and India best be quantified and analysed? Perhaps the single most important message to put across is that these trends are observable now, that change is underway, and it is the potential trajectories of this change and its impact on European future success that in particular need to be understood by decision makers. In this sense, there are now new competitors in the research, innovation and commercialisation landscape, outside Europe and America, with whom western administrations must now learn to contend.

3.5.1 China and R&D Upgrading

The knowledge sector evolution in China has changed the whole character of the international R&D framework in recent years, with western multinationals such as Microsoft and BT creating genuine Centres of Excellence across the Middle Kingdom, from which global products are created and marketed to both Chinese and international consumers. This is no longer the hierarchical division of labour that characterised American and European engagement with China in the past, wherein low-tech, low-value work was outsourced and high-tech, high-value invention was kept firmly within Europe and US hubs (although in some sectors, such as consumer electronics hardware assembly from other East Asian partners, it can be argued to still represent the norm).

Chinese government led initiatives include recognisable features of typical European innovation systems policies, such as tax incentives on R&D expenditure and sector focus on technology and IT industries. The country also has substantial revenue commitments in funding available for different projects, and significant depth in its pool of human resources that it can use to achieve outcomes. Moreover, the Chinese have also recently unified their corporate taxation system, ending preferential treatments for foreign-funded enterprises and bringing into being a more sector based feel to incentives and rebates, in moves designed both to stimulate more indigenous innovation and create a more modern and streamlined fiscal framework (Xuedong and Li, 2008).

From 1st January 2008, key new features of China's corporate tax system have included new characteristics that would not look out of place in any EU member state's policy portfolio:

- Preferential income tax rates for all high-tech enterprises.
- R&D Tax Credits for expenditures in developing not only new technologies but also new products and processes as well.
- Proportional tax deductions for qualifying investments by venture capital firms.
- Tax exemptions for qualified technology transfer proceeds.

These examples of new policy initiative, skills upgrading and competence building provide evidence for the view that China should now be seen as a nation having come of age in some of its R&D capabilities in a number of niche areas, especially in high-tech research and development, software and telecommunications. Tacit market intelligence and technology know-how, gained by local Chinese working both directly within such centres and for partner firms in related clusters, can then be used as the basis for tailored localised products, entrepreneurial spin-outs, and as the basis for enhancing the quality of university-business

collaborations in the future. Such ventures should not be confused with illicit purloining of IP, but instead should be seen as the natural by-product of Schumpeterian creative destruction in the clusters and science parks of mainland China, in exactly the same way as has evolved the character of Silicon Valley in the US and Cambridge in the UK. Combined with a deep resource pool that comprises both local and overseas educated talent, the emergence of China into the spotlight of innovation oriented economic growth should not therefore, come as so much of a surprise.

Even outside pure R&D initiatives, growing international visibility is occurring. For example, in business software and IT services, real progress is being made in the outward facing expansion strategies by China's leading software companies, using their distinctive advantages in a still-expanding domestic market as a solid base for future growth. Genuine potential threats could exist to Europe's in-shore and near-shore providers of task specific software development offshoring and non-voice IT out-tasking.

Ireland, Czech Republic and Romania all offer attractive skills-based service propositions to Europe's enterprises, but will they be able to compete in the future with the significantly lower price points and markedly larger resource teams available in China, especially when such services can be combined with *on-shore* specialist consulting assistance provided by the Chinese supplier through their own local captive firm or niche partner? Indeed, the nature of this precise kind of threat not lost on the Indian services industry, which has been keeping a careful watch over China's East Asian technology evolution for some time.

Skills shortfalls and product portfolio weaknesses *do* remain in the Chinese system, and will continue to give European enterprises both competitive advantage and partnering opportunity. However, the sheer pace of change in the structure of the international economy, the unbridled ambition of China's technology enterprises, the accelerating acquisition of skills by Chinese firms, and the investment support offered by Chinese state organs should give Europe's business strategists and political elite significant pause for thought.

3.5.2 India's Challenge to Global Pharmaceutics

In pharmaceuticals, Indian value propositions have been moving away from a singular focus on generics manufacture to an embrace, at least by some enterprises, of drug discovery and development investment. In the short to medium term at least, there would seem to be genuine opportunity for synergies between Indian organisations offering low cost high-skill solutions for offshoring R&D and clinical trial management and western pharmaceutical manufacturers seeking reductions in bringing new medicaments to market to better respond to price pressures imposed by western state-regulated healthcare sectors.

In the long-term, however, adverse impact on western firms growth prospects, the HR expansion needs and their ultimate profit margins cannot be ruled out, and leading Indian firms should be considered as genuine challengers to the existing order.

3.5.3 Threat Assessment Matrix

Emerging Sector	Characteristics of the Threat from Asia	Threat Potential?
Chinese Software Product Development.	i) Direct competition with overseas product majors in China's domestic markets in software sales revenues. ii) Competitive potential to expand across East Asia and outwards to other regional markets that have growing integration with China such as Africa and Latin America. iii) Competitive potential to enter European and US markets with niche market innovative software / hardware product combinations to directly challenge majors on their home turf.	Current: *High* Future: *High* Current: *Moderate* Future: *High* Current: *Low* Future: *Moderate*
Chinese IT Outsourcing Industry	i) Competitive threat to Indian, European and US outsourcing firms in the Chinese domestic and regional Asian markets. ii) Competitive threat to near-shore Eastern European IT outsourcing suppliers based on cost *and* skills arbitraging, with local partners. ii) Competitive threat to *Indian* software majors in European (and US) outsourcing markets.	Current: *High* Future: *High* Current: *Moderate* Future: *High* Current: *Moderate* Future: *High*
Indian Pharmaceuticals Manufacturers	i) Increase market share of generics and authorised generics revenues within western healthcare sectors. ii) Compete in cost effective drug discovery and development work in global shift of medicament creation sector.	Current: *High* Future: *High* Current: *Low/Growing* Future: *Moderate*

Source: Author's assessments.

3.6 Conclusion

This section has drawn together evidence from two important industry sectors that feature in both China and India's active engagement with the international knowledge economy. It is now important to review how European firms and governments have sought to upgrade their own innovative capacity and to put this into a wider context of western responses to the rise of Asia's challenge.

4 Moving Beyond the Lisbon Strategy: Recognising the Asia Challenge

The world is now facing a seismic shift in the tectonics and dynamics of economic power, caused predominantly by the re-emergence onto the world stage of India, and especially, China. Europe is not the only region of the world to have to come to terms with these new competitors from emerging Asia, as the United States, Latin America and Africa, are, each in their own different ways and to different extents, now considering the manner and implications of future engagement strategies with Asia.

In terms of innovation and the role of knowledge sector industries, it has been shown that genuine progress has been made across a number of sectors by both China and India, and that a commercially sustainable competitive advantage is being built within these economies. In particular, building on research into comparative perspectives of the Korean and French national innovation systems by Lee and Yoo (2007), it may now be necessary for western political, economic and corporate actors to recognise that heavily state-coordinated systems, such as the framework of China's emerging innovation infrastructure, may now be just as capable as liberal-market economies at nurturing an innovative capacity, and at producing and exploiting economically and commercially valuable innovation outputs.

Moreover, Europe has both particular characteristics and challenges in its economic and political structure that brings the future significance of Asian competitors into sharper relief. The region is in one sense highly integrated as a community of national member states in the European Union, pooling sovereignty and sharing in the benefits of the single market and free movement, but is also highly diverse, both economically and culturally, making the unity of responses and the coherence of community-wide policies key issues of effectiveness that can be just as important as the content of the responses themselves.

A number of initiatives and programmes have evolved during the last 10 years to characterise Europe's response to these changing dynamics, but it was the Lisbon Strategy that encapsulated on one side the ambitions of European politicians and on the other, both the potential and the problems of the European region as a whole. Lisbon was designed as a cornerstone of the EU's endeavours to meet the challenges of the 21st Century and reconcile the economic and political realities of the Union with policy and outcome necessities of a new millennium. It is therefore useful to briefly locate its principal objectives and to understand its key weaknesses.

4.1 Overview of Lisbon Objectives

The Lisbon Strategy was launched from the European Council meeting held in Lisbon in March 2000 and aimed to make Europe the most competitive economy in the world by focusing on growth priorities through building an innovation-oriented region by 2010. It introduced a number of proposals for reforms, anchored on economic, social and environment "pillars" of policy activity, whilst introducing an open method for coordinating policy responses (OMC) between member states, recognising that the main policy areas of the overall strategy fell into member state areas of competence. It was an ambitious plan that sought to correct deficiencies in labour productivity, market flexibilities and innovation intensity.

The original strategy set some important targets, such as raising EU levels of research and development investment to 3% of the community's total GDP, boosting jobs by 20 million and achieving a 70% EU employment rate by 2010. The liberalisation of services to match

that of the single market for goods across the Union was an additional anchor to reflect that the majority of Europe's GDP is actually comprised from services sectors, including financial, tourism and information technology. The strategy could be said to have been born out of the optimism of the era before the dot.com bubble burst and it may also be true to say that the framework policies may not have taken full account of the potential disruptive nature of the more globalised world for the inputs and outputs of the innovation process, exhibited in particular by the extent and pace of change in both China and India that has taken place since the turn of the millennium.

The Strategy also consolidated calls by the Barcelona Summit of 2002 for an upgrading of Europe's human resource stock as a critical input into achieving the region's goals of becoming an innovative leadership centre. In this sense, meeting key educational targets for member states was encouraged, with particular emphasis on achieving an increase of at least 15% in the total numbers of graduates for maths, science and technology subjects across EU member states by 2010. Targets for completing secondary education across member states were also introduced, requiring a minimum of 85% of 22-year olds to have completed secondary education by 2010, reflecting the message that success in an enterprise-led knowledge economy is based as much on the building blocks of numeracy and communicative confidence as it is on the detailed outcomes from tertiary education (Riela, 2008: 30 – 37). Indeed, it is in their drive to meet these particular Lisbon targets that member states have experienced most success, with a steady improvement towards meeting or exceeding the original 2000 targets for science graduates and secondary education leavers already observable in a number of member states (ibid).

4.2 EU Innovation Strategy: Weaknesses and Challenges.

4.2.1 Lisbon and R&D Intensity Targets

In 2004, the High Level Working Group under Wim Kok conducted a mid-point assessment of the Strategy[30], the outcome of which was a report that highlighted a number of weaknesses in delivery and achievement (Dierx and Ilzkovitz, 2006), the main ones being:

- An overloaded agenda with too many competing priorities in different sectors.
- Lack of driving ownership at member state level.
- Deficiencies in economic coordination and governance at EU level.
- Disappointing delivery of benefits to EU citizens at the personal level.

The Lisbon outlook can also be said to have been born of an inward looking strategy that has singularly failed to recognise the globalised world in high technology production and knowledge sector R&D that now face European firms. It is therefore important to evaluate future strategies on these new conditions rather than dwell on outdated principles.

This dislocation between policy expectations, economic conditions and practical outcomes led to a reformulation of the strategy into one which focused more narrowly on growth and employment, and sought to inject renewed urgency into achieving greater levels of sustained innovation across key industries. In short, Europe needed to focus more on its own comparative advantage as a region of "extraordinary innovation potential" in order to satisfy its citizens' concerns about their own future (European Commission, COM502, 2006: 2).

[30] See EuroActiv website at http://www.euractiv.com/en/future-eu/lisbon-agenda/article-117510 accessed 1st December 2008.

The results from recent assessments appear to confirm ongoing weaknesses in Europe's capabilities to exploit its potential in science, technology and innovation. Recent analysis has highlighted ongoing competitive tensions, wherein Europe as a whole has both failed to catch the leadership of the United States whilst also being potentially squeezed by new R&D spenders, the most of important of which is clearly China. During the first decade of the new century, R&D intensity of the European Union, taking account of new member state accessions, has largely flatlined and has failed to rise above 2% (OECD, 2008b: 21).

Table 9: R&D Intensity for EU27 and selected other countries, 2006.

Country / Region	Gross Expenditure on R&D	
	Amount PPP US$	Intensity as % of GDP
United States	US$343.7 billion	2.62
EU27	US$242.8 billion	1.76
Japan	US$138.8 billion	3.39
China	US$ 86.8 billion	1.42

Source: Adapted from OECD Science, Technology and Industry Outlook, 2008, page 21. OECD Statistics Database.

The figures also indicate the dichotomy existing across the EU between member states and the challenge that may especially face those European economies whose innovation, science and technology infrastructure are currently weak and may be no match in competitive terms with the competences and resource availability of emerging Asian giants.

4.2.2 European and Asian R&D Trajectories

Whilst the most innovating-oriented European economies clearly have profound niche strengths, they are also some of the Union's smaller economies, and even these could over time become more vulnerable to skills upgrading by, and knowledge transfer to, economically innovative ecosystems with large human resource pools, high investment reserves, and tightly integrated political policy landscapes that characterise the support systems of Asia, and especially of China.

Perhaps of particular concern in relation to these intensity reviews, is the perspective given that in some member states, investment in R&D has actually been *falling* as a percentage of GDP. This is in stark contrast to the innovation investment trajectories of China and India, where significant increases in investment levels have characterised recent years. In Europe, the current economic slowdown, which will likely last throughout 2009, could create an even more uncertain picture for research investment and spending, as national priorities shift from longer term knowledge and skills upgrading to shorter-term crisis management.

Whilst clearly, much current focus in EU literature has been anchored on assessing, exploring and challenging the US leadership, analyses in the future may be more complex, and the rising tide of high-energy initiatives emanating from emerging Asian nations should not be ignored. Evaluations must now no longer be just about China's or India's capacity and capability, but instead, analyses need to include the extent to which multinationals and local European firms will consider relocating high value functions to centres of lower costs, but *not* necessarily of lower skills, such as Shanghai, Beijing, Wuxi, Hyderabad and Bangalore.

This could have a direct impact on jobs and livelihoods even in some of the most innovatively active regions of the Union (OECD, Regional Innovation Review, 2007).

Table 10: R&D intensity for selected countries and regions, 1996 – 2006.

Country / Region	1996	2001	2006
United States	2.55	2.76	2.62
EU-15	1.76	1.87	1.88
EU-25	1.68	1.78	1.79
EU-27	1.66	1.76	1.76
China	0.57	0.95	1.42
India	0.65	0.76	0.71
Selected EU member states drawn from across the region: Scandinavia; N. Europe; S. Europe; New Accessions.			
Sweden	3.47	4.18	3.73
Finland	2.52	3.30	3.45
Germany	2.19	2.46	2.53
Denmark	1.84	2.39	2.43
France	2.27	2.20	2.11
United Kingdom	1.86	1.82	1.78
Czech Republic	0.97	1.20	1.54
Spain	0.81	0.91	1.20
Hungary	0.63	0.92	1.00
Portugal	0.57	0.80	0.83
Poland	0.65	0.62	0.56
Romania	0.71	0.39	0.45

Source: OECD Technology and Innovation Outlook, 2008, page 22. OECD Statistics Database.

The challenge may in fact be even greater than it first appears, for two additional reasons.

First, according to some assessments, the United States spends at least US$200 billion *more* per year on the knowledge economy the whole of the Union, with the gap mostly characterised by differences between the two regions in the important sector of *business expenditure* on R&D (Muldur et al, 2006). Second, as has already been shown, the issue of business expenditure as a proportion of gross R&D investment is exactly the sphere where countries like China are advancing significantly in relative terms, with key investment initiatives across a number of cluster-based high technology sectors.

Moreover, recent technology policy assessments have reviewed national levels of what the Economist Intelligence Unit has termed "e-readiness" – or, a national capability for individuals and enterprises to utilise digital channels for personal and business communications and benefit generation (Economist Intelligence Unit, E-Readiness Survey 2007), and has found some mixed, and potentially worrying, messages for EU member states. Whilst in terms of government contribution to e-readiness, in issue-areas such as infrastructure support for e-business environment and e-procurement initiatives, member states such as Denmark, Sweden and the United Kingdom scored well in comparative assessments with global competitors (ibid: 17 – 19), the gap between "have's and have nots" in the wider sphere of technology upgrading is seen to be narrowing, with ranking gains being made in particular by East Asian economies of Hong Kong, Korea and Taiwan, whilst European nations commensurately slipped down the rankings. Whilst China currently lags most of its Asian neighbours in EIU rankings, the pace of infrastructure investment and speed with which mobile telephony and internet connectivity have advanced across the middle kingdom in recent years illustrates that complacency about China's current ranking would be a short-sighted response.

4.2.3 National Industrial Structure and the Wider Policy Framework

It is important to include at least some understanding of a nation's industrial support structure in any meaningful assessment of innovation policy, in that abilities and propensities to innovate are likely to be linked to a portfolio of different characteristics, including:

- Composition of firms
- Availability of skills
- National and regional investment support
- Tax incentives for R&D commercialisation.

Some member states with low R&D may have a singular absence of industries that stimulate the formation of R&D outputs, such as ICT, biotechnology or pharmaceutical manufacturing (Reinstallar and Unterlass, 2008). In this case, simply spending more in low-tech sectors may have limited beneficial results, and there may need to be a more radical adjustment of industrial structure first, in concert with increased R&D spending to gain maximum benefits.

Structural conditions may help to put China's strategy into wider context, as the national leadership is seeking to achieve exactly this kind of *structural* transformation, linked to co-ordinated support policies and commercialising tax rebates, whilst trying to create a more integrated system for innovation management that links inputs such as human resources, sector promotion and investment stimulus and outputs such as new products and processes. Such conditions may also help to explain Finnish leadership in R&D intensity, Czech Republic's relatively strong position in this factor, perhaps linked to its emergence as an on-shore IT services hub for European firms, and Poland's relative weakness, perhaps linked to its older industrial base.

In a related analysis, recent research has also spotlighted innovation trends in some of the smaller and more innovatively intensive EU member states that may have uncovered internal and structural issues that expose potentially serious weaknesses in their innovation landscape that may belie their current standing as exhibitors of high R&D intensity.

Two particular examples appear salient in this context:

i) *In Sweden*, the co-called "Swedish Paradox" may be a case in point that exhibits this type of condition (Edquist and Hommen, 2008). In this analysis, whilst Sweden scores highly for R&D investment levels on inputs, this is actually linked to relatively low levels of outcome pay-off, wherein R&D outputs are not sufficiently internationalised for globalised demand, even though the country's production systems are highly internationalised (Bitard et al, 2008).

   Moreover, Sweden is one of the few OECD nations not to stimulate the commercialisation of R&D outputs through tax credits, which stands in contrast to its net investment commitment. This not only creates a competitive domestic disadvantage by making commercial R&D more expensive for local firms, but it also makes the country less attractive as an international destination in the increasingly global search for the ideas, talent and collaborations that can create next generation high tech products (Marklund et al, VINNOVA, 2008). Such a position may have arisen due to the escalating burden on Sweden's public purse of such rebates at a time during the 1980's when other priorities intervened.

ii) *In Denmark*, there appears to be another example of this phenomenon. Whilst the country has undoubted and recognised strengths in both product and process innovation and the national system promotes effective interaction between enterprise

and university collaboration, the onset of the current stage of globalisation may be negatively impacting labour markets through an increased propensity to outsource and offshore both low and high tech jobs (Edquist and Hommen).

4.3 How can EU Firms compete in a Changed World?

Having highlighted some of the risks and weaknesses exhibited across the Union, it behoves a paper of this kind to try and contextualise potential solutions and actions to address these conditions, especially in light of the already discussed policy shifts being exhibited by emerging competitor nations across Asia, and particularly in China.

Recent research has indicated that three broad categories of analysis need to be reviewed in terms of improving the performance of European innovation activities and increasing the quality of its innovation outputs. Most importantly, by understanding the structure and drivers that facilitate innovative activity, the capabilities of less innovatively advanced regions may be shifted upward. Arundel and Hollanders have identified four innovation modes that can determine the extent to which national and firm strategies can intersect usefully to create competitive advantage (2008: 43). These are, in order of sophistication:

i) Strategic Innovators

In this group are economic actors who regularly introduce new product and/or process innovation developed in-house, and with R&D investment linked to the potential to diffuse these innovation outputs across national and international markets.

ii) Intermittent Innovators

This group is also characterised by producing in-house development of new products and processes, but with commensurately more intermittent R&D efforts, linked to intra-firm utilisation rather than pan-economy added value.

iii) Technology Modifiers

No in-house R&D investment and any new product or process based on applying incremental modifications to existing innovation outputs.

iv) Technology Adopters

These organisations are absorbers of diffused innovation from others, whilst also responding to, and benefiting from, these new methods and products as part of their own learning strategy.

They further maintain that, for example, whilst 13% of Finnish firms are strategic innovators, only 3% of Portuguese firms are thus endowed. Indeed, the majority of EU member states have markedly less than 10% of strategic innovators across any of their own industry sectors (see also Reinstallar and Unterlass, 2008: 16). In terms of industrial sector innovation internationally, the ICT and chemicals industries possess amongst the highest proportion of strategic innovator firms, at 26% and 31% respectively, particularly high when compared with traditional industries such as food, textiles and even automotives (at 11%, 12% and 19% respectively). The average percentage of strategic innovators in a sector across all industries is 15% (ibid: 11). Thus, countries with a greater sector-specific skill levels and strategic economic focus in ICT, chemicals, biotechnology and related industries are not only likely to have high R&D intensity requirements, they are also likely to induce greater strategic

innovation amongst firms, increased technology ownership and international diffusion across competitor markets.

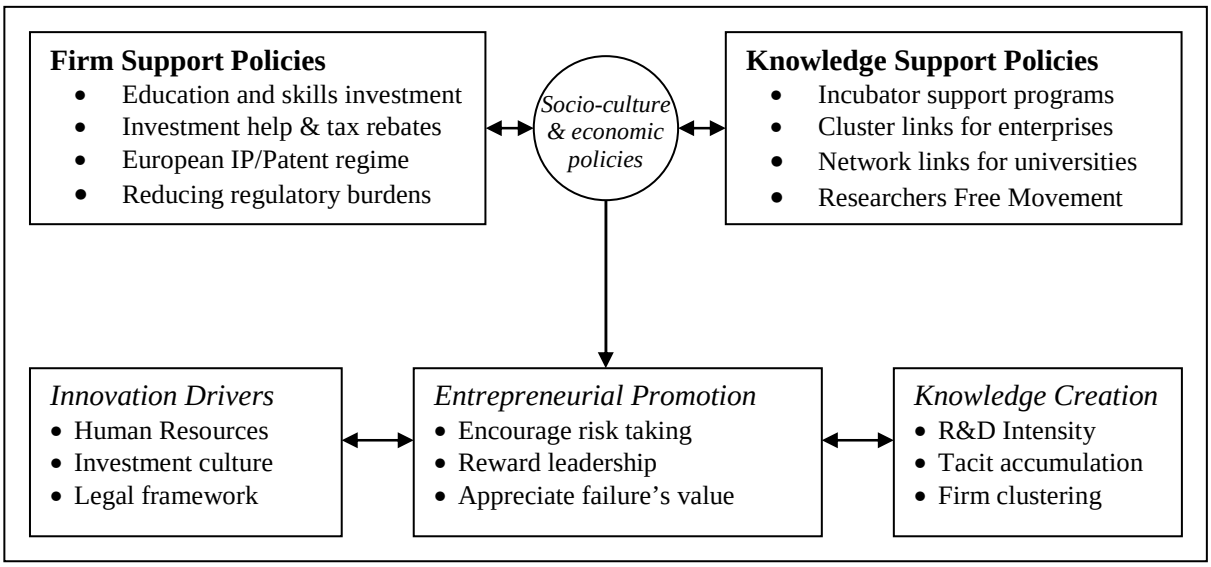
In addition to sector level issues, it is equally essential to try and understand what characteristics in firm behaviour and/or strategy that may exist to reflect these contrasts. One of the key differentiators may be the extent to which firms absorb and exploit *tacit* knowledge, learning through interacting with, and gaining experience from, customers, competitors and partners. This can be contrasted to a less successful focus on only *codified* knowledge accumulation, which is anchored on public information reservoirs and well understood standards definitions. Tacit knowledge absorption is seen as key to actual and potential innovation capability amongst firms and across economic sectors (Nauwelaers and Wintjes, 2008).

The exchange and distribution of tacit knowledge can be effectively promoted within high tech business clusters and knowledge hubs such as university science parks, and may help to explain the success in fostering innovation outputs from those enterprises active within locations of this kind. Interestingly, and of significance in an assessment of emerging Asia's economic challenge to Europe, as has already been shown, is in exactly this area of knowledge acquisition that both India and China have been upgrading their capabilities, seeking to shift from being dependent on codified knowledge to being owners of tacit knowledge and hosts to large science and business development parks, and on to which their own national innovation strategies are premised (D'Costa, 2004).

In terms of policy initiatives to promote more effective innovative outcomes, there would appear to be growing recognition of an intersection between different inputs, such as innovation drivers, knowledge creation and entrepreneurship promotion on the one hand (Arundel and Hollanders, 2008), and enterprise support and infrastructure development on the other (OECD, Regional Innovation Review, 2007).

In this way, a more complex relationship can be uncovered that can result in the emergence of something of a virtuous circle of innovation clusters, knowledge exchange networks, research cooperation and entrepreneurship (Graf and Morgull, 2008).

Diagram 3: Effective Innovation Dynamics



Sources: Derived and adapted from various sources including OECD Regional Innovation Review; Nauwelaers and Wintjes; Arundel and Hollanders; Graf and Morgull; and Author's assessments.

It is now important to put these drivers and conditions into the context of European initiatives and sector specific challenges.

4.4 Responding to the Challenge: The 7th Framework Programme

4.4.1 The Character and Structure of FP7

One of the weaknesses of the Lisbon approach was seen as a lack of horizontal coordination and a weakness in the establishment of a true European infrastructure for innovation support and knowledge sector development. In particular, the challenges facing Europe as a whole from established leaders such as the United States and highly committed and well-funded transitional nations such as China seem to lend increasing support to the need for a more pro-active role at Union level. Increased funding levels and a more definitive commitment to help SMEs in raising innovation activity and improving the quantity and quality of innovative outcomes would now seem to be vital.

The European Union Framework Programmes provide one mechanism to sustain a structure that might be able to deal with these perceived deficiencies and in order to stimulate improvements in coordination and policy responses. Perhaps one of the most important weaknesses that is an ongoing tension of the Union's structure is that there exists no genuine European Science and Technology policy, but instead the Union has to deal with what has been termed "a jigsaw of national public systems" (Muldur et al, 2006: 52)

In particular, action needs to be focused on promoting an outward facing innovation strategy at firm level, recognising the importance of collaboration, both intra-EU member state and between European firms and overseas partners, where synergies, mutual learning and tacit knowledge acquisition can be achieved. Transnational R&D initiatives are never likely to be at the top of national government agendas, and EU level encouragement, support and even facilitation could add an extra dimension to the competitiveness of the SME sector.

In this context, a brief review of the 7th Framework Programme for Research and Development 2007 (FP7) reveals both encouraging signs, but uncovers ongoing weaknesses. The new programme received an increase in budgetary funding to EUR 50 billion, and around EUR 70 billion including additional funding for education and training across the seven years, representing just over EUR 6 billion of the total EU budget for 2008, with the lion share being allocated to research (European Commission, General Budget, 2008: 11), and this also represents an increase of over 40% from FP6 funding levels (Muldur et al, 2008: 230 – 5). This is encouraging.

Nevertheless, this still represents just a mere fraction of the more than EUR 40 billion of the budget allocated to support agricultural markets (European Commission, General Budget, 2008: 12), which, according to research by Muldur et al, generates at best 5% of jobs, whilst SMEs are a key component of the region's innovation system, and should be seen as "the core of European industry" (2008: 219 – 21). However, this particular ongoing tension across the Union is unlikely to be resolved in the near-term, and concentration should be focused on practical and achievable outcomes to further boost innovation activity across the Union.

The broad structure within FP7 can be seen as follows:

- Cooperation and transnational project collaboration
- Joint technology initiatives
- Promoting of EU technology platforms
- Project coordination under the European Research Area.
- Enhancing dynamic frontier research
- Enhancing EU human resource capacities
- Infrastructure and support policies for SMEs

These elements illustrate that there are some useful overlaps with the demand needs highlighted in the Diagram 3 outlining innovation dynamics, but there are still sector-specific problems and issues to address.

In the ICT sector, for example, there is a recognition that in this singularly high risk industry, particularly in some of the more disruptive sub-sectors, and especially in software related ventures, firms exhibit a need for high investment in people costs, driven by technical skill requirements and business marketing competences once products are created, together with upfront investment in terms of funding both at seed (early stage) and at later points to refine products in the light of market reaction and feedback. These conditions are often linked to periods of high cost and limited return as businesses get their strategies under way.

4.4.2 Problems with Europe's Innovation Responses

Weaknesses persist across the EU in the way that high-technology innovation outcomes can be effectively achieved, especially in the following areas[31]:

i) EU market fragmentation:

Legal and organisational interoperability, even amongst high tech firms, can still be constrained by the national policy nature of Europe's unique mix of state subsidiarity together with the connected concepts of shared and community policy competences. Whilst the recent adoption of the Services Directive has assisted in smoothing some of the lines of divergence across the Union, technology-driven service ideas that can be brought to market very quickly in the homogeneity of the US, do not enjoy the same level playing field when applied across Europe. In areas that pertain especially to communications technology and supporting software, issues of patenting costs, legal IP assertion complexities, together with national standards and technical regulations, can become a major obstacle to sustained expansion.

ii) Human resource supply across the Union:

In this context, problems are especially resonant in both the absolute numbers enrolled in IT training courses and in the skills blend which can facilitate a mix of business and technology outlooks – critical for project success, especially in SMEs.

iii) Human resource mobility:

Whilst member state citizens enjoy freedom of movement, third country nationals (who are not EU citizen family members) seeking to fill working opportunities rather than tourist visits,

[31] These points are gained from multiple sources, including interviews with IT practitioners, existing EU institutional research together with reports from groups such as INNOVA, and the personal experience of the author as an IT entrepreneur and business builder in Europe over the last 20 years.

face a plethora of member specific regulations, permit applications and mobility inhibitors. Sponsorship complexities can be especially onerous for SMEs in one member state seeking to expand into others using non-EU skilled personnel, and are also recognised as an inhibitor to applications from overseas skilled parties. Whilst the US system is seen as generally more onerous initially than many EU member state regimes, at least it only needs to be tackled once.

iv) Venture investment climate:

The character of national venture capital regimes is not simply a matter of funding, but of mixing the right amount of early seed and mid-development second level investment in company lifecycles. Whilst research from the European Commission has shown that a significant number of EU firms do benefit from early stage funding across the Union (European Commission, Key Figures, 2005), the actual *amounts* of investment and the value of outcomes from that investment are substantially higher in the United States. This perhaps indicates a more proactive, hands-on role through incubators and personal networks that reflect advanced funding dynamics in many of America's high tech clusters.

v) Socio-culture and entrepreneurialism:

The entrepreneur is pivotal in the creative processes of innovative firms. However, whereas in the US, venture failure is seen as an acceptable and well-understood part of the entrepreneurial learning curve, such attitudes are harder to find across Europe, whether in the attitudes of commercial bankers, personal colleagues or even venture capital panel reviewers. Outside America, business failure is often associated with personal blame and competency uncertainties that can frequently be unjustified, in that subsequent success can often be built on previous learning experiences. This is an area where China is also experiencing challenges, as it attempts to move away from rote learning and a risk-averse approach to enterprise building, and it is vital that Europe's pace of change accelerates to match that of China.

vi) Inconsistent Fiscal Stimulus

Across the Union, there is much competition by member states to offer a range of national level tax incentive and investment support policies to attract and retain innovation oriented enterprises, but differences persist in implementation and character of each. In fact, what is perhaps most required by the firms themselves is a support framework that encourages collaboration, promotes shared projects to make the best use of scarce team resources and to be combined research and development incentives across borders in a coherent and structured way. Navigating the maze is especially challenging for SMEs, who are often those most associated with ground breaking ideas and who could most benefit from Union level R&D alliances, whilst absence of consistency could also undermine intra-EU expansion for innovating R&D intensive firms from one member state to another. Recent research has shown that the availability of tax credits can have an influence on R&D location decision making, and that R&D spending is subject to an element of "tax competition" (European Commission, DG Research, 2008: 112).

In particular, tax incentives for R&D expenditure should be better co-ordinated to ensure pan-Union application, and as much as possible should be shaped to sustain and extend the single market for innovative product development. Interestingly, China has recently introduced just such a streamlined *national* level of tax rebates for R&D investment to replace a mosaic of provincial and location-oriented set of policies, as part of major tax reforms introduced in 2008, and as part of a wider framework of policy upgrading (Xuedong and Li, 2008).

A *European* approach to creating special tax status for innovating companies along the lines of the "Young Innovation Company" approach put forward by Sweden's Institute for Food and Biotechnology could resonate with many smaller firms across the Union (SIK, 2006).

4.5 Implementing Political Support: The Ljubljana Process

A new accord was signed by member state ministers in April 2008 that seeks to reform the labyrinth of research and innovation channels that still persists in Europe. Named after the capital city of Slovenia, under whose presidency the Process was born, it is, more than anything, a recognition of the failure of both the Lisbon strategy and the 10 year old initial framework for the European Research Area (ERA), both of which were themselves meant to address deficiencies in terms of investment, funding, structure, mobility and coordination of innovation and knowledge sector policies. The constraints on policy action imposed by the economic slowdown and by a move away from credit finance may yet diminish further both the scope and commitment for action in this area.

The objectives are laudable, and include aims to specifically address a number of problems outlined in this paper (Slovenian Presidency, Draft Summary on Competitiveness, 2008):

- Enhance knowledge flows and research coordination across the EU
- Upgrade university and related institutional research capabilities
- Increase incentives for business investment in R&D
- Improve utilisation of R&D outputs from all institutions in the Union
- Facilitate a more accessible European research infrastructure

However, one of the ongoing problems is the "soft" nature of the Open Method for Coordination, making it hard to bring member state administrations along at the same pace as perhaps the Commission would prefer. This is also linked to the practical political need for consensus in European policymaking in issue sensitive areas – such as business incubation, innovation funding and education reforms. Whilst agreeing a vision is important as part of an emotional commitment across member states to engage positively with this process (European Council Conclusions – Ljubljana Process, 2008), European businesses face competitive challenges now from newly emerging innovative centres such as China, and continue to face ongoing constraints as outlined in this section. Pursuit of successful outcomes should be a priority, both for the short-term and the longer-term.

In fact, the advent of co-decision in Competitiveness and Innovation policy areas between Council and Parliament gives an important impetus to the debates at European level, and leverages the opportunity for businesses and individuals to inject perspectives and priorities through their democratic Parliamentary representatives. A supportive approach to engaging with these objectives and to securing positive outcomes should be at the forefront of enterprise-friendly principles of the European Parliament's political parties.

4.6 Conclusion

This section has sought to coalesce the issues that still face Europe's innovation industries, even despite the high level recognition of the importance of innovation funding and policy coordination. The current character, future trajectory and perceived deficiencies of Europe's innovation initiatives have been reviewed in a policy context. It is now important to analyse how state and non-state actors in Europe's knowledge sector landscape interact, in order to influence the innovative performance of firms, focusing especially on the success of functional aspects of relations between universities, enterprises, investors, and government and regional agencies.

5 Sustaining Europe's Position in a Globalised World

5.1 The Competitiveness of EU Member States

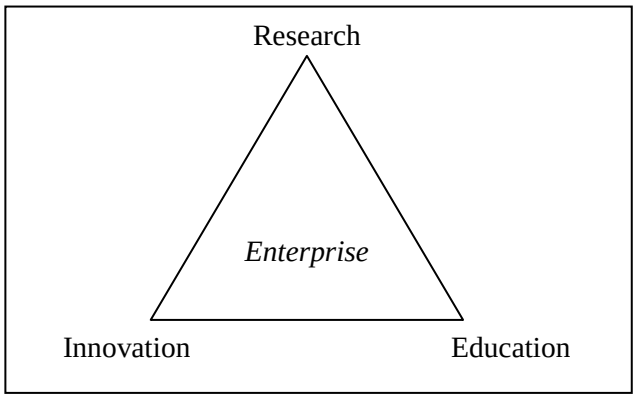
The European Union is still a highly competitive region of the world and is home to world class knowledge sector firms, such as Germany's SAP in the ICT and advanced business software sectors, and Britain's AstraZeneca in pharmaceuticals and drug discovery research. Of the top 10 countries in the World Economic Forum's Global Competitiveness Report, 12 are European countries and nine are member states of the EU, with many scoring highly for technology readiness and business sophistication pillars of competitive profiling. Thus, the groundwork exists for leveraging success into the future, but in fact, that success is by no means assured.

The problems facing the European Union in respect to sustaining its future potential stem from two interconnected reasons. First, there has been a failure to sustain levels of innovation investment as a priority in both public and private sector strategies at a time when emerging economies such as China are prioritising just such investment, and second, there has been a tendency to remain generally blinkered to events taking place outside community borders to properly understand, and thus respond to, the changing pace of globalised knowledge sector expansion, and the commensurate rise of genuine competitive threats to specific sectors in member states from the likes of China and India, not forgetting the current innovative capabilities already exhibited by East Asian tiger economies of Korea and Taiwan.

5.2 Policy Initiatives and the Knowledge Triangle

There needs to be a recognition at all levels of policymaking that creating an effective knowledge centred innovation system requires effort from both government and enterprises, but that public bodies in particular have key contributions to make in facilitating what the Commission has described as the so-called "knowledge triangle" (Riela, 2008: 16).

Diagram 4: The Knowledge Triangle: Simple and Compelling



European policymakers at different levels need to prioritise innovation *outcomes* in their thinking to better respond to this changing world. In particular, a conceptual framework should be created that is anchored on recognising and nurturing the importance of the role of firms in innovation networks, knowledge clusters and national competitiveness (Carayannis and Wang, 2008). In support of these concepts, the creation of the European Institute of Innovation and Technology (EIT), based in Budapest, is a welcome development to spur

further expansion public / private networks of universities and businesses that can help to create genuine "knowledge and innovation communities" (Economist Intelligence Unit, European Policy Analyst, 2008: 44).

Such a framework should include at least the following ideas:

- Putting enterprises, and especially SMEs, at the centre of integrated national and regional innovation support systems.
- Promoting brain circulation from research institutions and universities to innovative firms, helping to bring pure science and product development close together without blurring the distinctive contributions of each.
- Recognising the importance of clustering and innovation networks as the foundation of sustaining disruptive but commercially adaptable innovative outputs.
- Creating an integrated and cost-effective pan-European intellectual property system that can link application streamlining with legal clarity and enforcement efficiency.

It is clear that in seeking to achieve these objectives, the diversity and talent of European nations is, at the same time, a huge asset and a coordination challenge. It may be useful to spotlight some of the characteristics of regional innovation systems, mapping these to the needs of Europe as a whole but also recognising that different approaches and implementations may be suitable for different parts of the Union, and that no one template either exists, or even would be necessarily appropriate.

5.3 The Importance of Regional Systems of Innovation

Across Europe, the internet era has undoubtedly changed the way that individuals and organisations communicate with each other, and has opened the possibility for international collaborations and joint transnational project development in ways that were simply not viable before the widespread adoption of high speed network links. Nevertheless, important current thinking on innovation posits the view that even despite such internet-driven business models, *proximity* continues to be an important value contributor to sustaining innovative outputs (Cooke, 2008). This is the idea behind "open innovation" (OECD, 2008c), encouraging explicit knowledge transfer of ideas amongst firm networks linked to knowledge capability at a regional and/or local level, but connected to global markets and international customers using the integration of local and global networks. In this way, innovation clusters of closely proximate organisations connect with innovation networks of complementary service and product providers to create value and reach on an international scale.

Indeed, linked to previous discussion, it may be the very nature of the fragmentation of industries such as biotechnology and pharmaceuticals into distinctive specialisations that has been shaped by new types of innovation activity. This allows process separation of exploration, examination and exploitation in drug development businesses, and have been at the heart of how new competitor firms in India have sought to enter the market and challenge pharmaceutical leadership of European and American firms. This should not be seen as parochial in any way, as its objectives are to derive global advantage from local ideas, wherein success depends on exploiting regional competences and locally acquired tacit knowledge and applying it at an international scale, linked to multiple levels of governance for science, technology and innovation policy (Charles, 2008).

Longstanding complementarities to the European Research Area were anchored on support for regional innovation strategies and the promotion of regional research ideas under the EU's Framework Programme. This is not to say that the role of government is diminished just because the primary focus is on the enterprise: quite the reverse would seem to be apparent

from regional evidence – it is actually the *combination* of multi-level government support, effective and targeted funding structures, along with a visible level of institutional capacity that can facilitate the clustering proximity and knowledge spillover that innovative enterprises and creative individuals need to prosper. It can thus be surmised that it is this combination of institutional support, commercial enterprise and individual agency is exactly the starting point from which successful innovation centres such as Cambridge, Silicon Valley, Zhongguancun and Bangalore have emerged.

Drawing on work by both Cooke (2008) and Charles (2008), it can be further argued that what European firms may actually need to raise their own R&D intensity and to improve the quality and quantity of their innovative outputs, are not highly complex micro-managed sector-specific national innovation policies but instead, a high level strategic focus on the following value-based inputs:

- Regional cluster development initiatives to link universities, businesses and institutes.
- Broadband communications infrastructure building on the EU's i2010[32] plans.
- Streamlined public funding access with particular targeting to SMEs.
- Institutional support for technology education and knowledge circulation.
- Coordinated legal infrastructures for effecting knowledge protection and sharing.

5.4 Clusters as Innovation Facilitators

In its recent review of regional innovation policy, the OECD also highlighted the importance of clusters and knowledge networks as a *facilitator* for promoting innovation outputs, and pointed to India's clusters not just of ICT in Bangalore and Mumbai, but also of biotechnology, pharmaceuticals and bioinformatics, which all exhibit similar clustering characteristics in different states across the country. Additionally, the OECD highlighted the importance of *specialisation* at cluster level as an important potential positive, and indicated that regions in the United States tended to be more specialised in terms of their firm structure within clusters than those of the EU, and that this may in part explain some of the poorer outcomes from European R&D endeavours (OECD, Review of Regional Innovation, 2007: 54 – 55).

The Regional Innovation Strategies (RIS) that have focused on upgrading the innovative capacity of new member states and less developed areas of the union complement projects already underway to increase the number of world class clusters across the EU and to compensate for some of the national differences and specialisation difficulties that the EU possesses in its attempts to emulate the success of the United States in specialised cluster development (European Commission, Towards World Class Clusters, 2008). This concern would appear to be directly connected to research from the OECD, highlighted above, outlining issues of comparatively higher levels of sector specialisation enjoyed by clusters in the US, recognising that America is one country and Europe is, instead, a collection of countries, pooling some aspects of sovereignty and sharing some elements of national human resources and knowledge, through free movement facilitation, but with each remaining distinctive in its internal policies and industrial priorities.

EU level commentaries on regional innovation strategy have therefore had to reflect an ongoing tension between political realities, wherein each member state may actually be

[32] A set of coordinated initiatives that aims to build on revamped Lisbon objectives to foster technological upgrading across the Union and thus promote innovation from within societies of different member states. Laudable in its intent, it still needs concrete deliverables at firm, individual and household levels.

determined to grow domestic competences across sectors by being host to multiple clusters across multiple knowledge industries, and economic efficiency, where resulting duplication of cluster focus across the EU and dilution of human resource efforts may in fact become counter productive to business specialisation at a European level, as distinct from a member state level. Nevertheless, these Commission led initiatives are highly encouraging, as they offer both a good starting point and appear to illustrate increased recognition by the community leadership of the importance of an EU-wide "innovation systems" response to external challenges from US and Asia in respect to the Union's future innovative capabilities.

These include:

i) Supporting both member states and regions to improve their cluster policies through pan-EU mutual learning and knowledge exchange.
ii) Trying to ensure better consistency and complementarities between different Community instruments in support of clusters, whilst also recognising issues of cultural diversity and subsidiarity principles.
iii) Establishing a European Cluster Policy Group to advise the Commission and Member States on possible strategic orientations for the emergence and growth of world-class clusters in Europe.
iv) Encouraging the development of a common European research and innovation space through facilitating practical trans-national cooperation between clusters
v) Launching a European Pilot Initiative for Excellence of Cluster Organisations
vi) Improving the information on innovation support services available for European SMEs, in particular through the European Cluster Observatory and the Enterprise Europe Network.
vii) Harnessing the Competitiveness and Innovation Programme to better support the development of tools to facilitate SME participation in innovative clusters.

Source: European Commission "Towards world-class clusters in the European Union" COM(2008) 652, page 10.

5.5 Conclusion

This section has introduced some of the problems facing Europe as it seeks to come to terms with the nature of the challenge to emerging Asia's strength and capabilities. It has highlighted that Europe is well equipped with a bedrock of competitive characteristics and class-leading enterprises in different sectors, but that it needs to look outward and fully appreciate the nature and extent of the innovative threat to its knowledge economies from countries such as China. Some ideas have been introduced that conceptualise options facing European decision makers, but what is now required as a complement to these, however, are some practical steps to render into reality some of the themes outlined in these policies and in the current research literature.

Prior to exploring how Europe could address some of these areas, in both a national and supranational framework, it may be useful to briefly review the comparative context of policy initiatives and attitude responses that have helped to shape the knowledge economy of the United States.

6 A Comparative Policy Response: The United States

6.1 The US approach to innovation: their NIS.

The United States has an enviable position as longstanding first placeholder in the World Competitiveness Index and the country continues to enjoy a world-leading role in bringing to market disruptive technologies, pioneering inventions and individual vision from personalities whose contributions have had radical impact on the way the world works. Given Europe's ambitions to reach the Lisbon goals in terms of R&D and the continent's determination to meet the challenges facing European businesses from emerging Asian nations, it may be useful to briefly compare and contrast some key aspects of America's innovation support landscape and its approach to sustaining future business development.

However, perhaps the most striking aspect of the US innovation and knowledge sector support structure is just how important a role continues to be taken by the United States government. The United States is often seen as the nation that most epitomises the private sector, and which puts small government and the promotion of market forces primary policy objectives, but in fact, the US government system nevertheless has taken, and arguably continues to take, an important policy role in the evolution of the country's innovation support structure and knowledge sector development landscape.

The United States government takes what has been described as an important partnership role in fostering innovation activity and encouraging the commercialisation of innovative outputs (Gallaher et al, 2006). The rationale appears to be anchored on the premise that government response is most appropriate when addressing market failure conditions on the one hand and creating supportive legal and investment infrastructure conducive to promoting innovation on the other (ibid). In a similar vein to Europe and Asia, there is a mix of push and pull factors, with the "push" of policy stimuli being able to link remarkably effectively with the "pull" of market demand (Ibata-Arens, 2008).

In respect of market failure support, drivers for intervention can be argued as:

i) Innovation leads to technology
ii) Technology is the principal driver for economic growth
iii) Absent government intervention at particular points in the innovation lifecycle of knowledge creation and commercial exploitation, firms would under-invest in innovation processes which could otherwise result in useful knowledge spillovers and market seeking outcomes.
iv) Government must redress this potential imbalance through incentives to promote research and development activities and nurture enterprise formation and growth.

In respect of a policy framework design, emphasis is put on three interlocking areas:

i) Support the innovation *structure* at systemic level for America's NIS.
ii) Signals and support for basic R&D in frontier sectors.
iii) Direct funding to firms to lower private R&D costs and to stimulate new business formation and facilitate growth in new industries.

Moreover, multiple levels of the American government structure can facilitate stimulus of R&D through their own funding arrangements, helping to ensure that no single blueprint, or centralised approach, is mandated by federal authorities (ProTon Europe, 2007).

In terms of innovation infrastructure, the US has always maintained the importance of an effective, flexible and rigorously enforced intellectual property system. Indeed, the US Constitution itself promotes the value and importance of protection for a citizen's "exclusive right to their respective writings and discoveries"[33]. One outcome from this philosophy has been the evolution of the national IP system to respond to changes in technology outputs, driven by both political and legal actors responding to changing needs of American businesses and individuals.

Such changes have taken place in both legislative venues, such as the US Congress initiating the controversial Copyright Term Extension Act of 1998, and in judicial interpretations, such as the US Supreme Court's ruling in Diamond v Diehr in 1981[34] on software patenting. This landmark case is widely seen as having introduced the concept of a software patent, the growth of which has allowed the harvesting for business advantage of patents directly from problem-solving software design algorithms by American enterprises, providing an important asset in company valuation and venture investment processes, capturing the potential for future license revenues, and offering the enterprise future participation in patent pooling and patent exchange partnerships. Whilst the extent of software patenting in the US, and the qualitative aspect of some software patents themselves, has certainly generated considerable controversy over recent years, similar opportunities are not available at European levels to capture value from software designs with the same extent of clarity, as judicial interpretations, the character of legal systems and attitudes to software patenting *per se*, appear to markedly differ across EU member states' regimes. It can be argued that this is an unfulfilled element of Europe's single market, a debate that will be explored further in the context of evaluating the character, strength and weakness of European innovation systems.

6.2 Government Support for Basic R&D in Frontier Sectors

US Government support policies for research and development has over the years undergone something of a transformation, with early post-war decades dominated by defence and space sector investment, with much focus on government-sponsored research heavily biased to these industries (Block and Keller, 2008). However, something of a sea change took place during the 1980's as response to international competitive threats and as a stimulus to promote economic growth after the difficult years of the previous decade. Whilst it is still true that defence related R&D continues to be a strategic part of government's annual overall R&D expenditure totals, federal legislative and executive decision-makers have been active in promoting other areas as well (OECD, 2008b: 26).

Moreover, a substantial part of American government activity is connected to levels of *direct* funding for business expenditure on R&D, as opposed to Treasury costs born of fiscal incentives. Indeed, a recent NESTI-OECD assessment of the proportions between direct funding and fiscal stimulus in terms of overall government support for business R&D showed that in 2005, the US spent significantly more on direct funding methods than in fiscal policies, and proportionately more of its total than Belgium, Portugal, Ireland and the Netherlands whose policy mix favours the fiscal approach over direct funding (ibid: 27).

[33] See Article 1, Section 8, Clause 8 of the United States Constitution (sometimes referred to as the "intellectual property clause"), at the United States Archives, accessed 8th December at http://www.archives.gov/exhibits/charters/charters.html.
[34] United States Supreme Court, *Diamond v. Diehr*, 450 U.S. 175 (1981).

Table 11: Direct & indirect government funding of Business R&D & tax incentives for R&D*

Country	Costs of fiscal incentives (% GDP)	Direct government funding of BERD (% GDP)
United States	0.04	0.18
France	0.05	0.12
United Kingdom	0.05	0.09
Spain	0.03	0.08
Norway	0.06	0.07
Belgium	0.10	0.07
Ireland	0.04	0.03
Netherlands	0.07	0.03
Portugal	0.03	0.02

*2005 or last year available

Source: OECD, based on national estimates, (NESTI R&D tax incentives questionnaire), some of which may be preliminary. See "OECD Science, Technology and Industry: Outlook 2008", page 28 and also OECD Statistics database at http://dx.doi.org/10.1787/450611456265.

A particularly important starting point in this policy effort was the Bayh-Dole Act of 1980, which radically altered the way that intellectual property spawned from federally funded research activities could be exploited and appropriated by individuals, institutions and companies. By loosening many government controls on research spin-outs and by encouraging scientists to push their discoveries into commercial ventures, the Act was a particular stimulus to university research departments and the bedrock of human talent encapsulated within them (ibid).

Some initiatives were less successful at developing desired innovation outcomes. The Orphan Drug Act of 1983 was originally designed to stimulate research and development into drug formulations to target rare medical conditions suffered by only a small number of Americans, whose narrow focus and potential returns made for unpalatable and unprofitable work for the major US pharmaceutical multinationals (Ibata-Arens). But the application complexities, paper trail requirements during funded research activities also made for an unattractive prospect to smaller and medium sized enterprises as well, and for most of the last two decades, limited innovation outcomes have resulted, although a recent re-launch of the policy, with altered regulatory constraints, might change this picture into the future.

The government also introduced a number of important policies that directly supported and funded innovative small enterprises.

6.3 Government Stimulus for New Business Formation

In order to complement private sector venture capital activities, during the 1980's and 1990's, the American administration has introduced two highly pertinent policy frameworks that encourage small firms to take research and development steps that they may not otherwise do.

The Small Business Innovation Development Act of 1982 and the Small Business Tech Transfer Act of 1992 were both designed to foster funding support to the SME sector. A particularly important character of these initiatives was to provide pre-seed funding to university spin-outs and innovative micro-firms (typically employing less than 10 people) that would otherwise not have gained visibility on the radar of commercial venture capital organisations. Such funding allows proof-of-concept type activities to take place that can

push the boundaries for what may then become a breakthrough commercialisation. Both the National Science Foundation and the US Department of Defense continue to be active at different stages of the investment lifecycle, and the importance of acquiring support from these sources accrues more than just money to the enterprises concerned, as endorsement can act as a powerful certification effect and a catalyst for next stage private sector investment (Ibata-Arens).

Moreover, government support for the role of business incubators, in partnership with private sector sources, university spin-off centres and the Small Business Association, has resulted in a majority of American incubators being launched on a non-profit basis, with many even having full-time managers, and exhibiting important contributions to national growth, with what some assessments have described as "an economic development focus" to their activities (ibid: 323). Some of the important activities that US incubators provide to resident SMEs can include vital added value functions, all of which complement national funding policies, including:

- Introduction to local venture capital community
- Access to patent attorneys and accountancy services
- Integrating SMEs into the social fabric of the community
- Enabling cost-effective recruitment networking

Nevertheless, all of this federally funded activity should not mask the impact that the private sector has on innovation and firm growth, as the US also continues to be one of the leading actors in international assessments for private sector R&D intensity (OECD, 2008b).

6.4 Private Sector Support for US Innovation

Despite the important role played by government, it is the commercial sector that is still the main source of funding for research and development investment: "cumulative VC [sic] in the United States (that is, venture capital investment that has yet to exit) is the largest in the world" (Ibata-Arens: 326). Moreover, the role of business angels in catalysing early stage business development should not be underestimated, and, although typical investment amounts are smaller than comparative VC inputs, average US capital investment from angel sources is around US$450,000 which is not an insubstantial figure, and is actually about the same amount as the average for a *venture capital* investment in the European Union (ProTon Europe).

America is regarded as having a much more developed venture capital market, with a culture that nurtures disruptive thinking and a funding environment that is risk aware, rather than being necessarily risk averse, with investment firms and angel consortia more likely to look favourably on past entrepreneurial failure as useful and necessary learning experiences than their European counterparts. Furthermore, its incubators and science parks have generally led to highly effective business-university links, with the knowledge spillovers, the business synergies and the sheer innovative energy that encapsulate clusters such as Silicon Valley in California needing to be directly experienced to be truly appreciated, and, whilst Europe "has made some small steps in closing these gaps", many consider these "too little to fulfil the ambitious goals of the Lisbon Agenda" (Aiginger and Landesmann, 2008: 65).

6.5 US responses to Asia challenge

Given this leadership in innovative activity and innovation outputs from across the US economy, it may be surprising to detect clarion cries of concern across America about the

relative decline of its competitive edge and the potential challenge from Asia's technological rise (Innovation Task Force, 2005). However, this may be a prematurely pessimistic stance (Economist, 2008: 81), as American business and technology leaders continue to dominate many of the world's innovation intensive sectors.

In IT alone, Americans have made significant contributions to technological development. For example, Vinton Cerf who created the communications protocol that underlies the internet[35], Bill Gates at Microsoft who pioneered software for personal computing, Steve Jobs at Apple who pioneered radical design ideas and ease-of-use concepts to make complex software more accessible to consumers, and Sergey Brin at Google who revolutionised large-scale data searching and information mining technologies, are but a small handful of path-breaking industry leaders.

It is particularly this disruptive ability and risk-taking confidence that can empower the country into the future, although it is clear that even in the US, a global outlook to the future of innovation collaboration and the opportunities presented to specific enterprises by rising competences and growing demand from Asian economies will impact corporate decision making in the years ahead. The creation of offshore research and development labs by US multinationals, whether in India for pharmaceuticals, or China for software product and communications development, all form the framework for a more complex innovation policy space that will need to be faced by its own politicians. It remains to be seen how the Obama Administration will react to these global shifts to help maintain American leadership in this arena.

6.6 Conclusion

The United States presents an interesting and useful comparison for European policy makers. Whilst clearly driven by the principles of liberal market economics, the America's national innovation system reserves an important place for state actors, at different levels and to different extents, to contribute important and specific policy inputs. For example, the state has an especially significant contribution to make in the support of areas of potential market failure, such as pre-seed funding for micro-companies, and in shaping appropriate levels of stimulus for science-based university spin-outs.

Whilst sharing some of the concerns of Europe in respect to the rise and competitive challenge now emanating from Asia, it can be argued that many of its pioneering business leaders have already embraced the ideas of open innovation and transnational collaboration in their research and development strategies. Moreover, the country's next generation of disruptive thinkers and industry pioneers are able to benefit from a proven platform of advanced cluster networks, effective VC and angel capital investment, and incubator nurtured high technology support systems from which to build new enterprises.

It is now important to critically evaluate European policy responses to the same challenges and concerns, in terms of its systemic character and its effectiveness at promoting enterprise led innovation.

[35] Britain's Sir Tim Berners-Lee pioneered the software technology that facilitated the data level connectivity that became the "world wide web". These two interconnected concepts (the internet and the web) are sometimes confused, but in fact they are symbiotic in having created the platform for the development of commercial, mainstream internet-based business models.

7 Evaluating Policy Responses at EU and Member State Level

7.1 Overview of Innovation System Characteristics

The characteristics of appropriate policy responses should be premised on coordinating the following features into a coherent framework, with key components maintaining consistency across member states even if local variations need to be responsive to different cultures and social structures. In overall terms, there needs to be a focus on the following areas and responses:

Policy Area	Response Character
Overall NIS Framework	There should be a mix of state-led and market-led initiatives that recognise the importance of coordinating a state-sponsored infrastructure for innovation to take place but enabling enterprise-led market flexible sector-specific outcomes to evolve dynamically. Other infrastructure initiatives include concluding the ongoing debates on a community patent and software patenting to provide clarity and efficiency for innovating firms.
R&D Programmes	These should be integrated into firm strategies to respond effectively and efficiently to market induced needs, rather than through centralised "five year plan", which contrasts with the style evident in parts of Asia. It is Europe's dynamic enterprise culture that should be at the core of its innovative response.
Research Institutions	These should be fully integrated into local and regional clusters that can combine innovative enterprises, universities and public institutions. Recognition of the different emphasis between academic and applied research implies that each actor in the innovation system brings a unique contribution to the overall process, but that spillovers between them adds additional value. Human capital mobility needs to be promoted beyond member state nationals, and coordination should take place in respect to cross-border movement of research-skilled 3rd country citizens.
Education System	Support should be given to consolidating the development of human capital across the Union. In particular, there needs to be a collective response to the deep resource pools of skilled graduates from China and India, there should be renewed efforts at ensuring the baseline of skills in numeracy, problem-solving, verbal reasoning and written communication in secondary school leavers beyond the targets set by Lisbon, which did not and could not reflect the current challenge from emerging Asia. This platform should then be consolidated with support for courses aimed at up-skilling capabilities in both natural and computer sciences. Additionally, schemes should be included that can nurture continuing career education (lifelong learning) and that encourage intersections between business and marketing skills with academe and science.
Financial System	A mix needs to exist that reflects the critical role that state funds have in supporting pure science as one input into the innovation system, whilst encouraging the provision of more business centric financial resources for innovative start-ups and later stage company growth, facilitated by angel networks, VC communities and through fiscally imaginative R&D tax rebates applied across the Union.

7.2 Linking Innovation Dynamics to Policy Proposals

It may be useful to recall Diagram 3, *Effective Innovation Dynamics*, as an anchor for creating practical and achievable policy outcomes at both national and supranational levels to try and address shortcomings and to target knowledge creating opportunities by better exploit the skilled human capital, significant financial resources and strong political commitment that characterises Europe's strategy for success in the 21st Century.

Through a combination of firm and knowledge support policies, the EU should harness the social, political and economic diversities present across the member states into a coherent and coordinated collection of initiatives. Responsibilities will inevitably be shared across national and EU competences, but outcomes should be anchored on:

- Stimulating innovation drivers
- Promoting entrepreneurialism
- Nurturing knowledge creation

7.2.1 Firm Support Policies

There are many important elements to coherent enterprise support infrastructure, but two particularly important factors stand out, which offer immediate policy opportunities at both EU and member state levels. These are: first, investment in business education; and second, the creation of an effective European patenting intellectual property regime.

7.2.2 Education & Skills

Member states have already achieved some progress in absolute targets for science and technology graduates, but in terms of expenditure per head, the United States still outpaces European efforts on higher education in terms of spending per student by as much as 3:1 according to some recent estimates (European Ideas Network, Summer University Final Report, 2008: 23). Further effort is also now needed to link accumulated tacit knowledge between the scientific and business communities, and to better equip those already in business with entrepreneurial capabilities and risk assessment disciplines, so as to encourage and empower business building and enterprise growth.

In particular, member state policy initiatives and EU-wide coordination is needed to achieve the following:

i) Link science and technology skills with business opportunities

Further encourage science graduates to understand potential interconnection between their own research, business spin-offs and enterprise culture. These initiatives could be driven by universities, science parks, national and/or regional development agencies or a mix of all. Initiative details could encompass and range of funded processes:

- Themed conferences/seminars between science and non-science participants
- Training programmes utilising university and business mentors
- Entrepreneur presentations explaining path dependencies and pitfalls
- Spin-out support systems covering IP protection guidance and business partnerships
- Funding programmes for sponsored start-ups and graduate seed capital ventures

Examples of such initiatives already exist, such as those stimulated by the Cambridge science, engineering and entrepreneurial business hubs: for example, see Cambridge University Technology and Enterprise Club[36] and Cambridge University Entrepreneurs Society[37], both of which are particularly strong in engineering and technology areas.

However, many of these kinds of initiative are currently linked to the imagination and successful track records of current hubs and clusters, and remain active due to the energies of individual business, faculty and student resources. A coordinated approach to expand such templates across member states could add value to processes across the regions, and could reduce duplication of effort and add to the potential to share cross-sector expertise.

ii) Promote continuing business education for entrepreneurial skills

Business education should be linked to activities and training outcomes that go beyond both the MBA and the boardroom. Entrepreneurial thinking and the processes of risk evaluation, team building and product marketing that are critical to success in fast-paced innovative environments are not necessarily absorbed by all at the same time, or in the same formality of university teaching programmes. The internet provides a new and ideal medium for reaching out to a wider audience for education products through e-learning support mechanisms, whilst specialists within business schools that focus on entrepreneurial skills acquisition can add value to continuing education programmes aimed at mature age part-time students and practising professionals alike. But such concepts need proper resourcing, both to enable coherent curriculum development and to ensure that valuable from practitioners are not excluded from programmes simply because of an inability to adequately compensate busy executives for their time.

Funding options need to be more carefully crafted to support both institutions offering such courses and individuals seeking to take advantage of them. In particular, governments should take care not to impose unnecessary funding constraints on institutions which offer certificates or diplomas to students who may already have a higher education qualification at the same or higher level, reducing funding availability on studying, for example, a diploma (in any subject), if someone already has possession of a degree (in any subject). In this context, the UK government's recent decision to instruct England's Higher Education Funding Council (HEFC) to implement just such a policy from 2008 / 09 academic year seems perplexing[38]. Not only does this approach completely undermine the concept of lifelong learning, it militates against many forms of imaginative career development and / or career change. Such short-sightedness should be robustly countered with more imaginative policy proposals.

To an extent, there also needs to be a maturing of European attitudes to entrepreneurialism, such that even business failure should not be seen in such a wholly negative light. Much learning and improvement can be gained from business failure – indeed, in United States venture capital circles, such a cathartic experience is often seen as an essential learning-curve event on the road to producing successful entrepreneurial outcomes in the longer term (Cope et al, 2004: 25 – 26). Yet, in Europe, an interview-based survey of UK venture capital community perspectives reinforced the stereotype of British intolerance to failure, and made the point that the United States "is more sympathetic and supportive of entrepreneurs and entrepreneurial activity in general" (ibid: 26). Moreover, Flash Eurobarometer reports have

[36] See CUTEC at http://www.cutec.org accessed 5th December 2008.
[37] See CUE at http://www.cue.org.uk accessed 5th December 2008.
[38] The policy for England is known as "Withdrawal of funding for equivalent or lower qualifications (ELQs)" and more about the consultation and debates can be found here, accessed 9th December 2008, at http://www.hefce.ac.uk/learning/funding/elq/.

suggested that around 50% of potential European investors would decline involvement in a business venture where the business that had previously failed[39].

Initiatives across the wider educational spectrum need to include:

- Focused internet driven e-learning in entrepreneurship skills acquisition.
- Structured support framework for mature age and part-time professional students.
- Funding processes that adequately support and recompense professional-level trainers.

It is again the leading university hubs that have been at the forefront of initiatives of this kind. See examples at Judge Business School's Centre for Entrepreneurial Learning[40] and the recently Launched Advanced Diploma in Entrepreneurship in collaboration with the Institute of Continuing Education at Cambridge[41]. But such activities have both fixed investment costs in curriculum development and ongoing operating costs in staff and professional consulting support: but the potential gains for both individuals and society could be significant, and may illustrate a case for more proactive policy support at strategic levels to overcome potential market failure in knowledge acquisition and disbursement.

7.2.3 Europe's IP Regime Development: The Community Patent

Intellectual property protection is an important pillar of an effective innovation oriented economy. It provides both the stimulus to invest and the protection to share valuable knowledge and product development skills, gaining reward from technology licensing and ownership valuations that IP systems naturally provide (Granstrand, 1999).

In the sciences, patent filing and assertion are vital processes that support a number of invention-based industries, such as pharmaceutical research and drug discovery, and biotechnology product development (Heiden and Petrusson, 2007; Pugatch, 2004). Indeed, one of the main drivers behind China's state led endeavours to improve and upgrade its own IP regulatory system, and its patent system in particular, has been the intentions to promote innovation and knowledge ownership as part of their strategy to move up the value chain of their economy's productive capacity. Despite being much maligned, improvements in China's regime sophistication have been made over recent years, and cultural understanding of IP principles has been growing amongst the local business communities across the country.

Europe's IP regulatory and enforcement system has some striking advantages and collectively is seen as one of the three principal IP regimes of the world, along with the United States and Japan – the so-called Triadic IPR systems. But Europe also is saddled with undeniable weaknesses, especially in respect to patent management.

The European Patent Office (EPO) administers patent grants on behalf of contracting states to the European Patent Convention (EPC), a mechanism that sits alongside application processes offered by national authorities in those countries, at does least provide a streamlined mechanism for pan-European patent filings. However, "[o]nce a 'European Patent' has been

[39] See web article commissioned by PriceWaterhouseCoopers for their European Restructuring and Insolvency Guide 2005 / 06: "Entrepreneurship, business failure and starting afresh: the work of the European Commission", by Horst Reichenbach, Director General & Sonia Herrero Rada, European Commission, Enterprise Directorate General. Article available and last accessed 6th December 2008 at http://www.europeanrestructuring.com/05intro/022_025.htm.
[40] See CfeL at http://www.cfel.jbs.cam.ac.uk accessed 5th December 2008.
[41] See details of the diploma and its potential relevance for scientific and biotech communities at East of England Biotechnology hub ERBI website, accessed 5th December at http://www.erbi.co.uk/pooled/articles/BF_NEWSART/view.asp?Q=BF_NEWSART_307877

granted by the European Patent Office, its 'European' character evaporates as its unitary form ends", as the patent applicant must still file national-level applications in every country for which protection is being actively sought (Manderieux, 2007: 8).

These procedural requirements, coupled to national-level annual renewals, mean that it can still cost, on average, up to five times more to file a patent for the eight largest European economies that it does to file the same patent in the United States (ibid). The London Agreement of the EPO, which came into force in May 2008[42], has sought to control translation costs for European patent applications by limiting text requirements to one of three core languages: English, French and German. Whilst this is useful progress, it hardly compensates for an absence of a EU-wide Community Patent to match the elegant simplicity of the Community Trademark.

Moreover, it is also at the level of national judicial systems that patent assertions and legal claim must still be made, with each patent dispute being subsequently subject to distinctive and varied legal systems of interpretation at the point at which assertion is made

Nevertheless, the current operational framework creates a number of problems, not the least of which include:

- There remain high costs and process complexity in patent filing compared to the United States. Even despite cost savings offered by using EPO services and by the London Agreement, not all members are yet London signatories, and clarification of language requirements still takes time and specialist knowledge. It is thus still an expensive process to file an application for all of the EPO member states, or even for just EU countries, rather than the additional EPO nations. Costs can be particularly prohibitive for smaller firms whose patent protection tactics and potential licensing revenues are important to their growth strategies.
- Assertion must still be pursued at national level with introduces different legal systems and further complexities and costs, again an especially difficult burden for SMEs.
- There is no formal current agreement as to the applicability of software patents that can match the purpose offered by the United States Patent and Trademark Office's (USPTO) acknowledgement and enforcement of software patents. Notwithstanding the arguments over effectiveness, clarity and quality of some of the most recent US software patent grants, there continues to confusion across European litigation jurisdictions as to how and whether software should be excluded "as such" from patent filings, or can be included as part of a wider assessment of inventive effect under computer-implement inventions.

Unlike the trademark regime, there is no Community Patent as yet agreed that could facilitate a single application, deliver a single grant document, resolve at European level patent assertions, and provide a single legal framework for litigation subsequent to grant approval. In 2005, both the Community Patent and Software Patent issues went before the European Parliament, but were defeated. It can be contested whether combining the software patenting and community patent issues into one large legislative initiative may have overburdened evaluation on each topic, creating the complexity and interdependence of intertwining when in fact, they could have been treated as related, but separate, concepts. This may be true, but the fact remains that the European Union persists as a region whose promotion of innovation as a singular strategic objective is not matched by a comprehensive and cost-effective patent application support infrastructure, either for inventions or for software.

[42] For further details, see The Register legal news reference accessed 5th December 2008 at http://www.theregister.co.uk/2008/02/06/european_patent_translation_agreement.

European politicians need to take the lead at a *European* level. At the recent EIN Summer University in September 2008, debates during the Competitiveness and Innovation Roundtable made clear that the absence of a community patent continued to be a vexing matter for those enterprises engaged in outward looking innovative businesses. Matters of sensitivity concerning translations should be no excuse for failing to deliver what knowledge industry businesses need, and the London Agreement already gives a useful template for progress. The European Patent Litigation Agreement (EPLA) dovetails important legal support for pan-European assertion and enforcement of patent rights, by both holders and challengers, and should be brought to a conclusion within the context of an overall Community Patent solution.

The following practical steps need to be prioritised:

i) *Separate* the issues of Community Patent and Software Patenting. Both are sensitive and important points, but a super-directive covering all aspects of each risks an overloaded agenda and the potential for colliding arguments between what are, in fact, different issues.
ii) *Resolve* translation issues in respect to Community Patent filings by importing London Agreement principles.
iii) *Create* an EU-specific EPLA framework as a pillar of the European Court of Justice to facilitate pan-European legal patent dispute handling.
iv) *Enact* the Community Patent as a matter of *priority*.

7.2.4 Consistency and Imagination in R&D Tax Credits

Article 163(1) of the EC Treaty specifically mandates "strengthening the scientific and technological bases of Community industry and encouraging it to become more competitive at international level" (European Commission, COM728 2006: 6). The Commission has already recognised that there is a problem in the increasingly diverse sets of R&D tax incentives available across some member states, especially since many have only emerged in recent years (although, importantly, not all states have them – for example, Sweden now opposes such instruments in favour of other expenditure priorities). The consequences of this new fragmented fiscal landscape have been identified as "excessively complex and sometimes discriminatory against foreign organizations and multinational R&D partnerships"[43].

The application of R&D tax rebates broadly rests within the purview of Member State competence, but there are still Union level implications in policy framing. Whilst overtly territorial restrictions on R&D investment rebates for companies registered and operating in one member state that wish to secure a rebate for R&D investment that took place in another are unlikely to be accepted as legal by the European Court of Justice, uncertainties and disincentives undoubtedly remain a feature of the changing fiscal policy space, and can be an especially complex navigational burden for smaller enterprises. The Commission has focused its efforts in particular on promoting large-scale trans-national R&D projects and to encouraging member states to reduce obstacles to tax incentives for these types of undertakings through better co-ordination of policies. They have also been trying to encourage Young Innovative Company schemes to take root across the Union in order to help resolve the particular challenges faced by new innovating start-ups.

It is important that Europe takes forward both of these issues with renewed vigour: the Commission is largely constrained by realities of member state competences in tax affairs, and is primarily able only to offer advice on best practice, and to "inviting" member states to

[43] See "Tax incentives for Research" discussed by the European Commission since November 2006 at http://ec.europa.eu/invest-in-research/policy/tax_incentives_en.htm, accessed 24th January 2009.

look at key policy areas and to consider resolving anomalies. This is an area where Parliamentary activism could add value to Commission tasks, bringing both ideas and pressure back into debates at member state level, whilst also creating a set of best principles on creating enterprise incentives that can be disseminated through member state political parties. More radically, European decision makers should also prioritise discussions on creating an EU-wide definition of R&D and innovation activities, linked to the creation of a consistent and pan-European minimum framework for favourable treatment under the common consolidated corporate tax base proposals (CCCTB)[44]. Finally, efforts to support Young Innovative Companies (YICs) across the Union should be clarified more effectively, and current policy thinking on a special European tax status for these types of enterprise should be prioritised and taken to the next stage of implementation.

7.3 Knowledge Support Policies

7.3.1 Incubator and Cluster Support

The important research work of Cooke and Charles has highlighted the contribution that knowledge clusters and technology collaborations can have on the innovative capacity of particular regions. Importantly, a number of bottom-up pre-requisites can be highlighted as key drivers for the successful outcome to cluster and network projects. Each of these gives important message for potential policy action at regional, national and supranational levels.

Clusters cannot appear from nowhere, they require considerable planning and effort, from a range of sources, and their success is not assured just because there is a good local university nearby, or because a loose collection of businesses think that local proximity would be helpful. Their successful creation requires a mix of support from different actor levels: local and regional government providing strategic investment support, key individuals providing venture money and angel-consortia leadership support, innovating university departments providing the disruptive ideas, capable enterprises to exploit these ideas, and the creation of a human network of communication for mutual support and co-learning, that may then, in due course, be transposed into electronic and internet-enabled tacit knowledge exchange channels.

In broad terms, required policy inputs have been shown to be:

- Effective bottom-up government support at local and regional levels to act as a bedrock of administrative and communication infrastructure for initial cluster creation.
- The investment monies required to develop a physically proximate location with attractive working environments, high speed technology communications and incubator style centres that can support both SME start-ups and second stage expansion initiatives.
- Investment funding sources from national and supranational programmes that can complement and encourage further disbursement from business angels and private venture capital reserves.
- Sympathetic University and corporate policies that promote knowledge exchange, brain circulation and staff secondment, and that include coherent university IP spin-out procedures.

Even despite these foundations, the importance of human agency in the path dependency of any one particular cluster cannot be underestimated: visionary individuals and personal group

[44] For details on the CCCTB, see the Commission Working Group website, accessed 24th January 2009, at http://ec.europa.eu/taxation_customs/taxation/company_tax/common_tax_base/index_en.htm

networks can have a galvanising effect on all stages of cluster evolution. Nevertheless, a supportive platform of infrastructure and a protective umbrella of financial commitment from European framework programmes and regional investment funds remain vital inputs into a cluster's distinctive value proposition, which is where public policy has it own necessary role to play.

7.3.2 Researcher's Free Movement: A Blue Card for Innovation

Human capital is one of the key inputs into a successful knowledge economy. The Free Movement rights that facilitate nationals of one member state being able to relocate and work easily in another do not extend to third-country nationals, except for those who are close family members of EU citizens[45]. Labour is one of the four pillars of the factors of production that are central to achieving a truly effective single market under the Four Freedoms of the European Union, but in reality much more progress has been made with goods and capital than with services and people. Most recently, the Services Directive has sought to smooth inconsistencies across the Union and to promote especially the growth of online and e-services as part of innovation upgrading and enterprise development, but it was only introduced after some considerable debate and arguably some important policy dilution.

However, in terms of the free movement of *people*, matters become even more difficult to resolve. Immigration is an important area of national policy, and has become part of highly sensitive debates about unemployment, availability of jobs for citizens versus newcomers, and the effect new entrants may be having on national cultural evolution. These arguments are likely to gain even sharper relief in light of the recessionary trajectories predicted for European countries. However, in fact, free movement is arguably *more* important in a recession, as it creates flexibility and ease of access to match available innovative opportunities with skilled resources, and can help to ensure European businesses continue to grow, and that they can at least maintain their R&D capabilities during the downturn.

Whilst member states must accord with free movement principles for Union citizens, there are no such requirements for flexibility offered to the majority of others. In particular, residence and work permits are still handled at member state level, and permission to work in one state does not in any way provide an automatic right to move, on demand, to *work* in another state. But there is a special subset of highly skilled third country migrant – highly skilled researchers - whose ability to move across internal Union borders, and to participate in collaborative and remunerated research projects in more than one location, would arguably add considerable value to the overall innovative upgrading of pan-European outputs.

This management of work permission should be distinguished from an important related factor: short-term visits. The Schengen agreement (which anyway does not include either of two leading European innovation centres – Ireland and the UK) does facilitate short term rights for third country permit holders of any Schengen state to *visit* any other Schengen state, for tourism or business meetings, for up to three months without undue formality. But short-term travel for business or tourism does not capture the essence of what is required by highly skilled research specialists: the flexibility to move between assignments in different countries

[45] The Free Movement Directive, 2004/38/EC. However, there is some anecdotal evidence of problems with third-country family members of an EU citizen who is exercising their treaty rights where that family member is also a visa national (for example, a Chinese or an Indian citizen), with them having to submit burdensome documentary proof of funds, travel and accommodation for Schengen applications from some member states, in violation of the certainly the spirit – and perhaps even the substance – of the of Free Movement directive. See the following immigration discussion forum for an interesting series of debates on this topic, accessed 5th December 2008 at http://www.immigrationboards.com/viewtopic.php?t=15545.

where project timescales are longer than three months and where key contribution from the specialist needs to be provided across the entire project length, before moving on to another project, in another member state. In particular, SMEs often find work permit applications unduly onerous, and researchers themselves would be faced with different residence rules, one for each member state. The contrast with the United States' Green Card, allowing free travel across the country for work purposes and expedited immigration clearance on entry to the country along with citizens, sits in stark contrast to Europe's fragmentation, and may help to partly explain why America is more successful at attracting *and keeping* innovative-skilled nationals from third countries, including, significantly, a large proportion of overseas Chinese and Indian technology specialists.

Something else is needed to help struggling innovative European firms with their human resource sourcing needs.

The European Blue Card proposed by the European Commission to enable pan-Europe working rights for suitably skilled specialists is a policy whose time has now come, and it should be brought to fruition as a matter of urgency[46].

Policy highlights of the Blue Card include[47]:

- Valid for three years and renewable to cover long-term project involvement.
- Allows free movement across all European Union member states for the skilled migrant and their family.
- Does not grant immediate permanent residency but long term resident status available to holders after five years in Europe.

Whilst support in the European Parliament has been forthcoming from many sources[48], much remains to be done at member state level to better explain the realities and benefits of such an approach, and the costs and risks to Europe's competitive future of not tackling the problem at a *European* level, especially in economies where immigration has particularly high political visibility and a very distinctive *national* immigration policy framework, such as the UK.

Moreover, whilst it may be understandable that member states wish to maintain a range of specific and politically sensitive domestic policies to safeguard their borders, such an umbrella should not be allowed to mask the fact that this policy is aimed at fostering European levels of innovation and research excellence, from which all member states can benefit, as regional cooperation is able to nurture cross-border specialisation and promote project success. European politicians should be wary of too many compromises on the schemes effectiveness that would undermine its very purpose. This is a real opportunity to attract much needed and rare international talent: Europe as a whole should not squander the benefits of this initiative. Those committed to promoting a truly innovation-oriented Europe should integrate arguments and support policies to include Blue Card implementation across member states.

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[46] See EuroActiv article reviewing conference conclusions on the Blue Card as an "essential element" in maintaining Europe's comparative innovative advantage.
[47] See European Parliament website accessed 6th December 2008 at http://www.europarl.europa.eu/news/public/story_page/018-39206-287-10-42-902-20081013STO39205-2008-13-10-2008/default_en.htm.
[48] See European Parliament website accessed 6th December 2008 at http://www.europarl.europa.eu/news/expert/infopress_page/018-42218-322-11-47-902-20081117IPR42214-17-11-2008-2008-true/default_en.htm.

7.4 Conclusion

This section has highlighted how different levels of actors need to cooperate both within and across member state administrations of the EU in order to create an effective infrastructure for promoting, nurturing and sustaining an innovation driven knowledge economy across Europe. It has cast light on the importance of educational and legal foundations, such as entrepreneurial learning and tacit knowledge acquisition, together with required legal initiatives at supranational level that include moving to conclude a Community Patent and working on finalising free movement for non-EU nationals who possess the key research and innovation skills that European enterprises require.

8 Conclusions and Recommendations

8.1 Implications for EU Enterprises and Politicians

This paper has sought to introduce the extent of competitive challenge faced by European enterprises in the knowledge economy through the emergence on to the world stage of China and India. Key sectors such as those of software development, IT services and pharmaceuticals have been explored and it has been shown that European politicians and business leaders should not be blinkered to the expansion and current and future innovative capacity that industries such as these enjoy in Asia today.

Europe continues to enjoy singular competitive advantages in the sophistication of its knowledge industries and its experience in far-sighted research and development in some of the most advanced science parks and business clusters in the world. Nevertheless, an outward facing strategy is increasingly being required by all parts of the economy in order to grasp both opportunities for partnership, market development and tacit knowledge exchange *with* Asia, but also to recognise and respond to threats to Europe's comparative advantage in innovation *from* Asia. This will require multiple level policy and strategy responses from key actors in Europe, in politics and in business, in SMEs and in multinationals, and at national and supranational levels.

The world is changing rapidly and it has been shown that the current pace of globalisation and sector integration across the knowledge industries may not favour western enterprises in the way that earlier phases did. This pace of change is especially salient as it has been accompanied by a marked investment by Chinese and Indian government and commercial actors in upgrading their national innovation systems and improving their innovation outputs, as part of broad economic development strategies that seek to move domestic production up the value chain, directly intersecting with the market space that European companies inhabit.

This propensity to innovate by Asia has been explored in some detail. The paper has looked at case studies in software and pharmaceutical knowledge sectors and examined both China and India's technical, commercial and political reach across these sectors, which are important not only to their Asian government development plans, but to Europe's also. No longer can Asia be ignored and written off as incapable of achieving either market scale or product novelty.

European platforms for nurturing and sustaining its innovative advantage in knowledge sectors have both strengths and weaknesses, with strengths on the input side largely anchored of the equation, including human resources that cover scientific and research skills, business development and entrepreneurial skills, as well as a cultural diversity that brings with it a natural capacity to imaginatively with international opportunities. However, questions arise about the quantity and sustainability of scientific skills, and the extent to which innovating, disruptive thinkers are able to be linked to entrepreneurial doers, so as to create commercially sustainable outcomes. Clustering, business collaboration networks and continuing education are important inputs in this context. Moreover, fundamental legal foundations for creating a truly European innovation culture need also to be addressed, with the creation of a Community-wide patent framework emerging as particularly salient as one of the more complex and important policy areas.

In terms of outputs, the essential ingredients in member state and EU innovation systems development must be to address the relative decline in R&D intensity suffered by many member states over recent years. This observation becomes particularly important when it is

recognised that an emerging East Asian nation such as China is now spending *more* on research and development investment initiatives as a percentage of its GDP than many EU members. Of equal significance, much of this increase in Chinese investment is originating from *business* R&D expenditure, shedding light on the country's genuine embrace at enterprise level of improving knowledge industry outputs within the value chain.

8.2 Summary of Recommendations

These recommendations are structured based on the discussion presented in this paper and centre on broad themes of skills upgrading, knowledge support and innovation infrastructure improvement. These three categories are the key ingredients to achieving success with the "Knowledge Triangle" that can help sustain Europe's success into the future.

	Recommendation and Policy Outline	**Responsible Level(s)**
	Skills Upgrading	
1	Invest in initiatives to improve links between science and technology research and commercial business opportunities. Encourage spin-out support systems, provide seed start-up funding pool and design an approved delivery network for an affordable service "package" of IP protection advice and related SME support.	*EU & Member States*
2	Promote entrepreneurial skills acquisition through continuous education and lifelong learning initiatives, prioritising e-learning-based business school / industry collaboration programmes, linked to second qualification and mature-age skills upgrading.	*EU & Member States*
	Stimulating Enterprise	
3	Re-introduce the Community Patent Directive and EPLA framework to support cost-effective community-wide patent grants and adopt London Agreement solution for language translation disputes.	*EU*
4	Re-introduce a separate Software Patent Directive to clarify and coordinate a community-wide approach to categorising and recognising software-based IT innovations in Europe.	*EU*
5	Address the complexity, inconsistency and confusion that persist due to disparate member state approaches to R&D tax credits. Tackle two steps in concert: first, prioritise the tax credit issue within wider discussions on the Common Consolidated Corporate Tax Base proposals (CCCTB), and second, take forward as a policy principle, proposals to create a Europe-wide special tax status for Young Innovative Companies (YIC).	*EU &Member States*
	Knowledge Support	
6	Expand cluster support framework and design best practice strategy for cross-sector and cross-border collaborations across the EU by properly evaluating success factors and path dependency outcomes in existing successful clusters.	*EU & Member States*
7	Implement Researcher's Free Movement principles as part of rollout priorities for a European Blue Card scheme and monitor member state implementations to ensure that member states cannot dilute flexibilities to the point of rendering the initiative meaningless and thus worthless.	*EU*

9 About the Author

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