Intellectual property fuels a global sense of competitiveness

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The global economy is undergoing a major shift. For a nation to be competitive it must strengthen its research agenda, become innovative, strengthen and protect its intellectual property, and find resources for the continuing education of its citizens.

Keywords: Global economy, innovation, intellectual property, university education.

IN a global market economy, a company's competitive success depends heavily on the information and knowledge it possesses, whether it is in the skills of its employees or in the results of its research. Therefore, there is a natural rush to create knowledge, improve skills and convert them into assets, preferably in the form of patents. This is especially true in industry sectors such as biotechnology where initial investments are high, required knowledge and skill levels are at the cutting edge, and the costs of copying by experts are low. For example, Korea and Singapore have become acutely conscious of the fact that in order to stay economically viable, their industries must upgrade from being investment-driven to being innovation-driven. This essentially means dealing with cutting-edge research and protecting intellectual property (IP). Their programmes include creating research policies, development of first-class research infrastructure and institutions, nurturing and sourcing of creative talent by relaxing immigration laws, and providing high-quality education and training that would be compatible with global standards. Given the high cost of R&D, the intentions are clear: avoid R&D duplication and practice economies of scale in R&D efforts by excelling in specific research areas. Apart from Korea and Singapore, many other countries are aiming to spend 3% (roughly 1% from government, 2% from private) of their GDP on R&D by 2010. Here we outline certain steps taken by various governments keen to be big players in the new global economy. Since implementation of key steps in most countries began in earnest in 2006, their global effectiveness is expected to become visible around 2010.

South Korea

South Korea, a recently developed country with a population of about 50 million, is advancing rapidly both technologically and economically. One of the poorest countries in Asia in the 1950s, today its per capita GDP is over US$ 25,000. In 2004, it joined the trillion dollar club of world economies. It was the 12th largest economy in the world in 2005. It began charting an ambitious future in the 1960s. Once reputed as a country that did not respect intellectual property rights (IPR), South Korea now boasts a patent regime in line with international standards. The number of patent applications from foreign researchers doubled between 1990 and 2000. By 2004, almost half of all biotechnology patent applications were from foreign inventors[1]. It was ranked 13th in the world in terms of GDP in 2007. It is already world-class in semiconductor memory devices, CDMA cell phone, flat panel displays and plasma displays, automobiles, steel and ship building. By 2010, it expects to be world-class in information technology (IT), biotechnology, nanotechnology, energy technology and aerospace technology[2,3].

The government believes that South Korea can no longer survive as a production and export economy alone; it must enhance its knowledge-based industries. Accordingly, it now places greater emphasis on fundamental sciences than before. In October 2004, the post of Minister of Science and Technology was elevated to that of Deputy Prime Minister. In November 2004, the Office of Science and Technology Innovation (OSTI) was established to act as an administrative body of the National S&T Council. OSTI is responsible for the overall management and coordination of S&T policies, national R&D projects, industry and human resource policies related to science and innovation. It is headed by the Vice Minister of Science and Technology Innovation[2].

On 20 March 2008, the government announced that Korea's R&D spending will reach 5% of GDP in 2012, a substantial increase from 3.49% it spent in 2007. Fifty per cent of the total R&D spending for 2012 is earmarked for basic research compared to 25% for 2008. It also plans to spend US$ 610 million until 2012 to build world-class research universities and set aside another US$ 200 million by 2013 to give pensions to scientists and technologists[4].

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By 2006 Korea had reduced its patent examination period to 9.8 months, the world's fastest, and maintained that level in 2007 while maintaining global examination quality standards. It is now an active international search authority. In April 2007, Korea and Japan entered into an agreement wherein each country's patent office recognizes the other's examination results. A similar agreement between the patent offices of Korea and the US was entered into in January 2008. In 2007, World Intellectual Property Organization (WIPO) selected the Korean language as one of its official languages for Patent Cooperation Treaty (PCT) filings[5].

In May 2006, the Korean Intellectual Property Office (KIPO) concluded an unusual memorandum of understanding with financial agencies (including several banks) and technology appraisal agencies to support the commercialization of high-value patents owned by small and medium enterprises. This will allow financial institutions to extend credit, especially to small and medium enterprises which have inadequate material security, by taking patents as securities[6].

Singapore

Singapore, a developed city-state with a population of about 4.6 million, is reputed to be the least corrupt country in Asia; it has a relatively short history of innovation. Its heavy investment in S&T, with an emphasis on R&D activities across all industry sectors, by changing its focus from being investment-driven to being innovation-driven, is recent. Gross expenditure in R&D grew from 0.85% in 1990 to 1.89% of GDP in 2000 (with the private sector accounting for approximately 62% of that amount) to 2.25% of GDP in 2004, and is slated to grow further[7] to 3% of GDP by 2010. The number of research scientists and engineers grew from 28 in 1990 to 87 per 10,000 people in the labour force[7] in 2004. It does not have a dedicated science ministry. All S&T activities are funded and coordinated by the Ministry of Trade & Industry (MTI) through two organizations: in the public sphere by the Agency for Science, Technology and Research (A*STAR), and in the private sphere by the Economic Development Board (EDB)[8].

During 1986–87, the government formed four major research institutes. Now A*STAR alone has 12 research institutes. In 1991, the National Technology Plan was formulated, and provided with US$ 2 billion over five years. This gave a kick-start to Singapore's rapid technological growth. In 2000, the Bio-technology Cluster Plan (B2000) was unveiled with the strategic intent of turning Singapore into a leading biotechnology hub for discovery, development, manufacturing and services. In 2006, the government established a Research, Innovation and Enterprise Council (RIEC) chaired by the Prime Minister. On 1 January 2006 a new department under the Prime Minister's Office, called the National Research Foundation (NRF), was formed to support the RIEC, to implement key strategic R&D thrusts, to provide a coherent strategic overview of R&D at the national level, and to allocate funding to longer term R&D programmes.

In February 2006, the MTI announced its Science & Technology Plan 2010 (STP2010)[7] for developing a whole spectrum of research capabilities, from basic research to mission-oriented research with better integration into industry; to focus on growing the private sector's share of R&D since corporations are best placed to decide which areas of R&D to invest in, and to align R&D investments with commercial opportunities; and to develop stronger co-funding framework between industry and public education and research institutions to strengthen innovation in the private sector and to uplift technological and manpower capabilities in enterprises. During the Plan period, MTI will commit US$ 7.5 billion to sustain innovation-driven growth. Of this US$ 5.4 billion is allocated to A*STAR, and the remaining US$ 2.1 billion to EDB. A*STAR will encourage the commercialization of the IP arising from the research it supports, provide world-class infrastructure, and a conducive environment to attract R&D talent and investments globally. EDB will lead efforts to promote private sector R&D in areas selected by companies. EDB will also aim to anchor flagship R&D projects and attract more multinational companies to locate corporate R&D activities in Singapore[9].

Effective from 1 April 2007, Singapore has aligned its patent system to conform to PCT. In June 2008, the Intellectual Property Office of Singapore held a three-day IP Champion Camp for school students to teach them about innovation and IP rights.

Japan

Japan is a developed country with a population of about 128 million. It imports nearly 90% of its oil from the Middle East. Its population is aging faster than that of any other country. It is pursuing a visionary S&T plan aimed at making the country a global innovation leader. The basis for Japan's S&T policy dates back to 1995, when a law was enacted that required the government to create a basic S&T plan. The basic plan has thus far included three five-year phases with targeted measures for meeting the policy needs of those particular times. The first phase (1996–2000) included a major expansion in support for post-doctoral fellows and cost the government about US$ 150 billion over five years. The second (2001–05), categorized government R&D investment into eight areas, with four given special priority: life sciences; information and communication technology (ICT); environmental sciences, and nanotechnology and materials, and cost the government US$ 186 billion[10]. During this phase, in April 2001, 68 national research institutes were reorganized into independent administrative institutions, and in April 2004, national universities were reorganized into corporations, which enabled research institutions to learn the art of flexible research management[11]. The third phase (2006–10), specifically addresses Japan's most pressing problems, especially energy dependency and a rapidly aging population, and calls for government R&D investment of about US$ 221 billion[11]. To this end, the third phase calls for the establishment of 30 world-level centres of excellence in research, emphasizing the fact that the sole determining factor for the future growth of Japan's economy is innovation. The plan singles out 60 research subjects for priority support, ranging from bioinformatics, disaster recovery and cellular-level drug delivery systems, to next-generation supercomputers and automobile fuel systems that do not use petroleum[12].

To increase opportunities for researchers early on in their careers, for foreign scientists, and for women, the S&T plan aims to raise the proportion of female researchers in the natural sciences from 10% in 2006 to 25% by 2010. Additional goals are to improve cooperation between industry and academia, and to use government procurement to stimulate the adoption of newly created technologies[12].

It is noteworthy that during its prolonged period of economic stagnation, the government continued to set clearly defined targets for investment in R&D and that its science and technology budget has been growing at a faster rate than other budget items. Japan's intention is to expedite reforms that will encourage innovation and put in place a thorough merit system that will encourage recruitment of top researchers worldwide.

In January 2007, the Ministry of Economy, Trade and Industry (METI) announced its 'Advanced Measures for Accelerating Reform toward Innovation Plan' (AMARI Plan 2007) in patent examination as a new basic IP policy[13]. The Plan covers four main areas: promotion of global-scale acquisition of IPR and higher level of IP protection; further efforts toward expeditious and efficient patent examination; promotion of strategic IP management by companies; and support for local regions and SMEs in IP utilization. Achieving exemplary patent examination is a critical policy issue of the Japanese Government in the context of its future goals for economic growth. While maintaining high patent examination standards, by 2013, it expects to reduce first action pendency to 11 months, which currently is more than twice that period.

United States of America

The US with a population of about 304 million has an economy that leads the world mainly because its system of private enterprise rewards innovation. The US has a strong entrepreneurial culture, a favourable environment for company start-ups, and exemplary university–industry links, especially after the Bayh–Dole Act of 1980 allowed universities to keep patent rights and royalties resulting from federally funded research. Much of American growth in the last 40 years has come from new companies. Paradoxically the US has no explicit unified innovation policy, while Europe has clearly articulated innovation objectives. The US invests heavily in ICT R&D, but the European Union (EU) leads in research spending on automobiles and aerospace. Federal funding has significantly declined, especially in applied research, as a proportion of GDP. For example, applied R&D fell from 0.27% in the mid-1980s to less than 0.15% of GDP in 2005. Much of the increase in absolute overall spending is for defence. Apart from health, basic and applied R&D is under-funded[14]. The US is also concerned about the declining numbers of S&T graduates, and of foreign students. It is estimated that the number of jobs requiring technical training is growing at five times the rate of other occupations, while the number of students enrolling in the technical fields is declining, and the average age of the US science and engineering workforce is rising[15].

On 26 April 2004, the then President George Bush announced a series of measures to promote innovation in clean and reliable energy, better delivery of healthcare, and expansion of high-speed internet access throughout the US. The National Innovation Act of 2005 was introduced[15] on 15 December 2005 and was based on the report Innovate America[16] published in December 2004. The report focused on research investment, increasing S&T talent, and developing an innovation infrastructure. It resolved that 'Innovation will be the single most important factor in determining America's success through the 21st century'. The National Innovation Initiative defined innovation as the 'intersection of invention and insight, leading to the creation of social and economic' value. The goal of the legislation was to ensure America's global role as a leader in technological innovation and to tap into the vast expertise and talent pool at its disposal. The bill never became law. However, on 9 August 2007, Bush did sign into law, the *America COMPETES Act* (America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education and Science Act): 'To invest in innovation through research and development, and to improve the competitiveness of the Unites States'.

The US turns out 1.3 million college graduates and 70,000 engineers, while China and India together turn out 6.4 million college graduates and 950,000 engineers each year[20]. For large-scale manpower in the low-end services and support activities, the US has increasingly turned to India and China.

Beginning in 1991, university licensing revenue, chiefly from patents, increased nearly three times, from US$ 200 million to US$ 550 million in less than a decade. The top ten university patent holders accounted for two-thirds of licensing revenue in 2000 (Association of University Technology Managers, 2003). Subsequent years have shown similar trends. However, a high percentage of this revenue derives from a relatively few biomedical inventions. Nevertheless, the uncertain odds of pay-off have not deterred research institutions from investing heavily in such operations. In 1980, 24 universities reported having technology transfer offices; by 2000 nearly all research institutions had them[17].

The International Business Machines Corp. (IBM) is both the world's largest IT company and owner of the world's largest patents portfolio. In 2000 alone IBM generated more than US$ 1.6 billion in IP licensing income. It now has an annual revenue from licensing programmes of over US$ 1.5 billion a year. Not surprisingly, its IP policies are carefully watched by others. Its current thinking may be found in its scholarly reports[18–20].

On the dark side of the US patent system is the notoriety gained by the USPTO by granting 'silly' patents in the thousands, especially in software and business methods category, which has brought the USPTO under ridicule[21]. While it is widely recognized that the US Patent Act needs to be overhauled, attempts by the US Congress in the last several years to do so have made miniscule progress. Patent litigation is widespread in the US. Given that courts routinely award millions of dollars for damages and patent licensing fees, many American corporations have realized the financial benefit associated with winning a patent infringement suit. In fact, patents are used by many as nothing more than a bargaining chip in the court. Another recurrent problem is that important litigation cases, instead of being resolved by the courts are being settled out of court after protracted court battles.

Germany

Germany, a developed country with a population of 82.5 million, is the world's third largest industrial nation. The member states of the EU are its most important trading partners. Nevertheless, it believes that with R&D expenditure (private and public) at almost 2.5% of the GDP, it is trailing behind by international comparison: the US invested 2.7% in 2004, Japan 3.2% in 2003, Sweden 4.0% in 2003 and Israel 4.5% in 2004. The Government is pressing ahead with plans so that Germany can achieve a figure of 3% by 2010. It sees research and innovation as the keys to its future viability and as the source of its future prosperity. Consequently, it is paying great attention to its education and research policy, and on improving research and innovation capabilities through international cooperation. It believes that globalization offers more opportunities than risks when it comes to securing and expanding Germany's strong but endangered position in research. Consequently, science and research have assumed top places in its agenda and so has its desire to invest in people and make the country a hotbed of talent, through a variety of programmes, including improved integration of migrants, introducing children to the natural sciences at an early age, and making investments to improve the qualifications of the gifted. Under its Pact for Research and Innovation[22], it will guarantee R&D organizations an annual increase in funds of at least 3% up to 2010.

Notwithstanding that some 85% of all R&D expenditure in Germany goes into the automotive, chemical and machine-tool industries, the country has made substantial investments in advanced sectors like biotechnology, nanotechnology and IT. Innovative integration of 'high-tech' into 'medium-tech' products has already boosted manufacturing and to give it a further boost, close attention is now being directed to the small and medium enterprises (SMEs). The formidable network of SMEs, including many family firms, lies behind Germany's leading position in the world market for everything from machine tools to laser systems. The challenge lies in luring back venture capital, whose decline, particularly for company start-ups, has been dramatic. Early-phase investments (seed and start-up) in 2003 were below the 1998 levels[23].

In 2006, the Federal Ministry of Education and Research launched its 'High-Tech Strategy for Germany', as a long-term strategy to ensure Germany's continuance as one of the world's most research-oriented and innovative countries[24]. This national initiative embraces all ministerial departments. Following the first status report on the strategy in November 2007, on 21 May 2008, the Cabinet adopted the Federal Report on Research and Innovation, 2008. Similar reports are to be published every two years and provide wide-ranging information on the Federal Government's research, technology to innovation policies for the individual federal states, as well as for the EU. The 2008 report provides an overview of all R&D expenditure in Germany since 2005. Germany is investing around 11.2 billion euros in 2008 in R&D (2.7% of GDP) compared to 9 billion euros for 2005 (2.5% of GDP). For 2009, the tentative goal is 2.85% of GDP. Germany is thus inching closer to its target of 3% of GDP on R&D spending[25] by 2010.

The government is adopting a multi-pronged approach to build its future. It has initiated reforms of company taxation and the burdens of bureaucracy; is encouraging venture capitalists to increase their participation in funding high-tech start-up companies, and paying attention to improving the protection and exploitation of IP. The government has modified the instruments of venture capital promotion, and has set up a new joint venture capital fund for newly created innovative companies, to be invested in partnership with private investors. The government also intends to create a seed fund for R&D-based start-ups[23], mainly for young entrepreneurs with total capital requirements of up to €600,000. These are, in a sense, the bridges the government is building between research and markets. Germany is among the world's leaders in patents, and as an exporter of technological goods, it is particularly sensitive to violations of IPR[22]. On 7 July 2008, the German legislature adopted the Act on Improving the Enforcement of Intellectual Property Rights (Gesetz, Bundesgesetzblatt (BGBl) 2008 I at 1191). On 15 October 2008, the German Government finalized a Draft Bill for Unification and Modernization of Patent Law (Entwurf eines Gesetzes zur Vereinfachung und Modernisierung des Patentrechtes).

Where does India stand?

India, with a population of about 1.13 billion in a world population of about 6.7 billion, is not yet a significant player in the innovation game. India continues to be an investment-driven economy, with no signs of becoming an innovation-driven economy in the coming decade. The literacy rate in the country stands at about 61% (those of age 15 years or more who can read and write)[26]. A World Bank survey reported in 2005 found that 25% of the government primary school teachers in India are absent from work. Only 50% of the teachers are actually engaged in the act of teaching while at work[27]. There is no indication that the situation has improved since.

The Council of Scientific and Industrial Research, New Delhi, runs 41 research laboratories[28]. India has the world's third largest scientific and technical manpower, an irrelevant fact because of its visibly dubious quality. Of the nearly 400 thousand engineering graduates produced annually in the country, some 75% are widely believed to be unemployable; an unbelievable waste of our already sub-critical investment in education. India does not figure in the top ten list of IP generators in any category in WIPO's World Patent Report 2008 (which contains data updated to 2006)[29]. Indeed, patent awareness in the country is poor[30].

We have capabilities in nuclear physics, chemistry and chemical engineering, rocket and missile technologies, and satellite technology. These give the government some leeway in framing its defence and foreign policies, but little else. The IITs and IIMs have become highly respected global brands. However, only a few thousand students graduate from these institutes annually, most of whom become global resources, rather than Indian resources. None of these institutes is renowned for producing significant amount of high-quality research; in fact, their annual research output is low. The proposed creation of eight new IITs and seven new IIMs during the 11th Five-year Plan[31] is too little and too late. There is also the problem of finding adequate number of quality faculty for them. The government has no credible plans to set up or help to set up world-class research universities.

The deliberations of the National Knowledge Commission (tenure: June 2005 to October 2008)[32] do not show the scholarship or expert authority expected of such commissions. The Science and Technology Policy 2003 (ref. 33), Technology Policy Statement 1983 (ref. 34), and Scientific Policy Resolution 1958 (ref. 35) are well-meaning statements, but ineffective in the absence of critical masses of world-class doctorates and postgraduates in S&T relevant to the future economic development of the country. There is no foundational base of Nobel laureates or world-class researchers to mentor the new generation. Even the websites of our top national academic and research institutions fail to provide any substantial and useful knowledge to the public, even though supported by public funds. Ultimately, implementation is everything.

The country has an excellent record of being able to assimilate technology licensed from the advanced West, and hence it will succeed as a global manufacturing hub. But its inability to generate technology in important areas like biotechnology, nanotechnology, IT, robotics, etc. makes it vulnerable. The situation is further complicated as international movements of capital rather than international movements of goods drive the world economy, and increasingly today, trade follows investment.

A worrying feature is the country's current substantial dependence on the IT sector, which provides low-end services on a massive scale to the West for earning foreign exchange. The IT sector has siphoned-off the meagre talent pool from all branches of S&T available in the country and placed it at the disposal of the West for tasks that require lesser qualified people. This has gone on for over a decade, heavily depleting the talent pool available to the Indian industrial sector. More importantly, the original S&T skills they were trained in prior to joining the IT sector have rusted, to an extent where they are no longer employable in the technologies they were trained in. The financial prosperity enjoyed by the Indian IT sector will eventually come to an end in a few years (perhaps as early as two), simply because its ability to climb up the value chain is practically non-existent. It talks about knowledge management and even advises the government on it, but has no ability to spot talent, let alone harness it for the climb.

A prerequisite for climbing the value-chain is the ability to generate IP, protect it and commercialize it. It requires both universities and industries to learn to do collaborative R&D, but a prerequisite for that is the existence of a group of outstanding research universities, something that our policy planners have never paid heed to. The government's immediate focus should be to set up research universities, closing down those science and engineering departments of universities whose graduates are unemployable, and start continuing education programmes, if the country is not to be left behind in the new economy.

Finally, innovation requires a culture and creating a culture takes time. For India to eventually become globally competitive, it will be necessary to revamp the education system from the primary school up with the help of modern communications technology, especially the electronic media. The emphasis must be on helping students develop problem-solving strategies, rather than on rote learning. As a nation we have grossly underestimated the creative abilities of children and have failed to nurture their curiosity.

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