# THE RISE OF INNOVATION IN INDIA*

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In recent years, there has been much discussion in expert circles and the popular press about the rise of innovation in India. In the following extract from the chapter on India in the UNESCO Science Report-2010, we explore the reasons behind this success story and the challenges that remain.

The rise of innovation in India has been precipitated by a number of factors. Firstly, India has emerged as the fifth largest economy in the world in Purchasing Power Parity (PPP) dollars, according to the World Bank. In relative terms, however, India's economy is just half the size of China's, which also happens to be growing at a faster rate: 8.7 per cent in 2009 after progressing by 10 per cent or more for six years in a row. India's real GDP growth slipped back to 7 per cent in 2007 and to less than 6 per cent in 2009, after climbing from 5 per cent in 2002 to a steady 9 per cent in 2005–2007, according to the International Monetary Fund (IMF).

Secondly, there are many instances of innovation in the services sector, especially as concerns health care. Currently, the services sector accounts for two-thirds of GDP in India. Both the services and manufacturing sectors have been performing very well .

In the manufacturing sector, for instance, the release of Tata's Nano brand in 2008 hailed the advent of 'the world's cheapest car', at US$2 ,200. The car was designed at Italy's Institute of Development in Automotive Engineering with component parts manufactured by an Indian subsidiary of Bosch, a German company. Approximately two-thirds of the technology for Bosch products used in the Nano car is sourced from India. The initial production target is for 2,50,000 units per year.

In the health sector, the MAC 400 machine produced by General Electric's John F. Welch Technology Centre in Bangalore records a patient's electrocardiogram. As it is portable, it can be used in rural areas to diagnose heart disease.

For a very long time, Indian policy-makers avoided using the explicit term of 'innovation' in policy documents dealing with technological activities.

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The word 'innovation' appears in a policy document for the first time in 2008, in the draft National Innovation Act. This development reflects a broad sentiment in both policy and business circles that the country is becoming more innovative – at least certain industries.

A third factor is that the knowledge intensity of India's overall output has expanded. Currently, about 11 per cent of India's GDP comes from knowledge-intensive products and services. Also noteworthy is that growth in knowledge intensive production surpasses that of the economy overall.

The majority of new companies belong to knowledge intensive sectors and the number of knowledge intensive enterprises has mushroomed over the past seven years or so. This trend is corroborated by the technology content of all industrial proposals implemented since the first reforms to liberalise the economy got underway in 1991.

Once again, with the exception of the textile industry and a few others, the majority of new proposals emanate from technology-oriented industries in areas such as chemicals,energy, electrical equipments and so on.

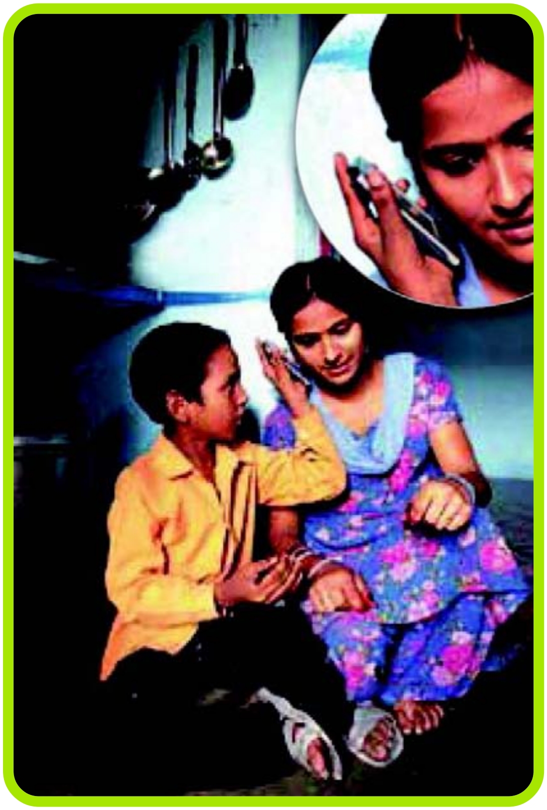
A fourth factor is that Foreign Direct Investment (FDI) from India has grown considerably, from just US$2 million in 1993 to about US $19 billion in 2009. This includes some high-profile technology-based acquisitions abroad by Indian companies. Examples are Tata Steel's takeover of British industry giant Corus, Bharat Forge's takeover of forging companies in Germany, the UK and USA, and Suzlon's takeover of wind turbine companies in Germany.

The growing number of foreign acquisitions of 'active targets' in technological jargon, has given Indian companies considerable access to the technological capacity of the acquired firms without their having to build this up assiduously from scratch. The same goes for mergers.
Before Tata Steel's purchase of Corus, Europe's second largest steel producer with annual revenue of around £12 billion, the Indian steelmaker did not hold a single American patent. The takeover brought it over 80 patents, as well as almost 1,000 research staffs.

In addition, the number of foreign research and development (R and D) centres have grown from fewer than 100 in 2003 to about 750 by the end of 2009. Most of these R and D centres relate to information and communication technologies and the automotive and pharmaceutical industries.

A fifth factor is that India has become more competitive in hightech areas. Although manufactured exports are still dominated by low-tech products, the share of high-tech products has doubled in the past 20 years to 17 per cent. India has become the world's largest exporter of Information Technology (IT) services since 2005 and exports of aerospace products have been increasing at a rate of 74 per cent per year, compared to 15 per cent for world exports of these products.
India is acknowledged to have considerable technological capability in the design and manufacture of spacecraft and is now an acknowledged global leader in remote sensing. According to Futron's 2009 ranking of ten entities in its Space Competitiveness Index, India ranks better than the Republic of Korea, Israel or Brazil.

However, the bulk of innovation in this area comes from the government sector rather than industry, a situation that is set to change. Aerospace exports from India have increased



manifold in recent years, even if exports tend to be confined to aircraft parts or components. With approximately 300 small and medium-sized enterprises active in this area, India is slowly emerging as one of the few developing countries to have a high-tech industry of the calibre of its aerospace industry.

## A limited spillover of government research to civilian use

Government expenditure on R and D in India tends to focus on nuclear energy, defence, space, health and agriculture. The spillover of government research to civilian use is very limited, although in more recent times, conscious efforts have been made by the government to orient research more towards socio-economic goals. This is slowly beginning to produce results, especially in the area of space research with the development of environmental monitoring, satellite communications and so on.

The higher education sector in India is not a source of technology for industry. This may come as a surprise, as the Indian Institutes of Technology do collaborate with private industry. Unfortunately, however, cases of actual technology generation are few and far between, as much of R and D relates to basic research. Moreover, the institutes tend to be extremely teaching-intensive institutions. It is estimated that the entire higher education sector in India contributes no more than 5 per cent of GERD. It does act as an important reservoir of skilled personnel, however, for the other factors in India's national innovation system.

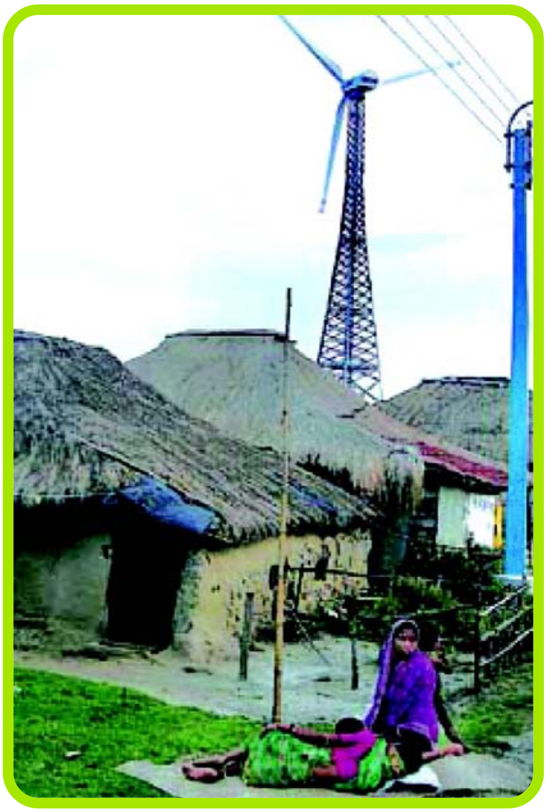
Currently, private companies spend approximately four times more than public enterprises on R and D and nearly three times more than government research institutes. In other words, private enterprises are moving towards the core of India's innovation system. Four industries account for the lion's share of investment in R and D, with the pharmaceutical and automotive industries topping the list. There is insufficient evidence to show that India's entire industrial sector has become more innovative since 1991 but India's pharmaceutical industry certainly has.

## Remedying a shortage of trained personnel

Of late, industry has been complaining of serious shortages in technically trained personnel. A study by the Federation of Indian Chambers of

Commerce and Industry in 2007 revealed a 25 per cent shortage of skilled personnel in the engineering sector.

Two issues have an impact on the potential supply of scientists and engineers for domestic businesses, in particular. The first is the long-standing issue of the migration of highly skilled personnel from India to the West primarily. There is every indication that this brain-drain has accelerated in recent times. The second issue concerns the growing amount of FDI flowing into R and D. Foreign R and D centres are able to offer domestic researchers and R and D personnel better incentives than domestic businesses. As a result, India's small stock of scientists and engineers may be lured to foreign R and D centres.



The central government in particular has reacted vigorously. In higher education, it is seeking to arise the gross enrolment ratio from 11 per cent in 2007 to 21 per cent by 2017, one of the targets of the Eleventh Five-Year Plan (2007–2012). One-quarter of the student body is currently enrolled in the fields related to Science and Technology (S and T), according to the UNESCO Institute for Statistics.
The government has opted to establish 30 new central universities from 2010 onwards, 14 of which will be 'innovation universities'. Each innovation university is expected to focus on one area of significance to India, such as urbanisation, environmental sustainability and public health. In parallel, the government is doubling the number of Indian Institutes of Technology to 16 and establishing 10 new National Institutes of Technology, three Indian Institutes of Science Education and Research and 20 Indian Institutes of Information Technology to improve engineering education.

This year, the government is also in the process of adopting a policy of permitting foreign universities to enter the higher education system in India by establishing their own campuses or via joint ventures with existing universities and institutes.

## The impact of the Indian Patent Act

One important policy change in recent years has been the adoption of the Indian Patent Act, which took effect on 1 January 2005. This ordinance sought to bring the country into compliance with the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) of the World Trade Organisation. The most distinguishing feature of this policy change is the recognition of both product and process patents, as opposed to solely process patents in the earlier Act of 1970. In bringing India into compliance with TRIPS, the intention was to restrict innovation in the pharmaceutical industry in particular, where the lack of product patents had allowed firms to reverse-engineer known products at little cost. This 35-year learning period seems to have given the pharma firms the time they needed to acquire the skills crucial to inventing new chemical entities.

After the adoption of the Indian Patent Act, it was expected that R and D spending by the pharmaceutical industry would slump. This reasoning was based on the belief that much of Indian R and D in pharmaceuticals still consisted of reverse-engineering. By requiring recognition of both product and process patents, it was thought that the amended Act would reduce the space for reverse-engineering. It turns out private pharmaceutical companies in India have actually continued to register an increase in R and D investment of almost 35 per cent per year (See Figure).

In fact, some of the provisions in the Indian Patent Act have protected Indian pharma companies, even if the ordinance imposes a 20-year protection period for product patents. For example, there is a provision for granting compulsory licences for the export of medicines to countries that have insufficient or no-marketing capacity, to meet emergent public health situations, in accordance with the Doha Declaration on TRIPS and Public Health. This allows Indian companies to produce and export AIDS drugs to African and Southeast Asian countries. Another safeguard has been the introduction of a provision making patent rights for mailbox applications available only from the date of granting the patent rather than retrospectively from the date of publication. This provision has saved many Indian companies from being attacked for infringement of patent law by multinational companies that might otherwise have obtained patents for drugs already put on the market by Indian companies.

As for the impact of the Act on innovation in the agriculture, biotechnology and IT sectors, this aspect still needs to be analysed in depth.

## The incredible feat of Indian pharma

Turnover by the Indian pharmaceuticals industry has grown from a modest US$300 million in 1980 to about US$19 billion in 2008. India now ranks third world-wide after the USA and Japan in terms of the volume of production, with a 10 per cent share of the world market. In terms of the value of production, it ranks 14th for a 1.5 per cent global share.

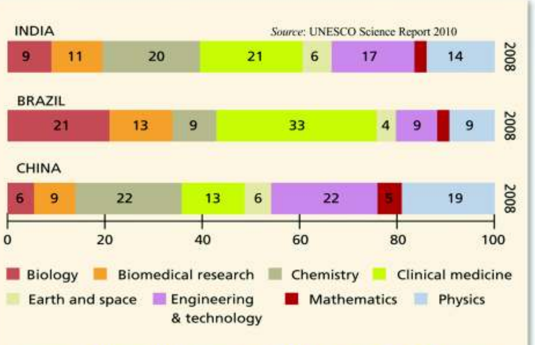
In all, there are about 5,000 foreign and Indian firms engaged in the manufacturing pharmaceuticals, which directly employ about 3,40,000 individuals. Much of industrial growth is fuelled by exports, which grew by 22 per cent on average between 2003 and 2008. The top five destinations in 2008 were, in descending order, the USA, Germany, Russia, United Kingdom and China.

The industry has four key characteristics:

- it is dominated by formulations, the process of combining different chemical substances to produce a drug, and employs over 400 active chemicals for use in drug manufacture, known as Active Pharmaceutical Ingredients;
- it is very active in the global market for generics, even supplying developed countries;
- it enables India to be self-sufficient in most drugs, as witnessed by a growing positive trade balance; and
- it is one of the most innovative industries in India, in terms of R and D and the number of patents granted, both in India and abroad.

One spin-off of India's innovative capability in pharmaceuticals is that it has become a popular destination for clinical trials, contract manufacturing and R and D outsourcing. These capabilities hold great promise for the Indian pharma industry, as an estimated US$103 billion of generic products are at risk of losing patents by 2012. Furthermore, the global market for contract manufacturing of prescription drugs is predicted to grow from US $26 billion to US $44 billion by 2015 or so. According to experts, the country has 'good' to 'high' skills in preclinical trials and Phase I clinical trials and 'very high' skills in Phase II and Phase III clinical trials.

A very recent trend observed in India's pharma industry is the wave of cross-border mergers and acquisitions in which Indian companies have taken over foreign ones and foreign firms have, in turn, taken over Indian companies. The pharma industry has become one of India's most globalised industries. One of the most high-



*Focus of Indian publications in 2008 by major field of science*
*Brazil and China are given for comparison*

profile takeovers concerns Ranbaxy, India's largest pharma company and the country's biggest producer of generic drugs. In 2008, Japanese pharma giant Daiichi Sankyo acquired a majority stake (35 per cent) in Ranbaxy, at a cost of up to US$4.6 billion.

## A sharp rise in publications

The most recent Thomson Reuters data confirm that India's strength truly lies in chemistry, pharmacology and toxicology (See Figure). The number of Indian articles recorded in the Science Citation Index have progressed rapidly, doubling between 2002 and 2008 to 36261. If this growth rate is maintained, India's publication record will be on par with most G8 nations within 7–8 years. India could even overtake them between 2015 and 2020.

## Foreign companies dominate patents

India has improved its patenting record in the USA, with an acceleration over the past decade.

Most Indian patents are utility patents, namely, those for new inventions. However, most of these patents are in chemistry-related areas and most are being granted to foreign companies located in India, based on R and D projects they have carried out in India. This is a growing trend.

Similarly, the number of national patents granted by the India Patent Office has increased tremendously, even if over three-quarters are still granted to foreign entities. Once again, most of these patents concern chemistry and pharmaceutical-related areas. Thus, although the TRIPS compliance of the Indian Patents Act appears to have had a positive effect on patenting by Indian inventors, most of the patents granted to Indian inventors both in India and abroad are going to foreign companies.

India has certainly made great strides in space research, life sciences and especially in biopharmaceuticals and IT. Although domestic science continues to dominate, there is also a growing presence of foreign entities in India's technology system.

The main challenge will be to improve both the quality and quantity of S and T personnel. Fortunately, policymakers are seized of this problem and have taken energetic steps to remedy the situation, as we have seen. The future success of India's national innovation system will depend on how well they succeed.