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India: Uneven Innovation Amid a Noisy Democracy

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Executive Summary

India has a fast-growing economy, a strong middle class, and constitutional support for freedom of expression, yet has failed to be consistently supportive of innovation. India is thus ranked number 64 on the *Global Innovation Index (GII)*. This paper provides a broad overview of innovation in India, seeks to identify specific connections between democracy and India's innovation performance, and offers an explanation for India's uneven innovation output.

The key argument of this paper is that innovation is more than ideation. For innovation to be complete, an idea has to be tested, validated, improved upon, and executed. While freedom of expression is guaranteed by the Indian Constitution, this alone is not enough to ensure ideation. Effective ideation may be blocked by other societal and cultural factors, such as the hierarchy of a traditional society that gets reflected in organisational structures and decision-making processes, and a lack of overall creative confidence. Even if this is overcome, innovation can be impaired by the absence of a supportive institutional environment, which prevents ideas from being validated and implemented. In the case of India, a lack of high quality infrastructure, absence of enough skilled manpower, and corruption across the government and regulatory framework are institutional voids which impede innovation. The argument is made that these are related to the malfunctioning of the social, political, and economic system in India, of which democracy is an important bulwark. Functioning markets, transparent regulation, and a uniform and consistent rule of law are some of the elements that need to be in place for innovation to thrive—India's present form of democracy does not provide these elements at the right level.

An outline of the historical context of innovation in India acts as a good starting point to understand innovation legacy. In the past, India's innovation capabilities and share of the world economy were constrained by British colonial rule. India missed out on the industrial revolution and the significant scientific developments of the early twentieth century. After independence, India's government tried to make up for lost time by focusing on industrial development and the development of science and technology institutions. Certain policy choices, including a focus on the public sector, for both R&D

(research and development) and industry; import substitution; and heavy regulation, resulted in the creation of some innovation capabilities but weak links with the market.

The significant economic policy changes in India during the early 1990s and the positive impact of these changes on innovation is the focus of the second part of this paper. However, in spite of the early emphasis on science and technology institutions, research output as measured by publications is low both in terms of output and quality. This is because of an over-emphasis on access and equity, and a neglect of quality in the higher education system. The strategic sectors of defence, space, and atomic energy have seen impressive technical achievements, but the impact of these has been attenuated by a lack of systems and processes to scale up the technologies created. The country's innovation potential continues to be unrealised, as reflected in its 64th rank in the 2012 *GII*.

An overview of business innovation reveals that some sectors, notably automotive and pharmaceuticals, have seen innovation across business functions, but innovation is not yet widespread across Indian industry. Barring some significant exceptions, Indian companies seem to be stuck in a paradigm of jugaad (creative improvisation) rather than embracing more systematic methods of innovation. In spite of India's demonstrated prowess in information technology, adoption of information technology by firms in India is low by global standards.

Further discussion explores the reasons why, despite the significant foreign direct investment in R&D which India is recipient of, multinational R&D centres in India tend to be disconnected from the broader innovation system. The legal framework for the protection of intellectual property rights has been strengthened in recent years, but procedural challenges and inconsistent application of the rule of law make enforcement of these rights difficult.

An overview of social and policy innovation suggests that these are bright spots but that the challenges posed by the scale and scope of India problems are daunting. The last major section of the paper focuses on the links between democracy and innovation. India's constitutional provision of fundamental rights has meant that freedom of expression has largely been upheld in India, except when it comes into conflict with extreme religious views.

A new generation of confident young Indians seems poised to overcome past inhibitions to creative thinking. However, Indian organisations are still conservative and hierarchical, and this impedes unfettered ideation.

Yet, the bigger problem may be with execution of innovation rather than ideation per se. A number of voids in the institutional environment come in the way of innovation, and make it both difficult and expensive. These voids—poor infrastructure, the absence of skilled manpower and endemic corruption—are the result of democracy that is primarily focused on elections and political power. Recent efforts by the government to support innovation do not address any of these problems. The paper concludes that unless India finds ways to make some of the important complements of electoral democracy work, for example markets, transparent regulation, and a consistent implementation of the rule of law, it will continue to be an uneven innovator.

Introduction

India is a vibrant democracy with dynamic political parties, hard-fought elections, and smooth transfers of power. Its constitution offers a range of fundamental rights including the freedom of expression and its legal system, at least at the highest levels, zealously guards these rights of citizens. Such a milieu might have been expected to support the flowering of ideas and their application, in order to solve a whole range of problems. Yet, India remains, at best, an 'uneven innovator'.

To understand why this is the case, this paper explores the political, social, and economic dimensions of innovation in India. Understanding the contours of innovation in India is helped by having a clear historical context, since India's innovation performance has been shaped by historical events, policy choices, and cultural features. Therefore, this paper begins by taking a bird's-eye view of innovation in India, from before independence to the advent of economic liberalisation in the early 1990s, before turning to a more focused review of innovation in India over the last two decades. This review includes: an overview of innovation during that time, science and technology, business innovation, multinational innovation in India, protection of intellectual property rights, social innovation and policy innovation. The section concludes with an identification of the barriers to innovation in India.

The aim of this section is to address how democracy has influenced innovation in India by discussing three themes: democracy, education, and innovation; democracy, entrepreneurship, and innovation; and creative confidence and ideation. Within the discussion, some of the new initiatives and policies taken to enhance innovation in India will be reviewed, and consideration will be given to the impact these are likely to have on the overall innovation scenario.

Innovation in India: the Historical Context

A country with strong innovation heritage but which missed the industrial revolution

As an ancient civilisation with a rich intellectual and cultural heritage, India was known for seminal contributions to the development of algebra, geometry, and mechanics. This rich heritage was built upon over the centuries, and India was a major contributor to the global economy. Some estimates suggest that India accounted for as much as 24 percent of the world's GDP in 1700.

However, with the entry of the British East India Company into India in the seventeenth century, and the subsequent formal annexation of India as a part of the British Empire, India was under colonial rule for close to two hundred years until its independence in 1947. India became a part of the traditional colonial economic model—a supplier of raw materials, and a recipient of finished goods from the British. As a result, India largely missed out on the industrial revolution, and instead became a supplier to the British industrial machine. The country became increasingly impoverished. At independence in 1947, India was one of the poorest countries in the world and its share of world GDP declined to four percent by 1950.

In addition to a failure to capitalise on the industrial revolution, India was also left behind in the major strides taken in science and technology in the late nineteenth and early twentieth centuries, a very fertile period for global science and technology. There were very few scientific or research institutions in India at the time of independence, and the university system was also restricted to a few pockets of the social elite.

However, there was one arena in which India demonstrated powerful new ideas—the way the country won its freedom. Under the leadership of Mahatma Gandhi, India followed a unique non-violent path to freedom based on civil disobedience and satyagraha (nonviolent resistance). Gandhi managed to galvanise a country that was historically stratified by caste, region, language, and religion to participate in a distinctive movement to oust one of the world's strongest colonial powers.

Post-independence efforts

India's political leadership, particularly India's first Prime Minister Jawaharlal Nehru, who led India from 1947 to 1964, was keen to make up for lost time. Nehru, who had studied at the University of Cambridge, was aware of the advancements of science and technology in the West. He believed that science and technology could transform India, and was determined that India should join the ranks of the global scientific community. Therefore, in spite of India's precarious financial position, India invested in creating science and technology institutions in the years after independence. The government's commitment to science and technology was formally enshrined in the Scientific Policy Resolution of 1958.

The formal innovation system in India became centred on national laboratories set up by the government in different networks. These consisted of a civilian network around the Council of Scientific and Industrial Research (CSIR); a defence network around the Defence Research & Development Organisation (DRDO); an agriculture research network around the Indian Council of Agricultural Research (ICAR); the Indian Space Research Organisation (ISRO); and the Department of Atomic Energy (DAE). On the academic research front, prominent institutions including five Indian Institutes of Technology (IITs) were set up in the 1950s and 1960s. Thanks to the establishment of these networks, India developed a sizeable science and technology workforce.

Social innovation also took an important leap in the early years after independence, as India successfully adopted a democratic, secular constitution. In retrospect, it is clear that the constitution provided a sound framework for the balance of diverse identities (religion, region, and language) with citizenship of the country. India took a major leap of faith as it decided to adopt universal adult suffrage straight away, in spite of high poverty and illiteracy levels. In the 65 years since independence, this framework has held up well except for the two years of emergency rule in the mid-1970s.

Role of industrial policy

For the benefits of science and technology to percolate into society, R&D has to be translated into improved processes, products, or services. Firms play a prominent role in linking invention and discovery to economic outcomes. Some choices made by India in the past relating to industrial policy had an impact on the extent to which this translation of R&D into economic benefits occurred.

While India adopted a mixed economy framework, the public sector was seen as the bulwark of the Indian economy. Under the Nehruvian development model, the emphasis was on setting up capital-intensive mother industries such as steel, machine tools, and other capital goods, and these were set up under public ownership. As the technologies required to set up these industries were not available locally, they had to be sourced from outside the country. For geopolitical reasons, the principal source of technology was the Soviet Union and other Eastern European countries. However, none of the local R&D institutions were involved in the technology transfer process. The public sector companies themselves enjoyed a high degree of protection, and were therefore under little pressure to improve productivity or expand their range of products. Hence they lacked an incentive to work with the R&D system.

Even in those industries in which the private sector was present, high levels of effective protection for the local economy and an elaborate licensing system meant that firms were under little pressure to make improvements or add on new products. Symptomatic of this was the production of motor cars in India by two private players (Hindustan Motors and Premier Automobiles), whose models remained largely unchanged for about 20 years after they licensed the designs from European companies.

While India developed good science and technology capabilities by developing country standards, the translation of these capabilities into benefits to the larger economy remained limited. Formal innovation in the industrial sector remained constrained, with most Indian firms remaining dependent on foreign sources of technology.

The only large-scale exception to this was the green revolution. Food shortages and the humiliating experience of having to seek emergency food aid from other countries in the early 1960s led the government to pursue the use of improved agricultural methods to enhance farm productivity. Under the leadership of Mr C. Subramaniam, a senior politician; Mr B. Sivaraman, a committed administrator; and Dr M. S. Swaminathanan, an agricultural scientist; together with the support of international agricultural research institutions, the country developed, adopted, and diffused hybrid varieties of wheat and rice, which have since become the mainstay of India's food security.

Innovation outside the formal innovation system

Amid this trajectory of the formal innovation system, local ingenuity did find expression. Traditional medicine systems that had been handed down through oral communication across generations continued to thrive. Farmers in different parts of the country improvised methods and tools to enhance their own productivity or make farming easier. Businessmen focused their ingenuity on finding ways to circumvent the complex controls that governed their existence.

Perhaps the most prominent display of local ingenuity that had a positive societal impact was in the social sector. Two examples stand out: the Jaipur Foot, and Aravind Eye Care System.

The Jaipur Foot, a low-cost prosthetic limb, which could be custom-fit for persons who had lost their limbs, was diffused across the country thanks to the Bhagwan Mahaveer Viklang Sahayata Samiti, a charitable organisation that took on the task of training technicians and sharing its know-how. The Jaipur Foot uses local materials, is easy to fit and replace, and only costs around 35 US$.

Aravind Eye Hospitals were founded in 1978 by Dr G. Venkataswamy ('Dr. V.'), an ophthalmologist who had retired from the government health service. Dr Venkataswamy understood that many people lost their vision due to untreated cataracts, and that removal of these cataracts at low cost could lead to the elimination of 'needless blindness'. Over the next two decades, he and his team at the Aravind Eye Hospital in Madurai, focused on improving the efficiency of the cataract removal process by using doctors, whose time is expensive, for only for the most critical parts of the cataract surgery, and training paramedical staff to carry out the less complex steps of the cataract removal process. Thanks to these changes, Dr Venkataswamy and his team were able to streamline cataract surgery into an assembly-line process, thus drastically reducing the cost of surgery. Aravind Eye Hospitals have used this modified process to do thousands of free cataract surgeries for poor patients, with the cost of their surgeries borne by fee-paying patients who subsidise the free surgeries.

Innovation policy framework

Prior to 1991, innovation policy support in India was largely focused on funding R&D in the government-owned and operated R&D system, and on supporting academic research in government-funded institutions. There was some financial support available for technology development and commercialisation in public sector enterprises, but no such support was offered to private enterprises. The only significant public fiscal support for private sector innovation was through accelerated deductions of R&D expenditure from income calculations used for the computation of taxable income. However, the government did support one kind of low-cost innovation explicitly; by excluding product patents on drugs from the intellectual property rights regime, the government encouraged the creation of an indigenous drug industry with advanced capabilities in developing low-cost drug development processes.

While India struggled to take inventions from the laboratory to production on an industrial scale, major social and economic challenges also remained. Literacy in India had reached only 52 percent in 1991, with female literacy at only 39 percent. The caste system continued to constrain social mobility and poverty remained endemic. Government programmes for social and economic development had achieved only limited success.

THE STATE OF INNOVATION IN INDIA TODAY

Starting in the mid-1980s, India started a gradual process of economic deregulation. This process picked up momentum from 1991 when the industrial licensing system was largely dismantled and India became more open to trade in both directions, with restrictions on import of technology removed. These changes were expected to unleash economic growth and there was an expectation that innovation would increase as many of the demand-side constraints to innovation were removed or weakened.

In recent times, growing evidence of the importance of innovation to economic growth and prosperity has induced many efforts to measure innovation at a national level. Each of these attempts at measurement emphasises a different set of variables. For example, the United Nations Conference on Trade and Development (UNCTAD) Innovation Capability approach is based on human capabilities, and therefore focused on human development indicators, the Georgia Institute of Technology approach uses high-tech exports as a proxy for innovation sophistication, and the Economist Intelligence Unit uses patents as its primary measure. However, as I showed in my book *From Jugaad to Innovation: The Challenge for India*, irrespective of how you measure innovation, India is a laggard on innovation performance.

A few years ago, INSEAD and the World Intellectual Property Organisation (WIPO) launched a joint effort to develop a comprehensive innovation index, the *Global Innovation Index (GII)*. Apart from the *GII* itself, the *GII* methodology involves the

computation of three other indices: an *Innovation Output Index*, an *Innovation Input Index*, and an *Innovation Efficiency Index*.

The *Innovation Input Index* rests on five pillars: institutions, human capital and research, infrastructure, market sophistication, and business sophistication. The *Innovation Output Index* consists of knowledge and technology outputs and creative outputs. The *Innovation Efficiency Index* is based on the ratio of innovation output to innovation input.

India's position

India ranked in the middle of the *GII* 2012 with a rank of 64 out of 141 countries. India's rank remained virtually unchanged from a rank of 62 in 2011. India was ranked 40, 96, and 2 respectively on innovation output, input, and efficiency indices.

To get a clearer sense of where India stands, it is useful to compare India with China. China does much better on the *GII* with a 2012 rank of 34. It was ranked 19, 55 and 1 respectively on innovation output, input, and efficiency.

China outranked India on three of the five input pillars with a rank difference of 40 to 50 places. China was marginally ahead of India on the other two input parameters—institutions and market sophistication.

On the output side, China ranked at 5 globally on knowledge and technology outputs while India came in at 47. This reflects the fact that, thanks to China's strong position in electronics manufacturing for the global market, China's high-tech exports account for 44.59 percent of its total manufactured exports while for India the corresponding figure is only 16.94 percent. The only output measure in which India surpassed China was creative outputs.

The raw scores that underlie the ranks reveal some interesting contrasts:

- China does much better than India in institutional factors like ease of resolving insolvency and ease of paying taxes.
- The biggest differences between India and China are in the education-related indices of reading skills (India scores 4.41 against 100 for China) and pupil-teacher ratio.
- China's score in gross expenditure on R&D is twice that of India.
- China's score in ISO 14001 environmental certificates is about seven times than that of India.
- China's higher score in business sophistication comes from the proportion of firms offering formal training to their employees (16 percent for India vs. 85 percent for China), R&D performed by businesses (34 percent for India vs. 72 percent for China), and high-tech imports (this is reflective of China's position in high technology manufacturing vis-à-vis India).

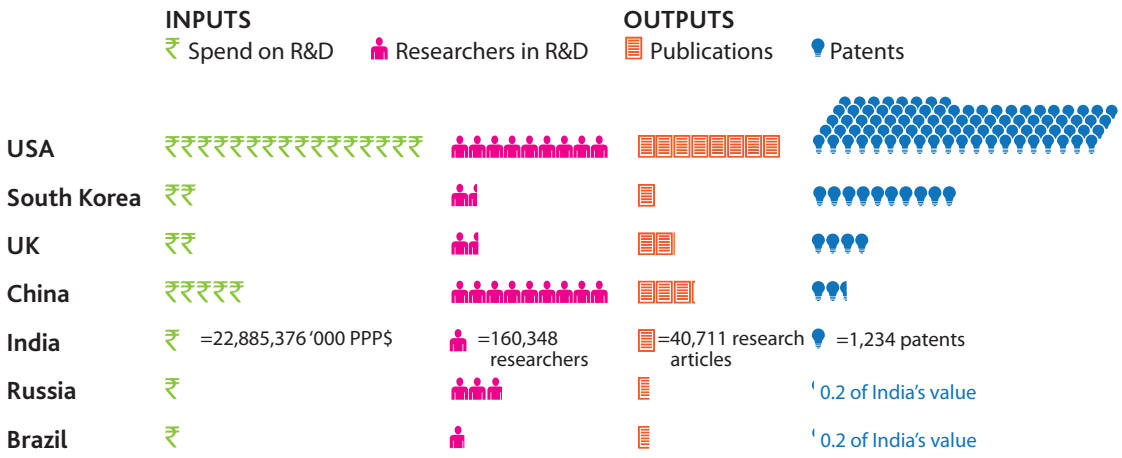
India's bright spots (when compared to China) are on the parameters of press freedom, efficiency of energy use, ease of getting credit, and services exports.

To sum up, this comparison of India and China clearly reveals that India has the advantage of democratic institutions such as free media and freedom of expression, but factors such as inadequate attention to infrastructure and education, low investments in research, and the absence of business sophistication are holding India back from achieving higher innovation output.

This picture is corroborated by a recent report prepared by Nesta. Figure 1, reproduced from that report, shows where India stands in comparison with other BRIC countries and some advanced economies. The performance of India's formal innovation system is clearly behind that of China.

FIGURE 1: COMPARISON OF INDIA WITH OTHER COUNTRIES ON INNOVATION INDICATORS

SOURCE: BOUND, K., AND I. THORNTON (2012)."OUR FRUGAL FUTURE: LESSONS FROM INDIA'S INNOVATION SYSTEM," NESTA REPORT, JULY.



The following sections will focus on different areas and sectors of innovation in contemporary India.

Science and technology: publications

Indian science and technology has gained significant achievements in strategic applications such as missiles, rockets, nuclear weapons, and spacecraft. In these sectors, the challenges have been in scaling-up and not in the application of science and technology per se. Despite India's early decision to invest in science and technology, India scientific output as measured by publications shows India struggling to keep up on both quantity and quality.

India's share of global publications (based on publications in SCI journals) is around 3.5 percent and the country ranks ninth in number of publications. This share reflects a recovery in research output; while India's share of publications was more than 3 percent in 1981, it dropped to almost 2 percent in 1997 but has since maintained an upward trajectory. According to one key policy-maker, this drop was due to a decline in funding for research, and the recovery occurred once funding levels improved.

China produced almost three times as many papers as India in 2008. However, as noted in the previous section, one reason for China's higher output is its higher investment in R&D. China had almost nine times the number of full-time equivalent personnel in R&D and spent close to 1.5 percent of its GDP on R&D in 2007 against India's 0.9 percent. It is also notable that India's R&D intensity has remained around this 0.9 percent level for close to two decades.

India's top five disciplines in terms of number of publications are chemistry, physics, clinical medicine, engineering and material science. Surprisingly, mathematics and computer science, often considered areas of strength for India, do not feature in the top ten.

The quality of Indian publications is also a concern. Citation impact of Indian publications nearly doubled between 1981—85 and 2006—10 but is still below the global average. The share of Indian publications in the top 1 percent of impact-making journals was only 0.54 percent in 2001. Around 2.5 percent of India's publications are in these top journals. A positive trend is that the number of papers in such journals is on the increase with engineering, chemistry, clinical medicine, and materials science accounting for 60 percent of the increase of Indian publications in such journals. Approximately 45 percent of Indian papers (2006—10) are not cited at all compared to 25 percent of papers from the developed world.

India's struggle to enhance research output is perhaps due to a lack of emphasis on research and quality in much of the higher education system over the past few decades. In fact, India has no institution of higher learning within the top 200 universities in the world, and only one institution in the top 500. Though, as mentioned in the introductory section, India under Nehru created high-quality technology institutions in the 1950s and 1960s, the government did not sustain this momentum. For example, after the first five IITs were set up in the early 1960s, the next IIT at Guwahati was not set up until the 1980s. Resource constraints, other priorities, and the lack of demand for highly qualified engineering talent are the likely reasons for this. In the meantime, the university system declined

due to poor funding, political interference, and the absence of objective faculty recruitment and appraisal systems.

When demand for talent surged in the 1990s with the success of the deregulation process, the gap was filled by a mushrooming of private institutions. This happened without the creation of a coherent policy or regulatory framework. Many of these institutions were set up by businessmen and politicians who could navigate the opaque system, but had little commitment to, or knowledge of, what constitutes good quality higher education. Driven by populist considerations, the government has intervened to ensure access (by regulating fees) and equity (by mandating affirmative action policies). However until recently there has been no concerted effort to improve quality.

While elite institutions like the IITs stand a cut above the rest in India on research output, their research output is substantially below the world's best. According to an analysis made by IIT Kanpur, the IITs research productivity is about one-tenth of the world's best institutions. Some of the reasons for this include inadequate funding, weak postgraduate programmes (the traditional emphasis of the IITs has been on undergraduate programmes), and the absence of strong faculty appraisal systems.

Science and technology: strategic sectors

As noted in the previous section, science and technology-based innovation in the strategic sectors has faced a different challenge—that of scaling-up. The problem of scaling-up has been particularly acute in public sector R&D, such as in defence. For example, India has been developing a Light Combat Aircraft (LCA) since the mid-1980s. Though prototypes have been demonstrated, the aircraft is yet to fly in a squadron of the Indian Air Force. India's difficulties in the area of large complex high technology projects are systemic, and can be attributed to:

1. Overly-exacting specifications: The first challenge in creating defence products from India is the product specifications. A common criticism of the Indian armed forces is that their specifications are often a combination of the best performance on each parameter offered by different vendors. A product with such a combination of characteristics is either unavailable anywhere, or if it exists, is exorbitantly expensive.
2. Lack of clarity regarding what local development means: Designing a product locally does not mean that all components and sub-assemblies have to be made locally. In fact, one of the key decisions to be made is what will be done locally and what will be sourced from elsewhere. Much is made of the fact that India has not been able to develop its own engine for the LCA, however, aircraft companies rarely design or make engines themselves. Most defence products require higher grade components with MIL certification. For many components, it is cheaper to import from existing suppliers than design and manufacture them in India to MIL standards.

3. Lack of technological competence in advanced technologies: Complex products require advanced competence in diverse areas. Often, India does not have companies or institutions that have the required level of competence in each of these areas. Even when available, such skills may be relatively shallow and limited in scope. When the skills exist in the academic or research institutions, they may not be application-oriented.

4. Inadequate number and frequency of experimentation and testing cycles: While complex products are today largely designed using computers (the Boeing 777, for example, was designed predominantly based on simulation through CAD/CAE), some amount of physical prototyping and testing is always required. Rapid testing, using low cost mock-ups and prototypes, wherever possible, is critical to completing the project quickly. However, design of complex systems in India is undermined by inadequate resources for experimentation and testing, and complex and time-consuming bureaucratic processes. This results in overly long development cycles.

5. Design/development and production gap: After independence, India adopted the Soviet model of separation of design and development from production. As a result, India has a huge network of government-owned and operated research and development laboratories and facilities, and a separate network of production units and factories (like the ordnance factories in the case of defence). The separation of R&D from production is particularly detrimental to the commercialisation of new technologically-intensive products. Designers tend to be relatively insensitive to concerns of manufacturability or support, hence the product can prove difficult to manufacture in large volumes, or at a reasonable cost. The manufacturers have inadequate know-how and know-why, and, in the process of trying to make manufacturing more streamlined, they make changes to the product or process that make it deviate from the required specifications. Commercialisation of complex technologies requires close co-operation between R&D, engineering and production, and this becomes more difficult if this involves crossing organisational boundaries.

6. Lack of tacit knowledge: Successful 'productionisation', or commercialisation of products involves, the generation and retention of a large amount of tacit knowledge. Successful product companies build huge internal repositories (both informal and formal) of such tacit knowledge. It is this knowledge that helps them avoid repeating the same mistakes or being able to move ahead rapidly when a project gets stuck. Building this knowledge necessitates going through multiple product development cycles and finding ways of capturing and building on such knowledge from one project to another. In complex product development like aircraft design, India has not gone through a complete project cycle even once. That is a major disadvantage.

Business innovation

The Indian business sector has grown rapidly since liberalisation. As of 2010, there were 141 publicly-listed companies in India with annual sales exceeding US$ 1 billion. Some of the sectors in which Indian companies have made a name for themselves include information technology, pharmaceuticals, and automobiles.

Over the last two decades, India has become a major player in the Information Technology (IT) services industry, with top firms such as Tata Consultancy Services and Infosys counted among world leaders in this industry. The Indian IT services industry can take credit for pioneering the 'global delivery model', a new way of developing and delivering customised software from development centres strategically located across the globe, taking advantage of distributed skills and lower costs. Firms in other industries including telecom services have created new business models that enable the delivery of low-cost services on a large scale. However, Indian IT companies spend only modestly on R&D as the services model in which they operate has not needed major investments in R&D so far.

While technological innovation has not been the focus of Indian companies, some of them have embraced product and process innovation to enhance competitiveness. The automotive industry (including Tata Motors, Mahindra, and Bajaj Auto) has been successful in developing new products that have attained dominant positions in the domestic market. The generic pharmaceutical industry is renowned for its ability to find alternate processes to manufacture drugs that bring down the costs substantially. Between them, the pharmaceutical and transportation sectors account for more than 60 percent of R&D expenditure incurred by companies in India.

However, the dominant innovation paradigm in Indian companies has been a form of creative improvisation, colloquially referred to as jugaad. At its best, jugaad represents a frugal, 'good enough' approach to innovation. Yet a reliance on jugaad has often meant quick-fix, non-robust, and non-scalable solutions. This approach has its roots in a combination of resource scarcity and a complex regulatory system. However, even after 20 years of economic deregulation, most Indian companies remain stuck in this paradigm and have not embraced a more planned, structured, or systematic approach to innovation. Among Indian entrepreneurs, even in large business houses, the fear of systematic innovation is that it will hamper them from being opportunistic, and prevent them from being agile and quick.

The negative side of sticking to jugaad is that Indian companies are missing out on the potential advantages of systematic innovation, such as:

- Enhancing the number of ideas being generated and considered so as to improve the odds of innovation success;
- Better alignment of innovation with market needs thanks to greater structured connections with consumers and other stakeholders;

- Making innovation more robust and scalable thanks to a focus on experimentation and testing to check out assumptions, refine, and reinforce ideas;
- Leveraging the power of many rather than depending on the intelligence of a few;

Some years ago *India Today* magazine asked me whether I could identify the top 10 technology or product innovations by Indian companies during the decade of 2000—2010. I accepted the invitation thinking it would be a straight forward task. But when I applied the twin criteria of novelty and impact, I struggled to find 10 outstanding innovations.

I first thought this was because Indian companies don't set their sights high enough when it comes to innovation. But it also raised the question of if Indian companies simply are largely unable to create the environment in which innovation is possible.

The answer varies across sectors. The Indian pharmaceutical industry has seen some ambitious efforts to develop new drugs. Parvinder Singh at Ranbaxy, Anji Reddy at DRL, Glen Saldanha at Glenmark, Pankaj Patel at Zydus Cadila, and Kiran Mazumdar at Biocon have invested substantial resources in their efforts to create new chemical entities, even if these efforts have not been commercially successful so far. The automobile industry has taken significant strides as well, but in a step-by-step fashion: companies such as Tata Motors and Mahindra first developed new vehicles (Indica and Scorpio respectively) with considerable involvement of foreign suppliers and consultants, but have graduated to doing more internal development in some of their recent product development projects. These two industries deserve commendation for their efforts.

However, in some other industries there is clear evidence of what can be described as an 'aspiration deficit'. The IT industry is a case in point. It prides itself on its talent, and the leading companies are financially stable, but there has been a lack of imagination and a reluctance to commit resources to high-impact innovation projects.

Many Indian companies tend to fear the risks involved in technology-oriented innovation. They see R&D as a bottomless pit that eats up lots of resources but often does not deliver commensurate results.

As a function, R&D has a credibility problem. The source of this is partly historical—public research institutions, where most R&D in India was performed in the past, developed a reputation for incomplete technologies or exaggerated claims. Yet the problem is institutional as well; very few of India's academic institutions are oriented towards application-driven research, so when graduates join industry they struggle to cope with the demands of industrial R&D. Finally, there is an organisational dimension to this problem: there are many ways of managing the risks of R&D, including building a robust innovation pipeline (instead of depending on the prospects of one or two innovations), using alliances, in-licensing and out-licensing (where appropriate), and understanding technology trends and evolving needs of customers well, but these practices are not widespread in Indian industry.

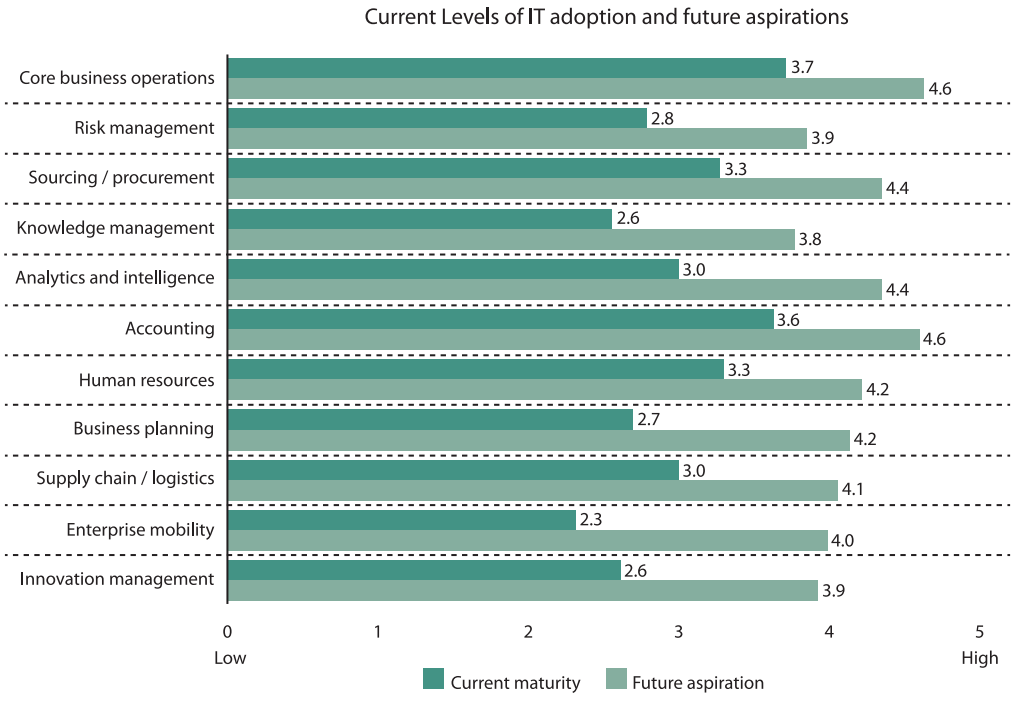
Technology adoption & diffusion: the case of information technology

Though India is considered a superpower in IT, thanks to the size and dynamism of its IT services industry, this industry has been primarily externally-focused. Most large IT services companies earn more than 90 percent of their revenues from developed markets, particularly the US and Europe.

While it is well documented that productivity growth in the developed world in the last two decades has come mainly from technology adoption (particularly that of IT), Indian industry has not been at the forefront of technology adoption. India's spend on IT is less than 1 percent of GDP compared to a global average of 2.5 percent. Indian companies have a lower level of IT adoption than their global counterparts. There is a high degree of variation in IT adoption across industries, with banking and telecom being much closer to global best practice, and healthcare and education being much farther away. IT management capabilities in IT user industries are also reported to be weak (see Fig. 2).

FIGURE 2: IT ADOPTION IN INDIAN COMPANIES

SOURCE: BCG-CII REPORT ON IT ENABLEMENT OF INDIAN BUSINESS: IT FOR INDIA—NEW HORIZONS, NEW OPPORTUNITIES. NEW DELHI: BOSTON CONSULTING GROUP AND CONFEDERATION OF INDIAN INDUSTRY, MARCH 2013, P.15.



FDI in multinational R&D

The inception of an R&D centre in India by Texas Instruments in 1985 started a trend of Foreign Direct Investment (FDI) in R&D by multinational corporations (MNCs). Recent reports indicate that today more than 850 MNCs have R&D centres located in India. These were originally started as extensions of the R&D centres in their home countries to augment R&D capacity at a low cost by using the talented manpower available in India. Over time, these centres have enhanced their capabilities, evolving into centres of excellence and, in some cases, spearheading R&D efforts directed at India and other emerging markets. Multinational corporations accounted for 2609 of the 4888 patents (53 percent) awarded by the US Patent and Trademark Office (USPTO) to inventors based in India between 1995 and 2008 (see Table 1). Representing their dominance of patenting activity in the fields of electrical engineering and information technology, they accounted for 1789 of the 1961 patents (91 percent) awarded by the USPTO to Indian inventors in these domains during the same period.

TABLE 1: US PATENTS GRANTED TO INDIAN INVENTORS OR INDIAN ASSIGNEES

COMPILED BY SWARNA KUMAR VALLABHANENI FROM WWW.USPTO.GOV

SOURCE: KRISHNAN, RISHIKESHA T. (2010). *FROM JUGAAD TO SYSTEMATIC INNOVATION: THE CHALLENGE FOR INDIA*. BANGALORE: UTPRERAKA FOUNDATION.

	1976-1994					1995—2008				
Field	MNC	Indian Corp.	Indian Res./ Acad.	Others	Total	MNC	Indian Corp.	Indian Res./ Acad.	Others	Total
Chem	158	19	40	69	286	432	651	962	203	2248
EE/IT	28	1	1	11	41	1789	66	44	62	1961
Instr.	13	2	1	22	38	255	23	54	55	387
Mech.	22	8	2	24	56	101	46	23	46	216
Other	2	3	1	8	14	23	6	3	17	49
Total	**223**	**33**	**45**	**134**	**435**	**2600**	**792**	**1086**	**383**	**4861**

One limitation of the MNC R&D centres in India has been their poor links to the broader Indian innovation system. This has meant that the spillover from these centres to the broader economy has been limited.

Protection of Intellectual Property Rights

Independent India started off with a fairly strong intellectual property protection system, a carryover from the system that protected the rights of British inventors under the colonial regime. However, there was growing disquiet about this system in the first two decades after independence, particularly in the area of pharmaceuticals, where strong patent-protection was seen as enabling multinational drug companies to extract monopoly profits from a poor country.

This culminated in India making important amendments to the Patents Act, including the removal of provisions to patent new molecules, and providing relatively short periods of patent protection in all cases. The new legislation—the Patents Act, 1970—is commonly credited with the growth of India's generic pharmaceutical industry (based on an ability to create new processes for known drugs and scale them up effectively) as well as of the lowest priced drugs in the world.

By the 1990s, many things had changed. Globalisation was the order of the day, and India also moved towards globalisation, joining international talks aiming to provide a supportive environment for global trade. These talks expanded in scope to incorporate intellectual property protection. In 1995, India signed up for the World Trade Organisation treaty and promised to put in place stronger intellectual property laws by January 1, 2005.

Though the law was changed, the procedural aspects of patenting have taken time to catch up. One of the important characteristics of a good patent system is easy availability of information about which patents have been issued. For several years this was a major problem in India, with such information not available online. Even now, though there is an online database, it is nowhere near as powerful or comprehensive as the USPTO's website.

Another important procedural issue is the speed with which the Patent Office considers applications, and the quality of the examination process. The importance of this dimension was recognised some years ago and a drive to hire and train patent examiners was launched. However, the job is underpaid so the government has found it difficult to attract qualified personnel at the salary offered.

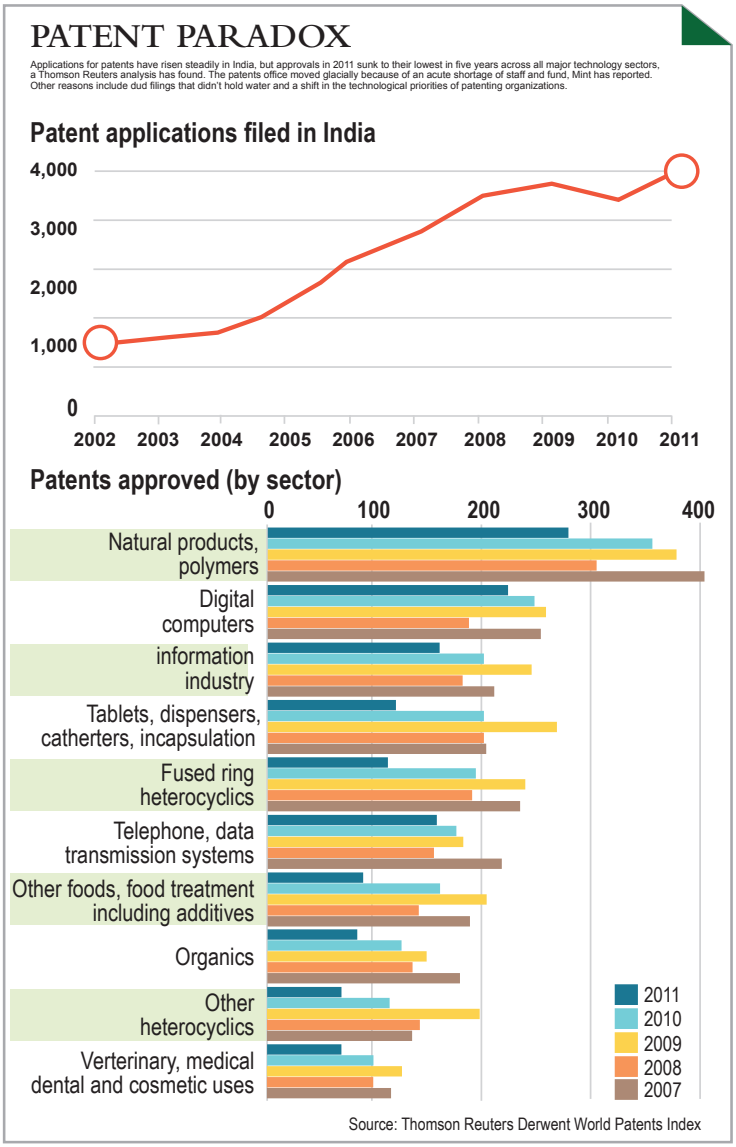
While it is difficult to judge the quality of patent examination, it is clear that after an initial spurt in the speed of examination and the speed at which grants are offered, process has slowed down again at a time when the number of applications is on the increase (see Fig. 3).

There has been reasonably widespread acceptance of the amendments to the Patents Act made in 2004, 2005, and 2006 except for two issues. The first issue is the now infamous Section 3(d) that seeks to prevent 'ever greening' by pharmaceutical companies by requiring a major inventive step, as reflected in enhanced therapeutic value, for a molecule to be awarded a patent. This has been a contentious issue since the new patents legislation was announced, and a series of refused or cancelled patents to big name pharmaceutical companies shows that the law has bite.

The second issue relates to compulsory licensing. On March 9, 2012, the Controller General of Patents issued the first post-2005 compulsory licence to Natco Pharma to manufacture its equivalent of Bayer's Nexavar, a drug designed for the treatment of kidney cancer. Issuing the licence to Natco Pharma has raised a number of contentious issues, such as what is a reasonable price for a drug, what constitutes 'working' a patent, and what is the appropriate royalty to be paid to the inventor company in the event of compulsory licensing?

FIGURE 3: PATENT FILINGS AND GRANTS AT INDIAN PATENT OFFICE

SOURCE: *MINT* NEWSPAPER.



Most of the controversies regarding the new patent law in India have centred on the pharmaceutical space. In this area, the Indian government has clearly come on the side of public health concerns and the importance of keeping drug prices low rather than ensuring the profitability of the pharmaceutical industry. This is a strong demonstration of concern for public support, which is critical to retaining power in a democracy.

Consistent with their position in other matters, Indian courts tend to be conservative in penalties and awards for intellectual property violations, unlike the multi-million dollar (or even multi-billion dollar) awards of American courts. This stance is a positive one because it prevents intellectual property from becoming a separate game of corporate strategy. However, there is the distinct possibility that an inventor may not receive adequate compensation for any infringement of their intellectual property rights. This can be particularly detrimental to the small inventor, who fights a David vs. Goliath battles if the infringer is a large company with the ability to exploit all the procedural opportunities for delay available in the Indian legal system.

Social innovation

Indian organisations have been at the forefront of healthcare innovation through the evolution of business models that deliver low-cost yet high-quality healthcare. Madurai-based Aravind Eye Care System, discussed in the introductory section, has been at the forefront of this revolution. Today, the Aravind Eye Care System model, which was originally developed for cataract surgery, has been the inspiration for hospitals taking on more challenging tasks such as retinopathy and in domains such as maternity care (e.g. Lifespring Hospitals, Hyderabad) and cardiac care (e.g. Narayana Hrudayalaya, Bangalore). In the process, the principles of low-cost healthcare have been well defined, making them applicable to more domains in the field. The three core principles are massive scale, focus on paraskilling, and a relentless focus on optimising scarce resources.

In recent years, there has been a focus on 'grassroot innovators'—innovators primarily from rural India, unlettered in a formal sense but highly practical in solving local problems. In the late 1980s, the Honey Bee Network was formed by Professor Anil Gupta and others to identify and document such innovations. A decade later, this movement gained government support with the creation of the National Innovation Foundation (NIF), and gathered further momentum during the tenure of eminent space-scientist Dr A. P. J. Abdul Kalam as President of India (2002—2007). Dr Kalam started the tradition of providing the inspiring environs of Rashtrapati Bhavan (the residence of the President of India) to felicitate outstanding grassroot innovators, and this practice has been sustained since then. In fact, the democratisation of innovation is championed by policy-makers and is now often mentioned by senior leaders of the government.

Policy innovation

In recent years, India has witnessed some policy innovations, particularly related to the social sector. At the urging of Sonia Gandhi, the Chair of the United Progressive Alliance government that has been in power since 2004, the government constituted a National Advisory Council (NAC) in May 2004. The NAC members are academics and social activists from outside government. The NAC has been instrumental in crafting a social agenda for this government.

The NAC can take credit for two recent government policy innovations that have made a major difference to the country. To fill the gap caused by the absence of a national social security net, the National Rural Employment Guarantee Programme, launched in 2005, guarantees 100 days of paid labour to one member of every family below the poverty line. The Right to Information Act, also passed in 2005, gives citizens the right to obtain information from any government agency in the country. While the former ensures a degree of economic stability that is a necessary pre-requisite for a functioning democracy, the latter acts as an important lubricant for democracy as well as a check on corruption and arbitrary government actions.

Two new initiatives—the Right to Education (RTE) Act and the Unique Identity (UID) programme—may also have a transforming impact. Already, the RTE Act has opened the doors of private schools in large cities to children from under-privileged backgrounds. The UID programme seeks to create financial inclusion and to act as a conduit for government transfer payments to citizens. A third initiative—a Right to Food programme was passed in 2013.

Taken together, these major programmes have the potential to create a well-nourished, better educated, and better informed citizenry that could enable innovation in India to move on to a higher plane. However, there is also the danger that these programmes could impose an unbearable burden on the government exchequer, create new opportunities for corruption, and engender an increasing dependence of people on the government.

More specifically, policy innovation to support innovation is also possible. India has a long history of individual policy-makers who have contributed to such policies. A recent example is Dr M. K. Bhan, who implemented a number of initiatives as secretary of India's Department of Biotechnology (DBT). When Dr Bhan took over, the DBT already had a good track record of supporting innovation and changing its innovation strategy to match the evolution of the field in India. During his tenure, Dr Bhan focused on industrial research, commercialisation, and creating the foundation for a strong industrial base in biotechnology.

Under Dr Bhan's leadership, the DBT pioneered initiatives such as the Small Business Innovation Research Initiative (SBIRI) and the Biotechnology Industry Partnership Programme (BIPP), which have the potential to change the innovation landscape in the biotechnology industry. The DBT has set up a separate non-profit company, the Biotechnology Industry Research Assistance Council (BIRAC), which is the DBT's window to emerging biotechnology companies. The DBT's initiatives cover the whole spectrum of innovation, from ideation to scaling-up to commercialisation. DBT typically provides 30—50 percent of the funding required for discovery-led innovation under these programmes. While the funding is in the form of outright grants to small companies, in the case of large companies the support is mainly in the form of low-interest loans.

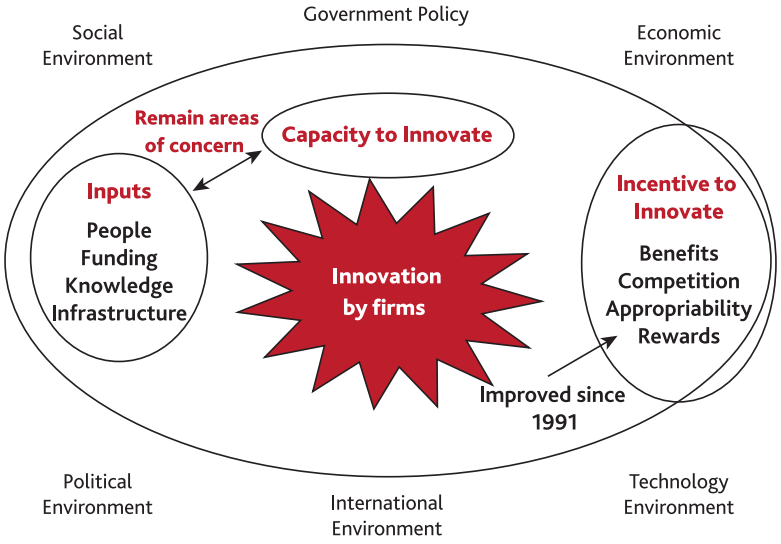
Dr Bhan supported the creation of collaborative programmes including the Stanford India BioDesign programme; the DBT Centre at IIT Madras Research Park, which is providing a platform for eye hospitals to collaborate; the Indian

Institute of Science and St John's Medical College 'glue grant', which encourages collaboration between these two institutions that despite being in the same city probably had little interaction earlier; the Wellcome Trust and DBT initiative on affordable healthcare; and the grand challenges programme launched in collaboration with the Gates Foundation and Canada.

Barriers and challenges to innovation

Earlier research, corroborated by the analysis in this paper, shows that for a number of reasons, India is unable to be the source of major industrial innovations on a sustained basis, even though it has skilled talent and a penchant for jugaad. Figure 4 shows the challenges in innovation as faced by India today.

FIGURE 4: CHANGE IN INDIAN INNOVATION SCENARIO, POST-1991



Firms are the primary agents of industrial innovation. While the incentive for innovation by firms in India has improved after economic liberalisation began in 1991, the inputs for innovation by firms (funding, trained people, and basic research and development) have not kept pace with firms' needs. At a broad level, firms have failed to build an innovation capacity because of issues of ownership and control as well as a number of deeply embedded social and cultural barriers to innovation, including poor teamwork, the enduring importance of upward hierarchical progression, and a weak systemic and strategic orientation. However, firms have also failed to invest in creating a more robust and systematic innovation paradigm within their organisations. This is a failure of leadership, and of strategic intent.

The government's efforts to enhance the availability of inputs to the innovation process have been ineffective because of the lack of a strategic and integrative vision, inadequate resources, and poor implementation.

DEMOCRACY AND INNOVATION

It is clear that India has pockets of innovation, but, has not, overall, been able to fulfill its innovation potential. The role of democracy in either supporting or impeding innovation in India is a crucial one.

Democracy, education, and innovation

As previously noted, India's performance on the *Global Innovation Index (GII)* indicates the barriers to progress. The *GII* confirms what is already known—India's biggest failure as an independent nation is in levels of literacy and the provision of basic education. No other country with which India compares itself has such a poor record on this basic pre-requisite of a modern country. While government initiatives such as the Sarva Shiksha Abhiyan (Education for All Movement) and the recent Right to Education Act have belatedly acknowledged this failure, there doesn't seem to be a sense of urgency in addressing this problem. This has serious implications not only for innovation but for the very existence and progress of India itself, as better education of its citizenry is essential to take a more rational and scientific approach to governance and to adopt and diffuse influential innovations.

India has succeeded in sending a spaceship to the moon, making long-range missiles, and building nuclear bombs. Yet, it continues to have a literacy rate of 74 percent : a very low rate for a country that aspires to be a 21st century economic superpower and a good 20 percent less than that of China.

Though literacy has increased by around 10 percent each decade, India has failed to robustly tackle the need to improve levels. National campaigns, such as those addressing smallpox eradication and polio eradication, represent one measure that could be taken. The right to education has remained a directive principle rather than a fundamental right until recently. No politician or political party has embraced literacy and education as the main planks of their poll strategies. It could be concluded that some parties have a vested interest in a percentage of voters remaining poor, illiterate, and uneducated, possibly so that they can exploit them as vote banks.

Thanks to the great heterogeneity in access to education, there exists a divide between un-schooled grassroots innovators who have solved problems through their own ingenuity, and more educated innovators who are part of the formal innovation system either through start-ups or working in formal organisations. Even where schooling exists, science education is likely to be devoid of the practical exposure that makes science an appealing subject. Private foundations such as the Agastya International Foundation are setting up science education centres as supplements to government schools, but it is unlikely that they can ever reach the scale required to provide science education across the country.

Whether democracy promotes freedom of expression and facilitates innovation is a question worth considering. Though the Indian constitution guarantees freedom of expression, and the courts have been largely willing to defend these rights,

politics has resulted in a curtailment of these rights in some high profile cases. The Bhandarkar Oriental Research Institute in Pune was ransacked by a mob for supporting the research on a book that allegedly contained defamatory remarks about Shivaji, an important historical figure of the Marathas; the internationally acclaimed artist MF Husain lived his last years in Qatar, as he feared threats from right-wing Hindu forces that had taken objection to his paintings supposedly showing figures of Indian goddesses in the nude; the Bangladeshi writer Taslima Nasreen was forced out of the city of Kolkata by the state government, reportedly in response to threats from Muslim religious forces; religious groups have objected to the screening of a number of feature films; a cartoonist was jailed for allegedly showing disrespect to the Indian constitution; and some citizens have been arrested for 'objectionable' posts on social media (though they were released after sustained pressure from the media and civil rights groups). In many of these cases, though the government has made weak noises about upholding the rule of law, individuals have felt threatened enough to seek exile. However, outside religious sensitivities, freedom of expression is generally upheld. Thus, there is nothing to suggest that there are any significant curbs on freedom of expression that could negatively impact on innovation.

Democracy, entrepreneurship, and innovation

In their provocative piece in *Foreign Policy* published in 2003, Yasheng Huang and Tarun Khanna argued that India's economic growth might be more sustainable than China's because India has a strong entrepreneurial base while China's growth came from either foreign direct investment or state-owned enterprises. Embedded in this piece was an argument that a bottom-up, decentralised model of growth based on individual economic actors making their own rational decisions was likely to be more effective in the long-run than a top-down, directed growth model.

Exactly a decade later, there is no evidence to support this claim. Growth in both China and India has slowed in recent years, but levels of growth in China remain well ahead of India. India's private sector enterprises continue to do well (since 2010, there have been 141 publicly listed companies in India with annual sales exceeding US$ 1 billion). However, that is not enough to improve India's economic growth or socio-economic conditions. India is ranked number 136 out of 186 countries on the United Nations Development Programmes' *Human Development Index* 2013, while China is ranked at number 101.

While it may be argued that Indian firms are not embracing an R&D culture because it is not a business imperative, the fact that Indian firms are falling short on environmental certification as well as training (as discussed in the previous section on the *Global Innovation Index*) suggests that Indian companies are simply not investing enough in their own long-term future. This is a sobering thought: the future of Indian business and the Indian economy are at stake, and long-term investment should be an important subject for reflection by the government and India's leading industry associations.

Creative confidence and ideation

Centuries of foreign domination sapped India of much of its creative confidence. While some of this confidence in the political sphere was restored by the success of the Indian independence struggle, building creative confidence in the industrial sphere is a more arduous task. This was made more difficult by the complex web of regulations imposed by the Licence Permit Raj that controlled business growth until the early 1990s. All creative energy was expended in finding ways around this web of restrictions. After liberalisation of the economy began, the release of pent-up demand saw Indian business racing to make the most of emerging opportunities and it was only once growth started to ebb that innovation became an imperative.

In terms of the impact of democracy on innovation today, it appears that not much impact is had on the ideation front. The younger generation of India (50 percent of the Indian populated is below the age of 25) has grown up relatively free of the controls that characterised India for decades, and is more confident of its place on the world stage. Several authors have observed the growth of a new breed of entrepreneurs even in small-town India.

Yet, innovation is much more than just ideation. The initial idea is, at best, a seed of innovation. An idea needs to be experimented on and validated, combined with other ideas, and put into practice before it can be called an innovation. While a functioning democracy prevents ideas from getting stifled, the evolution of an idea into an innovation can happen only if the institutional environment is supportive.

Unfortunately, the cost of innovation and entrepreneurship in India tends to be high because of a number of voids and distortions in the institutional environment. These include a lack of high quality infrastructure, absence of enough skilled manpower, and corruption across the government and regulatory framework. In addition, these institutional voids are in turn related to the malfunctioning of the social, political, and economic system in India of which democracy is an important bulwark.

The delays in creation of infrastructure are related to rent-seeking behaviour by powerful individuals and interest groups, as well as corruption. The lack of skilled manpower is due to the failure of education and training to keep up with the needs of the marketplace, and, as discussed in an earlier section, can be traced back to rigidities in the regulation of higher education that are endemic because they suit the interests of well-entrenched political groups across the political spectrum. The failure of India's parliament to create a strong anti-corruption law in spite of their public assurances to do so and the huge surges in wealth of politicians suggest that corruption is a common thread running across political parties in India. Corruption not only impedes the benefits of government programmes from reaching their intended recipients, but also inhibits individuals from getting involved with the government or with any activity that has a government interface.

In short, India's experience suggests that democracy (specifically, electoral democracy) by itself is inadequate to drive innovation. While there are a large number of educated professionals in India, functioning markets, transparent regulation, and a uniform and consistent rule of law are some of the other elements that need to be in place for innovation to thrive.

CHANGING THE FACE OF INNOVATION IN INDIA: NEW INITIATIVES AND POLICIES

The challenge posed by the growing knowledge-intensity of the global economy, and formally bringing into the policy frame the development of innovation capabilities, was addressed for the first time when the government of India set up the National Knowledge Commission (NKC) in 2005. A major focus of the NKC was the reform of higher education in the country. However, while the NKC produced a number of white papers on different aspects of the knowledge economy, including setting up new universities, innovation, and entrepreneurship, the NKC's recommendations remained largely on paper thanks to opposition within the Congress party and from the communist parties, which were a part of the United Progressive Alliance (UPA) coalition government that was in power from 2004 to 2009.

Attempts to convert the NKC's recommendations into legislation had to wait until the formation of the second UPA government in 2009, which was not dependent on the support of the communist parties. In the meantime, the eleventh Five Year Plan (2007—12) scaled up central government investment in higher education, leading to the creation of several new central universities, Indian Institutes of Technology, Indian Institutes of Science Education and Research, and Indian Institutes of Management. However, as of June 2013, many of the government legislations to allow foreign universities to set up campuses in India, and to create a regulatory framework for private universities, are still awaiting approval from India's parliament.

The main opposition to some of these legislations appears to be from politicians themselves, as they currently own and control, directly or indirectly, much of the private higher education sector that has mushroomed over the last two decades without much regulatory oversight. The Indian middle class, which is the main constituency that could benefit from the proposed changes, is not seen as electorally important enough by the political system to make these legislations a priority.

A National Innovation Council was set up by the central government in 2010 to foster an innovation culture across the country, and more importantly to catalyse innovation to solve social problems. Among its announced initiatives are the creation of sectoral innovation councils, building innovation ecosystems around selected institutions of higher education across the country, and the creation of a US$ 1 billion Inclusive Innovation Fund. However, as of June 2013, these initiatives are still largely on the drawing board, and it will be some time before the results of these initiatives are visible.

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Conclusion

India is a land of sharp contrasts. And nowhere is this more evident than in the case of innovation. On the one hand, India has seen the evolution and growth of successful enterprises that have pioneered new business models, and of NGOs that have created new ways of substantially lowering health costs. On the other hand, India has the largest number of poor people in the world and has not shown the will and commitment to enhance literacy and education standards to world levels.

Democracy in India makes it a fertile ground for ideas to solve myriad problems. Though freedom of expression can come under pressure when it comes into conflict with extreme religious views, in most other contexts a strong civil society and an alert judiciary enable uninhibited expression. However, Indian democracy, even if indirectly, has to take at least some of the blame for impeding the translation of ideas into reality and the scaling-up of ideas. Three barriers to such scaling-up—the absence of the right infrastructure, inadequate skilled manpower, and endemic corruption—are all closely linked to a malfunctioning democratic polity.

New government initiatives have the potential to create a stronger foundation for future innovation in India. Yet, unless the country finds ways to reform democracy to address the core issues identified in this paper, India is unlikely to realise its full innovation potential.

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NOTES & REFERENCES

1. I thank four anonymous reviewers for their useful feedback on an earlier draft. Their comments made me think harder about several arguments in this paper. Of course, I am responsible for any inadequacies that remain. This paper draws extensively on my prior work in this field, particularly Rishikesha T. Krishnan, *From Jugaad to Systematic Innovation: The Challenge for India* (Bangalore: Utpreraka Foundation, 2010) and posts on my blog http://jugaadtoinnovation.blogspot.in
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