Mapping S&T Innovations: A cross-country study of patenting

Executive Summary

There has been an attempt to enthuse all the concerned players to enhance innovation. This study examines the innovation as manifested in the US patents granted to China, Israel, and India during 2001-10, and patents obtained by Indian entities during the same period in the Indian Patent Office. This is an attempt to understand the strategies adopted by these countries for enhancing their technological innovation, and look for the possible learning from the same. The US Patents assigned to India has plateaued around 250 annually in the past ten years. The present analysis shows that the other countries have invested substantially in R&D. They have also broad based the innovation both in terms of number of innovators and institutions / firms working on them. Invariably industry has dominated patenting elsewhere. These countries have exercised technology option and have focused on a set of them to gain advantage. Incremental innovations have facilitated China not only in obtaining a large number of patents, but also with minimal time lapse in their grant by the USPTO. China's patents are largely soft innovations such as ornamental designs of the products and the like. The country's export oriented manufacturing base has also facilitated innovation. Israel has focused on niche technologies like computer software, medical instrumentation and the like, to balance their technology trade.

India has been patenting innovations coming out of laboratory intensive research, which are slow to come by and is also observed to take longer time for granting rights by the USPTO. Indian patents granted by the Indian Patent Office are relatively more in number. The analyses of these patents indicate the availability of motivated innovators in the IPR regime. Patent examination process in our context is slow and possibly trust in the IPR protection low. We need to adopt short and long term strategies to showcase our innovation capability and also to protect our market from within and outside the country. Technology forecast studies to understand the existing gaps, encouraging industrial sector into innovation mode through policy options, incentivising the process and strengthening the institutional mechanisms In patent protection are among the options suggested to catch up in the innovation game.

Innovation refers to exploiting new ideas leading to the creation of a new product, process or service. Innovativeness has become a major factor in the context of science and technology (S&T). Prominent among the measures of innovativeness of a country or an organization is the patents assigned to the same.

The current study examines the patents granted to China, Israel, and India by the USPTO, one of the three important patent offices in the world. The United States of America is the biggest economy and any worthwhile idea/ technology would have to succeed in that market, and hence, in most cases, would be patented in the country. More than 50 percent of the US patents originated from non-us sources. Apart from this, confining the study to the USPTO also ensures a common benchmark for the comparative study. This research also examines the patents obtained by Indian entities in Indian Patent Office (IPO).

The objectives of this study were the following:

1. to examine the patents granted to China, India, Israel by USPTO during 2001-10 in numerical and qualitative terms;
2. to analyze patents granted to Indian entities by Indian Patent Office during the years 2001-10;
3. to Identify the core areas of innovation activities and its growth;
4. to analyze the information on innovator as also assignee affiliation and collaboration;
5. to present a few cases that would take a closer look into the technologies patented within a given focus;
6. to infer the patenting trends, active components of the national innovation system and strategies adopted by the countries for obtaining the patents, and also elicit possible learning from the same, and finally.

Methodology & scope

The study considered all the patents assigned by the USPTO during the years 2001-10 to the selected countries. All the patents were examined individually and the same were categorized as appropriate to the context. The variables considered include, assignees, innovators, subject focus, and broad grouping of patents on technology level, time lapse in grant of patents, apart from growth trends of patents during the period. Technology levels of the patents were broadly classified into high, medium and low. High technology was defined to include cutting edge technologies originating from the lab-based research. These include nanotechnology, drugs and pharmaceuticals, semiconductor related research, and a host of related ones. Low technologies are those that are soft innovations or ones belonging to commonplace products. These also include soft innovations such as ornamental designs and the like. Medium technologies are the ones which do not fall in either group and cover innovation on a wide ranging products and processes. The classification broadly corresponds to embryonic, growth and maturity stages of technology S curve. Indian patents from the IPO was retrieved from its public domain database

Economic and S&T Backdrop

China:

During the 2001-10 period China tripled its GDP(PPP) and it was US$ 10,170 billion in 2010. Its per capita income also tripled during the period and stood at US$ 6,846 in 2010.

Whether it is the science and engineering papers that China's researchers publish in international journals, the amount of investment made in R&D or the number of patents obtained, statistics indicate that their S&T capabilities are developing rapidly. China has the stated ambition to be an *innovation-oriented country* by 2020, and one of the world's leading science powers by 2050.
China has been taking great strides on the R&D investment, which has grown from US$ 6.5 per capita in 1999 to over US$ 63 in 2010. It has also registered a steady growth in the expenditure on R&D as percent of their GDP. Business expenditure on R&D has grown ten-fold during the decade. Interestingly the number of R&D personnel has also grown four-fold during the same period. The country has the second largest workforce of scientists and engineers, second only to the U.S.

Israel:

Israel is 100th smallest country with population of seven million. During the 2001-10 period the country registered promising economic growth and its GDP (PPP) stood at US$ 218 billion in 2010. In the same year the country's per capita income stood at US$ 28,298.
Israel's S&T tradition predates formation of the country. The country has the highest ratio of university degrees to the population in the world, and has one of the highest per capita rates of patents filed.

Israel's expenditure on R&D and per capita expenditure on R&D is way ahead at 4.41 percent of its GDP and US$ 1242, respectively, in 2010. However, considering Israel's population is small, per capita measure does not add up to big numbers. Israel has seven R&D personnel for every 1000 people.

India:

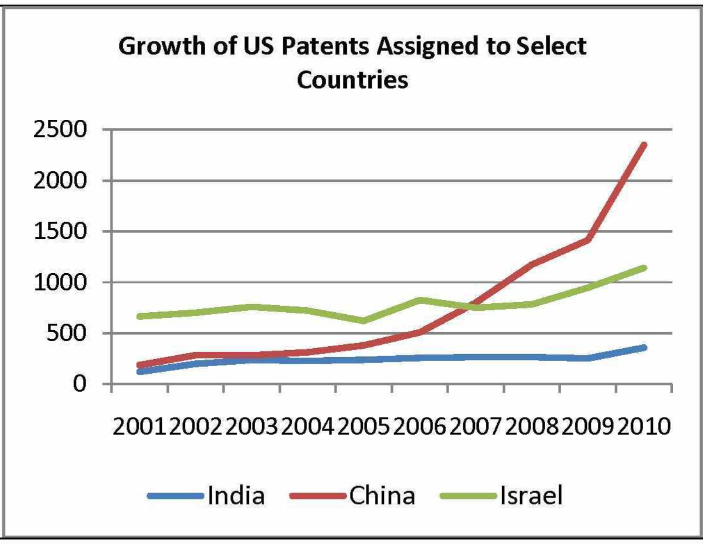
During the 2001-10 period India registered a promising economic growth resulting in almost four-fold increase its GDP (PPP), which stood at US$ 1,648 billion in 2010. Our per capita income during the same year was US$ 3,523.

Excepting for the size of the economy, India is comparatively on the lower end as to the parameters relating to R&D. Business expenditure on R&D has registered an increase in the recent years, though it is too meagre to make a considerable impact. R&D expenditure as percentage of GDP stands at 0.85, and the per capita R&D expenditure was $ 11.77 in 2010. Business expenditure on R&D has also registered a four-fold increase during the 2001-10 period and was US$ 2,800 million in 2010. Total R&D personnel, as per the data available, works out to be as small as one in every 5,000 people.

Analysis of Patent Growth

Growth of US Patents

	India	China	Israel
2001	121	186	665
2002	199	283	701
2003	237	282	760
2004	227	312	722
2005	239	380	621
2006	257	508	825
2007	266	800	750
2008	266	1174	783
2009	253	1414	947
2010	**358**	**2350**	**1142**



China:

China has registered a steep increase in the patent productivity in recent times. During the 2001-10 period of US patents assigned to China has increased over 12 times.

There is a distinct trend of industry dominating the patenting activity in China. They make up 90 percent of the total patents granted to the country. Research institutions and universities have also registered a steady growth of patents in numerical terms, though as a proportion to total they have crossed double digits in only one year. Also to be noted is the significant increase of patents by universities, which has registered a twenty-fold increase during the decade. Patents by research institutions have tripled during the 2001-10 period, though the numbers are relatively small. The trend is indicative of all round growth in innovation activities. China had 2,079 distinct patent assignees during the period

Chinese patents are increasingly an outcome of collaborative R&D investment and these have moved from 09 to 45 percent of the total during the ten year under study.

China also has benefited from international collaboration at assignee level. Starting with a mere 2.2 percent of the total patents in 2001 it increased to 37 percent of the total in 2010.

Sole inventor patents dominated in China in 2001. This trend has corrected itself over the more recent years. The changing trend could be an indication of increasing sophistication of innovation. It has changed from 70:30 - Seventy being single inventor - in 2001 to 67:33 - Sixty-seven, in the latter case, being collaborative - with more than one inventor - in 2010.

A little over eleven percent of the Chinese patents have exclusive foreign innovators, (i.e., invention carried out completely by non-Chinese) over the 2001-10 period. On a year-wise analysis this figure shows a steady decline from 23 to 7 percent of the total.

On the whole 12 percent of the Chinese patents could be classed as high technologies; 47 percent as medium, and 41 percent as low.

A closer look at the annual trends reveal that Chinese high tech patenting is on a gradual rise from 22 patents in 2001 to 242 in 2010, all along registering an increase. Chinese medium technology patents have risen from 17 to 57 percent of the total. The corresponding figures for low technology ones show a decline from 70 to 30 percent. However, the low tech patents have increased in actual numbers.

China seems to have benefited from filing the low technology patents in ensuring a quick grant of the same. Over 62 percent of the low technology patents taken by Chinese are ornamental designs and the rest are minor modifications of one or the other commonly used products. It could be observed that Chinese seem to have rapidly increased their patent count with an emphasis on low technology and low-end innovations. Analysis shows that a large portion of Chinese patents is granted by the USPTO with in a year or two.

China had initially depended on outsourcing the innovation in toto. They graduated into international collaborative research, more in medium technologies. The high technology patents are increasingly local in all its collaboration. Chinese seems to work with an intention to showcase an increasing innovation trend, as reflected in patent growth, and the plan seems to be holding good so far.

Chinese patents for the years studied fell under more than 359 distinct main classes of the US patent subject classification. China had 10,125 successful inventors as per this study and per capita patent per inventor works out to 0.76.

Major subject focus of Invention by China:

Designs patents (23 classes from D19 through D99)	1977
Electricity & Electrical machinery (US PTO Subject classes 361,439,324,60)	578
Textiles (US PTO Subject classes 94,141,19,26,58,28,57))	774
Office systems / supplies (US PTO Subject class D19)	164

China has defined its S&T objectives in various plans categorically, channeling the resources and efforts. Increase in the country's innovation base is also a result of China's emphasis on manufacturing oriented export trade. China has also taken the route of rewarding successful innovators through prize money at various levels, among other things, for moving towards its declared goal of innovation-based economy.

Israel:

Israel was ahead of India and China in 2001 and, in numerical terms, has been holding steady during the ten-year period. In fact, a look into the total patents assigned to Israel during the previous years shows that the number has been growing, though marginally, over the last ten years and from 2001 onwards it has been around 700. This number has shot up during the last three years of the decade.

Industrial sector dominate the patent scene in Israel. This sector has obtained nearly 87 percent of the total patents granted by the USPTO to the country, during the first decade. Absolute number of these patents going with the universities and research institutions are also relatively high, considering that the country has only eight universities and around 50 research institutions. Universities and research institutions have also carved a niche for themselves in innovation activities in Israel. Both universities and research institutions have annexed business organs to deal with the IPR and technology transfer issues. The country has earned considerable revenue through the technology transfer and has achieved a technology trade balance.

Israeli patents are mostly inventions by single entities (96%) and collaboration of two or more entities is a minor affair, both in actual numbers and as a proportion to the total. Foreign collaboration, as reflected in patents jointly assigned to the country, is below two percent of the total. Collaboration, however, is present at the inventor level. Eight percent of the patents have resulted from foreign inventor collaboration and 4.2 percent of the total had exclusive foreign inventor(s). One-third of the Israeli patents are also technologies developed by single inventors.

Low technology patents form a small proportion with less than 10 percent of the total. Medium technology patents, including those relating to software procedures, plants - mainly cultivars - cryptographic methods; engineering and electrical equipment make up almost two-thirds of the total. The rest of the patents grouped as high technology and add up to 10 percent of the total.

Foreign inventor collaboration could be noticed both in medium and high technology patents. It is more so in the high technology, amounting to 13 percent of the total in that category.

Israel has clearly earmarked sectors like software, biotechnology, pharmaceuticals, medical instrumentation, and agriculture, among others, for innovation activities. They seem to have made the best of available technical manpower, considering it is a small country with smaller population base. In support of this Israel has vigorously administered the government grants for R&D, and even encouraged MNC collaboration in R&D through official grants.

Israel's patents could be categorized under 217 main classes of USPTO classification. However, a few major categories make up a half of the patents. In all, there were 2,400 unique assignees in Israel and 9,475 unique inventors were identified from the data. Per capita patent per inventor works out to 0.84.

Major areas of innovation by Israel

Subjects	Patents
Communication - Multiples / Digital (US PTO Subject classes 370, 375, 340, 379)	675
Drugs (US PTO Subject classes 514, 424)	629
Medical Equipment (US PTO Subject classes 600, 604, 606, 623)	673
Optical systems (US PTO Subject classes 356, 359, 385)	419

India:

India was along with China in the number of patents in the year 2000 and also, even as late as 2003, in utility patents. India's annual patent count has been around 250 during the ten years under review. The composition of Indian patents granted by USPTO is interesting. The share of research institutions, which was as high as 63 percent in 2001, has reduced to 23 percent in 2010. The decline has been steady and it has occurred, both as a proportion of the total and also in actual numbers. As opposed to this, the industry has registered a growth from 37 to 74 percent of the total over the same period. The relative contribution of industry and research institutions has changed, almost depicting a scene vice versa of the one in 2001. The universities show a dismal picture all through the period. The picture is not rosy when we consider the actual numbers. There is a considerable decline in the patents granted to the research institutions. The annualised growth is only marginal during the decade.

Indian patents are increasingly outcome of non-collaborative R&D investment both for industry and research institution. Even among the academic bodies - universities and research institutions - the trend in India has been to 'go alone'. Inter institutional collaboration, be it between more than one research institution, more than one university, or research institution and university, is negligible. Also, there is no noticeable international collaboration in innovation in our context.

The patents, however, have increasingly come from collaborative teams of inventors and such instances have remained above 80 percent all through the years for India. Around 4,800 inventors obtained 2,420 patents, making it about a patent for two inventors over the decade. India had 386 distinct patent assignees during the study period. Indian patents falls under 181 US patent main classes.

Relatively greater proportion (56 percent) of Indian patents comes under high technology, and low technology innovations are less than ten percent of the total. This distribution reflects our patenting priorities, which tend to be less of low end products and more of lab based processes and the like.

Major areas of innovation by India

Chemistry of organic & inorganic compounds (US PTO Subject classes 160, 423, 435,536, 540, 544, 546,560, 562, 568, 548, 549,	798
Drug, bio-affecting and body treating compositions (US PTO Subject classes 514,424)	517

Due to the presence of MNCs with their R&D laboratories in all the three countries they have lost their local innovative potential to other countries. That is, invention by Chinese, Indians and Israelis, as the case may be, but the patents assigned to an entity other than the respective countries. In fact, during the decade China and India have lost more innovations to others than the countries have as their own. It is also the case with Israel though not to the same extent. This trend exists despite the growth in number assigned to countries during the period. What is alarming is that this trend has consistently increased for India and has declined for China in recent years. Only 7.15 percent of our US Patents (173 our 2420) are licensed as technology trade.

Case Studies:

Case study of the patents in the US Patent Class 370/641- thermal conduction of electronic equipment - reveal that China took up to patenting on the technology when the innovation on the technology was on the decline elsewhere. China learnt the technology through collaboration with Taiwan and later continued on its own. Most of the patents they obtained in the process were based on fine-tuning at the sub-component level. These patents could be categorized as either exploitative innovation or creative imitation. The new patents provided a learning opportunity for China and also helped in bringing in small improvements in the electronic products they were putting together. It would have also helped in avoiding license fees to other IPR holders on the technology.

Case study on design of pens, which could be categorized as soft patents, reveals that initially Chinese firm co-opted with Taiwan by outsourcing the innovation. After this learning period it took up to patenting new designs. A careful study of the trade figures show that through these exercise, along with the cost advantage, China could garner substantial world export share on the product within a short span of time.

Case study on medical device patenting by Israel show that the country promoted innovation on the technology in the late 1990s and carried on during the next decade. As there were well-established players in this technology market with patent wall in place, Israel's innovation could at best plug the holes in the technology. The patents obtained were in group B and C category technologies, which fall in low-moderate and moderate-high risk group of products. Nearly 25 percent of all these patents (169 out of 690) were licensed out by the original assignees as technology trade. More recently Israel has moved into innovation in Cryosurgery - relatively new technology, with limited players. This way, the strategy seems to be in the forefront on the technology. This approach contrasts with that of Chinese method of coming late in the process and innovating at the margins.

Case study on patents obtained by Israel on multiplexers - a software driven network device - show that innovation on this technology spans over 122 sub-classes with varying narrower foci in none of these sub-classes Israel is a domineering player in numerical terms. Yet, closer examination of the data indicates that 56 percent of these patents were licensed to other users in the value chain (210 out of 372). Thus, the country's innovation in this technology is at the cutting edge level and has facilitated technology trade.

Indian Patents Granted by Indian Patent Office

Analysis was also carried out on the patent records obtained from the public access database of the IPO. As per the available records Indian patents obtained from the Indian Patent Office shows a more promising trend. The patent growth shows a prominent upward trend and reached an annual grant of 2056 patents in the year 2008. This number declined in the last two-years of the decade. Over all the number adds up to a substantial 7,899 for 2001-10 period.

Unlike Indian patents in the US PTO, within the country, industrial firms have assumed a leader role with 45 percent of the total for the decade. Considerable number of patents is also assigned to research institutions and universities. Universities make up six percent of the total, with 465 patents in all for the decade. Included in this list are IITs and other such institutions of national importance. An unusual pattern in our local patents is the dominant presence of the unaffiliated assignees. These are individual inventors who have also mantled the role of assignees. This category makes up almost one-fifth of the total patents for the decade. This phenomenon reflects lack of awareness and low importance given to IPR by some institutions where the patented idea was worked on. Despite considerable increase in the overall numbers, there is no consistent trend of growth for any of the major assignee groups.

Three-fourths of the local Indian patents were obtained by single entities; collaborative research at the organizational level is relatively less. Inventor collaboration, on the other hand, is widely noticeable with two-thirds having two or more inventors. Assistance taken from foreign inventors either through exclusive outsourcing or innovation through collaboration is meager.

Medium technologies dominate the patented innovations, as opposed to our patents obtained in the USPTO. These innovations broadly fall in the category of products in one or the other engineering fields. Only 20 percent of the total could be classified as high-tech, which includes innovations involving laboratory based research or the new areas such as nano-technology and the like. There were only 16 patents that could be categorized as low tech. Absence of soft patents such as designs under our patent law could be one of the reasons for this low number.

Subject-wise classification shows that our innovations are skewed towards chemistry based processes, (including pharma products) and mechanical engineering, (including auto-components etc.). These are followed by innovations in metallurgy, electronics, electrical goods, food technology based products and medical devices. Relegation of electronics to the secondary level and medical devices that are only in the Group A (low risk) category does not speak highly of our innovation priority, considering the market potential for these products.

Indian innovator base, as per the IPO records, is strong with 11,855 individuals who have obtained one or more patents. Assignee base is also strong with 2,663 entities in the IPR game. CSIR owns nearly 20% of the total patents granted, followed by Hindustan Unilever (643), BHEL (199), SAIL (165) and the IITs (162).

Patent granting process in Indian Patent Office is slow and on an average it has taken nearly six-years for the grant and in an extreme case the figure stands at 17 years.

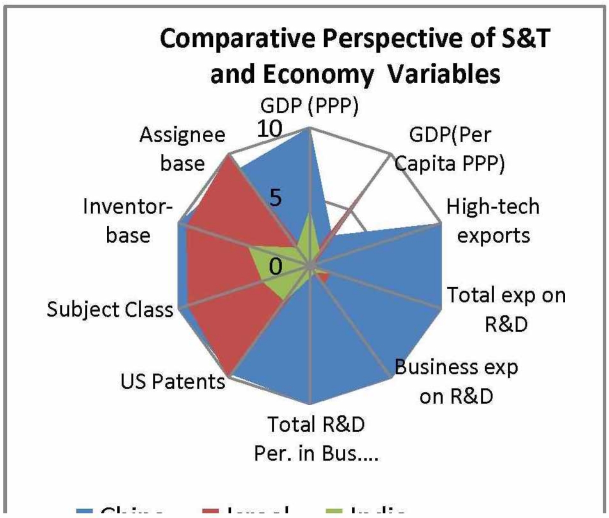
Innovation trend on the whole indicates the availability of the talent and also eagerness to patent. There is a need to strengthen the institutional base for IP protection, including providing a credible database of the patents in the public domain. There is also a need to spread greater awareness of the patentable innovations.

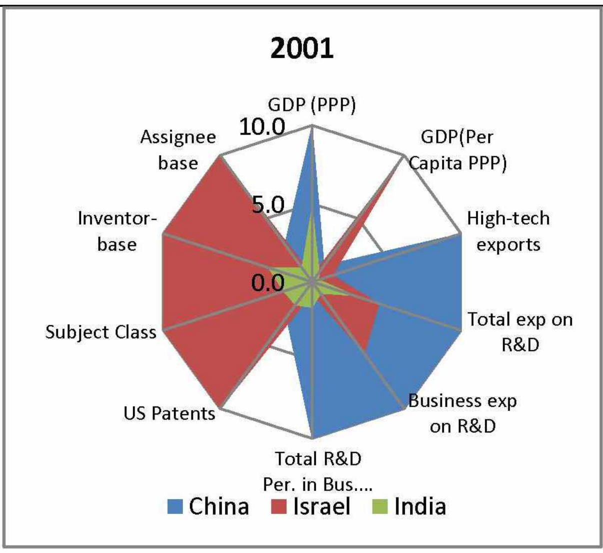
Summary table of R&D and US patent data 2001-10

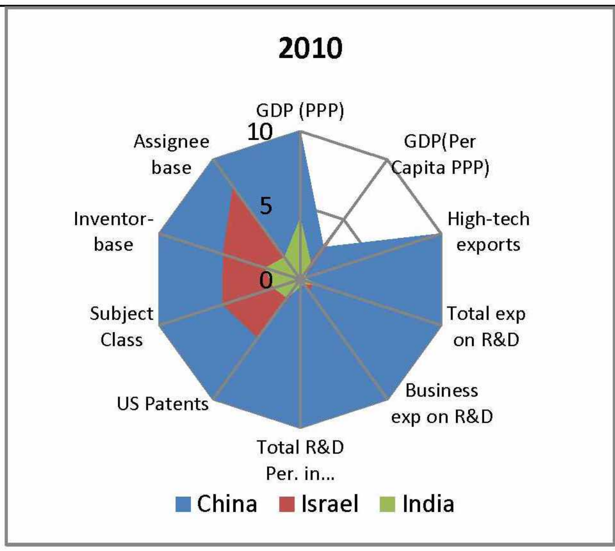
	GDP * (PPP)	GDP(Per Capita PPP)*	High-tech exports*	Total exp on R&D*	Business exp on R&D*	Total R&D Per. in Bus. Ent.*, **	US Patents 2001-10	Subject Class 2001-10	Inventor-base 2001-10	Assignee base 2001-10
China	10169.52	7583.54	223795.39	44252.10	31450.85	1046.13	7679	4717	10125	2079
India	4194.86	3523.04	5427.31	7354.42	2001.39	87.25	2420	1681	4794	386
Israel	217.84	28298.66	6067.36	6973.54	5457.38	44.57	7916	4372	9475	2400

- Annual average for the period 2001-10 (US $ million)

** (FTE thousands) (Indian figures were calculated on the basis of 2006 figures)



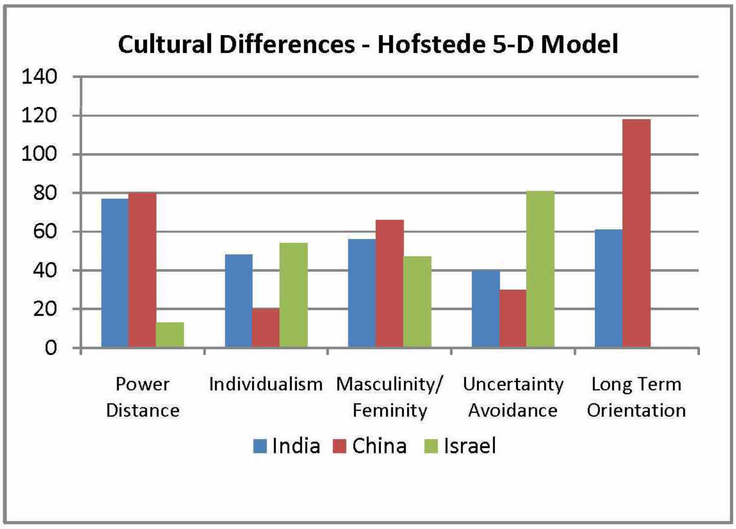




2001	GDP (PPP)	GDP(Per Capita PPP)	High-tech exports	Total exp on R&D	Business exp on R&D	Total R&D Per. in Bus. Ent.	US Patents	Subject Class	Inventor-base	Assignee base
China	3334.18	2612.44	49409.51	12595.14	7611.82	532.10	186	156	259	122
Israel	130.39	20059.38	6741.83	5661.84	4318.19	39.14	665	595	1227	411
India	1616.45	1571.30	2286.51	3610.85	697.81	87.25	121	114	361	46
2010	GDP (PPP)	GDP(Per Capita PPP)	High-tech exports	Total exp on R&D	Business exp on R&D	Total R&D Per. in Bus. Ent.	US Patents	Subject Class	Inventor-base	Assignee base
China	10169.52	7583.54	406089.69	104317.56	76592.23	1873.91	2350	1606	3997	653
Israel	217.84	28298.66	7978.96	9566.84	7635.00	49.35	1142	886	2191	505
India	4194.86	3523.04	10086.63	14015.21	2803.25	87.25	358	303	993	119

Cultural Dimensions

To examine the possible cultural difference in innovations comparative national scores on variable such as power distance, individualism, masculinity/ feminity, uncertainty avoidance, and long term from Greet Hofstede's 5-D model was compiled. Innovativeness is known to correlate with communication across hierarchy in organization, risk taking behavior, individualism, among others. The data for the three countries indicate that Israel is distinctly different on several dimensions. There is a considerable overlap between India and China on all the five dimensions. On power distance, individualism and uncertainty avoidance, China scores relatively low compared to India. In its record growth in patents during the decade, China has fared well, despite some of the possible cultural obstacles. The success points to a host of policies China adopted to enhance their performance.



http://geert-hofstede.com/national-culture.html

Innovation Strategy of China, Israel:

Strategy is the art of devising and employing plans towards accomplishing a goal. Patent or IPR strategy is a part of the larger technology management strategy.

Technology management strategy includes:

- Recognition of technological threats and opportunities,
- Exploitation of existing technologies,
- Identification and evaluation of alternative and emerging technologies,
- innovation activities,
- Protection and exploitation IPR.

An innovation strategy guides decision on how the resources are to be used to meet a firm's / country's objective for innovation and thereby build value and competitive advantage. It entails judgment about what kind of innovation process is more appropriate for the circumstances and ambitions. The strategy identifies technologies and markets it should best develop and exploit, to capture and create value.

Four levels of innovation strategy are recognized. These are: **Reactive** - where the innovation is entirely incremental; **Active -** wherein the innovation, though is not first to market, but are well prepared to follow; **proactive -** in which the innovation is mainly radical in nature; and **passive -** in which case the product improvements take place only on customer requirement.

Patenting strategy involves mechanics of achieving exclusivity in a technology area. At the firm level these include:

- Broad or narrowly claimed patents
- Patent flooding or blanketing around an original patent.
- Wall strategy, in which the firm knows that the patented technology would be surpassed in functionality. The gain is in the time delay imposed on the competitor.

Patent strategy at the national level is part of -

- S&T policy, which may sometimes include an exclusive innovation policy
- Industrial policy, which may include growth strategies desired, such as export led growth or focus on internal market through protection mechanisms, and
- Industrial manpower policies, which could include capacity building, among other things.

Israel has consciously opted for technology and innovation led growth model. Considering the relatively small population base, the technologies opted by the country are the high end ones such as medical devices, IT, drugs and pharmaceuticals etc. The government has also devised ways for risk absorption in innovation process, through grant programmes at all levels of technology development process, namely embryonic, growth and maturity stages. It has also encouraged formation of technology-based enterprises through venture capital mechanisms and funds operated for the purpose. International and bi-national interactions for technology development are facilitated through specific programmes intended for the purpose. The results of this are reflected in the patents obtained by the country.

China has explicitly stated goal of transforming the country in to an innovation-based economy by 2020. Among the strategies adopted towards that goal are -

- Manufacturing export led growth;
- Import of technology to facilitate manufacturing, mainly through open door policy for trade and industrial establishment;
- Protection of local markets through appropriate IPR legislation, such as
    - Utility model patent;
    - Making local patenting mandatory for MNCs engaged in R&D within the country;
- Changing labor laws to make the manufacturing process competitive;
- Encouraging local innovators through incentivization at various levels;
- Restructuring the S&T organizational set up to make them competitive;
- Selectively developing universities to achieve the best standards and establishing benchmarks;
- Adopting a slew of measures, such as venture funding, tax based incentives to facilitate innovation and patenting;
- Continuously revising the national policies, which have also earmarked a set of technologies to focus on in the coming decades.

The outcome of these measures in terms of innovation and patenting is immense. These have resulted in new innovators and firms harnessing the IPRs.

One of the outcomes of the active and proactive innovation is the patent rights and is less so when the innovation strategy is reactive. China's innovations range from '*proactive to* '*reactive*' '. They are, however, skewed towards '*reactive*'. This is reflected in their innovations, which are minor improvements of old products and designs. The country is also involved in an '*active*' innovation strategy in certain medium technologies. China is also engaged in science-based inventions - particularly the ones emanating from its universities. The trick in the rapid growth on patent graph is that much of the low technology products, nominal design improvements that are normally not widely appropriated as IPRs have been converted as patents. Protectability of many of them could be an issue, and its intrinsic worth in the market is debatable.

Nonetheless, this exposure to patenting has broadened the innovator base, spread awareness of IPR, its commercial importance, and generally prepares for a wider innovation culture. China, through its policies, is aiming for such a change.

Israel's strategy is to engage in '*pro-active*' to '*active*' inventions on select technologies. In technologies such as computer software, medical instrumentation, biotechnology and drug development the country is proactive and engage in cutting edge research. In several other areas invention is pursued at a level that could be adopted directly by the industry. Active venture capital firms facilitate the inventors / entrepreneurs. The government also facilitated in lowering the R&D risks through imaginative programmes. This has served the intellectual property generation very well for the country.

Indian patents largely fall in the categories '*active*' and '*reactive*' inventions, the bouquet, however, is small.

Learning from the others' Experience:

Innovation cannot happen in a vacuum. In our plan to enhance this activity we could realistically consider the desirable social, economic and political environment, along with S&T factors to facilitate technology development and patenting.

While we examine our relative strength there is a need to increase the inventor base. We are lagging behind both in terms of sheer number and also in the productivity of the existing stock. We also have to broaden the subject coverage in the range of innovation activities. The innovation plan must enthuse to engage with the peculiar local needs going with our socio-cultural background and the way of living while preparing technology wish list and idea generation. Though innovations of that nature may not be cutting edge, we would not face foreign competition on such ventures and those technologies would also cater to the market needs.

SOCIAL ENVIRONMENT

Philosophy of Life
Social Conditions

POLITICAL ENVIRONMENT

External / Internal Environment
Leadership

Individual Capacity
Motivation

Innovation

ECONOMIC ENVIRONMENT

Economic Strategy
Industrial Scene
Manufacturing /
Labour Policies

S&T ENVIRONMENT

S&T Policy / Innovation Policy
Science Institutions
Patenting Organization
Higher Education Institutions

The country already has several schemes to encourage research and innovation. They cater mostly to science based research and development. These include:

- ✓ Industrial R&D Promotion Programme;
- ✓ Technology Development and Demonstration Programme;
- ✓ Technopreneur Promotion Programme;
- ✓ Technology Management Programme;
- ✓ International Technology Transfer Programme;
- ✓ Consultancy Promotion Programme;
- ✓ Technology Information Facilitation Programme;
- ✓ Technology Development & Utilization Programme for Women.
- ✓ Innovation in Science Pursuit for Inspired Research

There are also various such programmes under different union ministries to encourage extra-mural research. Considering that these schemes are already in vogue for several years, there is a need to evaluate their efficacy.

Immediate attention could be given to some of the following:

- ✓ A proper appreciation of what is 'patentable innovation'. We seem to have a different notion on what is patentable. This is reflected in our focus on lab-based innovations.
- ✓ Broad basing the R&D grants to accommodate technology development risk and failure as is done by Israel. S&T grants could be administered through regional offices for better inventor spotting, immediacy of innovators, and project monitoring.
- ✓ A re-look at the tax-based incentive for R&D.
- ✓ Considering direct grant to industry when taken up in collaboration with academic institutions.
- ✓ Examine the adequacy of the support base for prototype development activities, which are essential components of innovation eco-system.
- ✓ Broadening the inventor base through incentivizing patenting in a major way.
- ✓ Strengthening the local patent offices and bringing in an element of professionalism in their activities.
- ✓ Encouraging hands on innovation activities and the importance of new ideas and products at various levels.