Patent as an Indicator of Technological Capability: Case Study based on Indian Patenting Activity in the Biotechnology Sector

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Abstract

It is well recognised that technological capability is intrinsic to the 'catch up' process. However, it is difficult to capture 'properly' technological capability attained by a country in a particular industry/sector and gauge future trends. Present paper addresses this issue. We argue that it is possible to judge technological capability through novel indications derived from patent statistics. We analyse India's patenting activity in biotechnology (a country epitomising developing economies) to make this argument. Global patenting trends shows core activity areas and changing dynamics. In addition comparison was undertaken with BRIC countries to assess India's activity in proper perspective.

Analysis was undertaken for the 'biotechnology domain' and individual technology classes that constitute this domain. Indian patenting activity was delineated under Indian organisations, foreign R&D canters and resident individuals; to assess role of each entity type in technology creation. Along with trend, types of actors involved, collaboration, linkages with other industries, etc were investigated. The study shows India is developing technological capability both in terms of depth and breadth. However, in comparison to global landscape, it is still in infancy. We conclude that in spite of limitations, novel indications derived from patent statistics is a good indication of measuring a country's technological capability.

Introduction and Purpose of the Study

Economic success of a country is largely intertwined with its 'capabilities' (competencies) for carrying out innovation of technologies that compete at the state-of-art in the world market. Fai and Tunzelmann (2000) defines technological competency as the ability to create and use a particular field of technology effectively. Technological competency is the ability to develop and design new products and processes, and to operate effectively including the ability to learn (Dosi et al., 1992; Patel and Pavitt, 1994). In this context a key intellectual, strategic and policy relevant exercise concerns 'proper' assessment of a country's technological capability, and also reveal how it is building up its capability. The present study addresses this issue using India as a case study. India was chosen as it epitomizes to a large extent emerging countries that have undertaken technology based economic growth for development. The investigation of technological capability assessment was undertaken for 'biotechnology industry'. Biotechnology was chosen for investigation as it is a 'high' technology research field of immense applications across a wide domain of industries, agriculture and health sector. Thus a country's competitive capability in 'biotechnology' makes a strong assertion of its moving into the domain of complex/critical technologies. In other words, it shows a country is 'catching up' with technologically advanced countries.

The study used patent as a 'proxy' indicator of technological capability (*justification of patent as an indicator of technological capability is given later*). Different indications were derived from patent statistics to reveal how a country (in this case study India) was attaining technological competency. To reveal further insights Indian patenting activity was delineated

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under three categories: patents granted to Indian entities (IOP), patents granted to foreign entities in India (FOP), and resident individuals. To assess India's technological capability in a proper context, comparison of India's patenting activity was made with other BRIC countries i.e. Brazil, Russia and China. These four countries have a number of commonalities (reason for their being given this nomenclature): they are among the fastest growing economies in the world, are rapidly entering 'niche' areas that were domain of a few developed economies, their fast integration into the global economy, etc. Thus, these countries provide a 'good' comparator set. Further, global patent trend was compared with patenting trend of the four BRIC countries to reveal to what extent their patenting pattern matches with the global trend. Some of the research questions probed to judge India's technological capability were: Does Indian patenting trend matches the global biotechnology patent landscape?; Are Indian firms addressing complex technology classes within biotechnology?; The intensity and nature of its collaboration?; Is India a leader or follower among BRIC countries?.

Patent as an Indicator of Technological Capability

Justification of using patents as a proxy indicator of technological capability stems from prior scholarly applications (see for example Patel and Pavitt, 1991; Cantwell & Hodson 1991). The major criticism of using patent as a 'proxy' of technology or technological capability is its inability for disguising both inter-industry and inter-firm differences in the propensity to patent and differing levels of significance of each patent in relation to technological advance. However, patenting in an emerging high technology field provides a strong indication of a country's ability to understand the 'nuances' of a new field i.e. the complexities and uncertainties of a 'new' technology; and shows that it is developing 'absorptive capacity' to assimilate new ideas (Cohen & Levinthal's (1990). The above assertions are truer for science based field such as 'biotechnology', 'fine chemicals', were invention and innovation are closely linked (Fagerberg, 2005) and firms increasingly rely upon patents as a means to protect inventions and gain competitive advantage., and thus appropriation is significantly dependent on patents. These insights from literature review provided the rationalisation of investigating patenting activity to uncover technological capability.

Methodology

Patents granted in 'biotechnology' by the US patent office i.e. the USPTO (United States Patent and Trademark Office) was used as data source for this study. For a variety of reasons, the USPTO is a natural choice for investigating the question of capability based on patenting. Primarily the USPTO has played the 'key' role in defining the standards of patenting in biotechnology. Moreover, for cross-country comparisons it is important to select a neutral country, suitably a country that has high propensity by different countries to patent their inventions. The US because of the major market for high technology products is a natural choice for countries to protect their inventions as it provides them scope for future leverage.

The definition (defined in terms of IPC: International Patent Classification code) provided by OECD (OECD, 2005) that has emerged from extensive review and verification by patent experts and has been empirically tested, was used in this paper for extracting patents in the biotechnology domain. Biotechnology field under this classification is defined in terms of 30 IPC codes. To provide further meaning we classified the 30 IPC codes into broad groups. This exercise included discussion with subject experts. Table 1 illustrates this grouping.

Table 1: Thirty IPC Codes in Biotechnology Classified Under Broad Groups*

IPC Codes	Group
A01H 1/00, A01H 4/00	Agricultural Biotechnology
C12N, C12P, C02F 3/34, C12S, C12Q, C12M	Enzyme Related
A61K 38/00, A61K 39/00, A61K 48/00, C07G 11/00, C07G 13/00, C07G 15/00, C07K 4/00, C07K 14/00, C07K 16/00, C07K 17/00, C07K 19/00	Medicinal Group
G01N 27/327, G01N 33/53, G01N 33/54, G01N 33/55, G01N 33/57, G01N 33/68, G01N 33/74, G01N 33/76, G01N 33/78, G01N 33/88, G01N 33/92	Investigation Group

* Authors own delineation

It should be noted that each group is not a watertight compartment in itself. For example, 'Investigation Group' that covers various methods for analysis, mainly addresses bio-medical applications. There could be another way of classifying many of the IPC classes in the 'Investigation Group' as a subset of 'Medical Group'. Our rationale of keeping them separate as a group was to underscore the activities under 'Investigation' domain.

It should also be noted that within each group, technology classes cover different aspects or range in different levels of complexity. For example in the enzyme related group, C12N defines creation of micro-organisms/enzymes whereas using enzymes to synthesize a desired chemical composition is specified by technology class C12P. These two classes differs from C02F 3/34 and C12S that shows specific applications; C02F 3/34 in water treatment and C12S in detergents. Finally, the other two classes C12Q and C12M cover instruments using micro-organisms or enzymes. Similarly, 'Medical group' include biotechnological processes as well as compounds addressing bio-medical applications. In this group, one can find medicinal preparations containing antigens or antibodies (A61K 39/00) to complex 'modern' biotechnology based medical application of Gene therapy under the class A61K 48/00. For the two technology classes covering *agriculture biotechnology; one can find* traditional biotechnology method of tissue culture (A01H 4/00) to genetic engineering application in agriculture (A01H 1/00).

Discussions with subject experts lead to the understanding that traditional methods can be as complex as 'modern' biotechnology tools and techniques. Nevertheless, it is safe to assume that genetic engineering applications such as stem cells or production of monoclonal antibodies are not possible without advanced human skills, knowledge and sophisticated facilities. Similarly, genetic alteration of bacterium required to trigger some specific enzymes which is not naturally occurring (for example human insulin) is of higher complexity then incrementally modifying characteristics of a naturally occurring bacterium producing a certain enzyme. Thus the purpose of delineating the various groups was guided by the desire to obtain further insights from the 30 IPC codes and also to provide a broad assessment of technological complexity by examining patenting activity across different technology classes. The complexity judgement was also made in terms of a country entering new technology class or consolidating its activity in a technology class.

The study period and sub-periods were carefully defined to address the objectives properly. It was felt that to capture global biotechnology patent landscape (Endnote 1), the study period should correspond broadly with the evolution of 'modern' biotechnology (Newell-McGloughlin and Re, 2006)). For comparative investigation, it was felt that period and sub-periods should be delineated keeping in consideration the advent of biotechnology in BRIC countries and phases of development therein. For investigation of the Indian activity, the sub-periods should ideally correspond to the advent of biotechnology research in India, activity during pre-WTO period, post-WTO period: initial phase, and the contemporary scenario. The result of this introspection led to the study period as illustrated in Table 2.

Table 2: The Study Period

Study Period	Sub-Periods
Global Biotechnology Patent Landscape 1970 to 2007	1970 – 1980; 1981 – 1990 1991 – 1995; 2001 – 2005 2006 – 2007
Patent Landscape of BRIC countries 1975 to 2007	1975 – 1990; 1991 – 1995; 1996 – 2000; 2001 – 2005; 2006 – 2007
Indian Patent Landscape 1975 to 2007	1975 – 1990; 1991 – 1994; 1995 – 2000; 2001 – 2007

Findings

Global landscape

Patenting activity in 'biotechnology' in US patent office that is largely the reflection of global patenting trend in this area is shown in Figure 1.

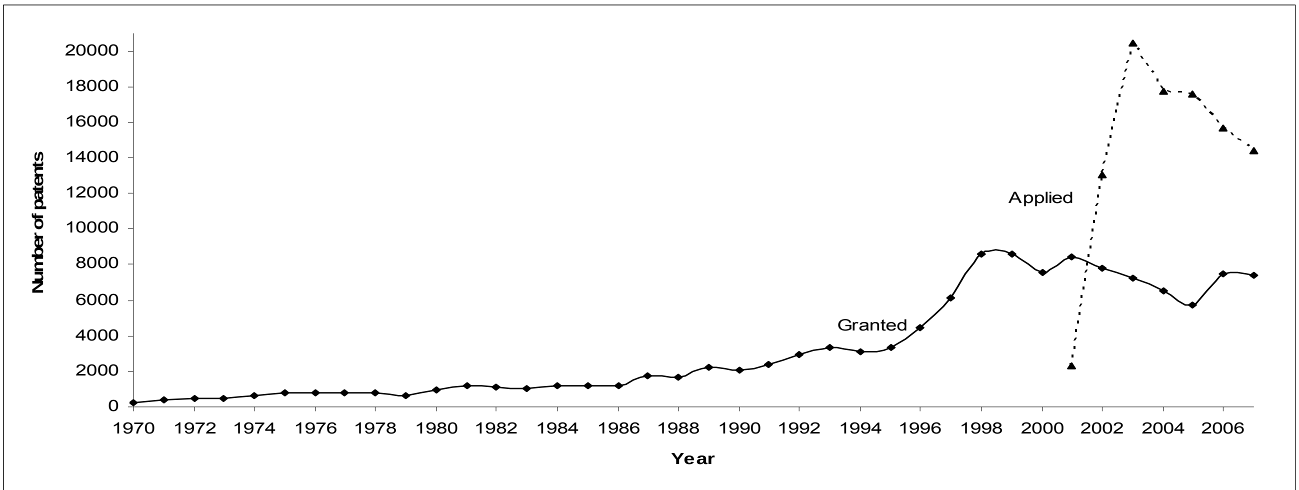

Figure 1: Patents Granted and Applications Filed During 1970 to 2007 in the USPTO in Biotechnology

Figure 1 shows steady increase in biotechnology patenting from 1970 onwards. This figure provides a broad assessment of the evolution of modern biotechnology and role patenting has played therein (see for example Bud, 1993; McGloughlin & Re, 2006). Decline in granted patents (approved patents) is observed from 2001 to 2005. Similar decline since 2001 was reported by two independent studies published in June 2004 (Lawarance, 2004). Both the studies cited increasing pressure for clearly defined patent applications, the completion of the

Human Genome Project and the 2000 biotech market bubble as factors responsible for this decline.

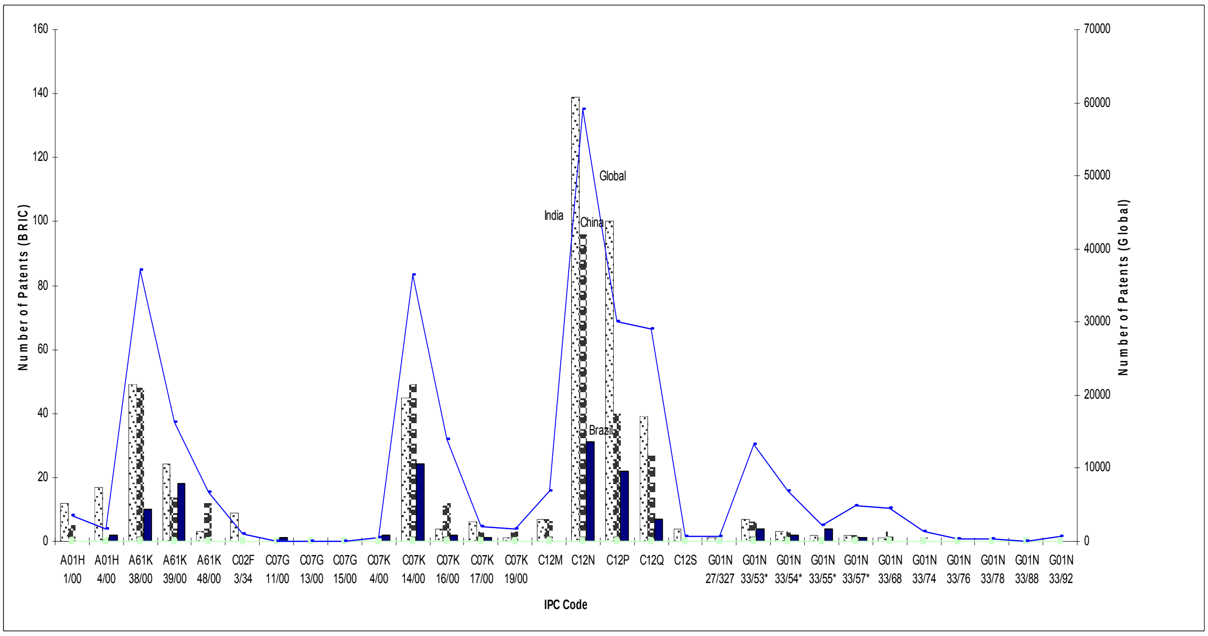

Figure 2: Patenting Across the 30 IPC Codes

Figure 2 highlights activity in the thirty IPC codes- global patenting and by BRIC countries (aggregated for the period 1990-2007). Figure 2 shows that class C12N is the most active areas of patenting with 60,146 patents granted during the entire period (1970 to 2007). C12P is also a very active area accounting for 31,036 patents. Both these classes belong to 'enzyme related group'. Two other active technology classes 'C12Q' and 'C12M' also belong to this class; implying 'enzyme related group' as the most important area of patenting within 'biotechnology'. 'C12N' and 'C12P' are also the most dominant areas of India's patenting activity with 139 and 100 patents granted in these two areas, ranking as number 1 and 2 respectively. There were 1079 and 624 patents (global patent landscape) in the two application domains C02F 3/34 and C12S respectively. The lesser number of patents in these two classes may imply the significant difference between inventions that cover a broad domain with specific/targeted inventions. India has 4 patents under C12S whereas none of the BRIC countries have any patents under this class. In C02F 3/34 India has 9 patents, Russia with 4 patents is the only other country among BRIC countries being granted patents in this technology class. Although minuscule, India's patenting trend in 'enzyme' matches that of the global patent trends in this domain.

Other active groups are 'Investigation' and 'Medicinal domain'. Medicinal preparations containing peptides (A61K 38/00), and antigens or antibodies (A61K 39/00) are the most active technology classes within this group. India is also active in the above two technology classes falling within this group: A61K 38/00 (55 patents) and A61K 39/00 (15 patents). However, Indian patenting is almost non-extent in 'Investigation' group. Thus, in spite of this 'gap', Indian patenting trend in the other three groups broadly matches global pattern.

Figure 2 is an aggregated picture. Examining activity for separate five year periods, we find there is not much change in terms of dominance of the above three groups namely 'enzyme related group', 'Investigation' and 'Medicinal group'. However there is change in the technology classes active within each group. In particular, 'gene therapy' (A61K 48/00) is becoming active in the later periods i.e. after 2001. Genetic engineering application in agriculture 'A01H 1/00' is also emerging as an active technology class.

The broad picture of global patent landscape (as reflected through the patenting in the US), illustrates how the biotechnology field is developing and also provides an overall perspective for examining the trends of biotechnology patenting by India. Figure 3 exhibits trends in biotechnology patenting by India during the period 1975-2007.

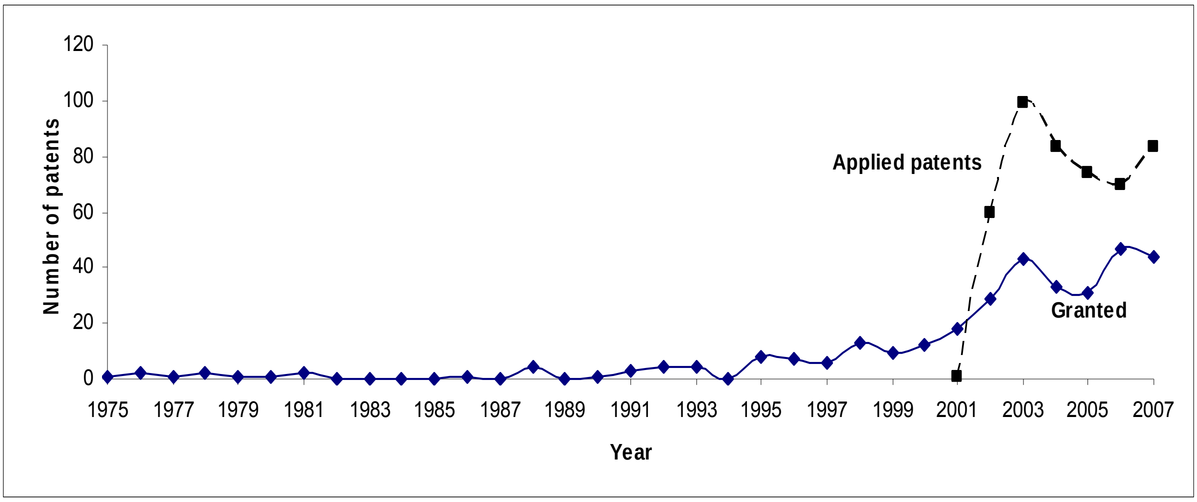

Figure 3: Patents Granted and Applications Filed during 1975 to 2007 in the USPTO by India in Biotechnology

Some interesting dynamics of patenting activity can be observed from Figure 3. A steady rise in patenting approval can be seen from 1999 onwards, reaching peak in 2003. It can be observed that the pattern of Indian patenting activity is similar to the global profile, but lags by a few years in grants as well as applications (see Figure 1). The changing policy environment and emergence of biotechnology as a major driver in pharmaceuticals seems to have a marked positive effect in the patenting activity in the country.

There were 329 patents approved from India by the USPTO during the period 1975-2007. This comprised of 241 patents granted to Indian entities (73% of the total), 62 granted to foreign entities in India (19% of the total) and the rest 26 patents (8%) to residents. Sixteen patents were granted during the period 1975-1990; foreign firms dominating this activity with 9 patents granted to them. In 1991-94 foreign firms accounted for all the 11 patents that were granted during this period. Thus pre-WTO period was dominated by foreign firms. From 2001 onwards, a substantial rise in patenting grant can be observed. Earlier periods were the formative stages. The IOP patents exhibited the maximum rise in comparison to the other two categories as 213 of the 245 patents were granted to Indian firms. However, still the major drawback is the limited number of entities involved in the patenting process. So far there have been 30 Indian entities involved in patenting activity. Surprisingly, similar numbers of foreign entities were involved in the patenting process. In both the cases, except for a few entities, the activities of majority of entities were very sporadic i.e. involved in patenting activity occasionally or sometimes it was a one time activity.

Activity within the distinct entities

One of the characteristic features of biotechnology evolution has been the involvement of varied types of organizations, and the ever increasing application areas of biotechnology. We examine this in the Indian context using patent statistics.

In the sub-set comprising Indian entities (IOP)

Table 3 shows distribution of patents across entities.

Table 3: Patents Granted to Different Types of Indian Entities during the Period 1975-2007

	Dedicated Biotechnology Firms	Pharmaceutical Firms	University	Research Institutions
Number of Entities Involved	9	7	5	9
Total Patents	29	18	8	200

One of the salient aspects that this table conveys is the involvement of various actors in the patenting activity. However, number of firms involved is miniscule in comparison to international standards. We also do not find any firm other then pharmaceutical firms involved in biotechnology patenting activity, although the target area of a few dedicated biotechnology firms were in agro-chemicals. But the dominant target areas of the dedicated biotechnology firms were again in bio-pharmaceuticals (vaccine development, molecular synthesis, etc). Ranbaxy, Lupin, Dabur, Wockhard were some of the big Indian pharmaceutical firms that seems to have incorporated biotechnology tools & techniques in their pharmaceutical research as evident from patenting activity by them (in biotechnology). However, there were some big Indian firms such as Dr Reddy's laboratories, Cadilla, Cipla, Sun pharmaceuticals missing in biotechnology research activity as evident from patent statistics. Among the universities, there were three specialised universities – in agriculture, engineering, and medical. Patenting by research institutions was dominated by the CSIR (CSIR: Council of scientific and Industrial Research, a public funded entity with 40 laboratories in different application areas of S&T; is the premier industrial research set-up in the country. Three laboratories of CSIR have biotechnology as their focus area of research). Of the 200 patents granted to research organizations, CSIR alone accounted for 182 patents.

In the sub-set comprising foreign entities

Patenting activity by foreign entities includes a more diversified set (Table 4).

Table 4: Patents Granted to Different Types of Foreign Entities during the Period 1975- 2007

	Dedicated Biotech Firm	Pharmaceutical Firms	Agro-chemical Firms	Computer Firms	University	Research Institutions
Number of Entities Involved	5	12	1	2	8	2
Total Patents	5	43	1	3	15	2

It is interesting to note that two major computer MNCs namely IBM and NEC Corporation had undertaken biotechnology related research in India. Involvement of foreign universities requires further introspection. It seems that research leading to biotechnology patents had emerged from research funds provided by foreign university. Major pharmaceutical MNCs such as Nova Nordisk, AstraZeneca, Aventis were involved in patenting activity.

Activity under Different Technology Class

Major areas of activity do not vary much across the different groups. Foreign firms are focussing on India's areas of strength that falls broadly under two areas: 'micro-organisms or enzymes: compositions, fermentation using them' and 'medical preparations' (broad domains derived from IPC codes – refer methodology section).

Main driver of research into new patentable areas were Indian entities. Indian entities had exclusively addressed four areas that cover genetic engineering and its applications namely A01H 1/00, G01N 27/327, G01N 33/54, and G01N 33/57. IOP addressing these areas show Indian firms moving into further complexity in biotechnology. Two application areas namely C02F 3/34 (water treatment), and C12S (detergents) were also exclusively addressed by Indian entities. Again it shows Indian firms moving into application domains addressing areas other then pharmaceutical applications.

Linkages of biotechnology with other industrial areas

In many respects, biotechnology is not an industry per se, but a set of technologies with the potential to transform various fields — pharmaceuticals, chemicals, agriculture, veterinary science, medicine, food production and processing, energy, even waste disposal. Using concordance between IPC and industrial classification (Schmoch et al. 2003) we examined to what extent Indian patents in 'biotechnology' are addressing different industrial sectors (Figure 4). This would show the dynamics of its patenting activity in biotechnology.

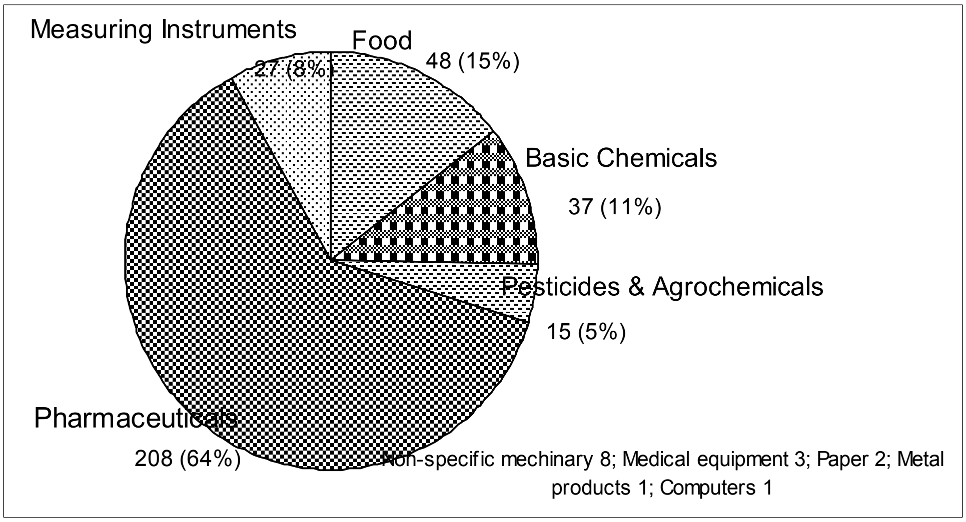

Figure 4: Different Application Areas Addressed by Biotechnology Patents of India

It is evident that pharmaceutical was the dominant area of biotechnology patent applications. This is not surprising considering the dominance of pharmaceutical firms in patenting activity. Pharmaceutical research has been transformed with the advent of molecular biology resulting in major applications of biotechnology in pharmaceuticals. World-wide major pharmaceutical firms are involved in biotechnology research and patenting activity and thus Indian biotechnology patents core focus in pharmaceuticals is reflection of the international trend. However, increasingly other areas are also aggressively addressed internationally by biotechnology patenting. As visible from Figure 4, biotechnology patents from India are also reaching out to other areas in a limited way.

Collaborative Activity

We observe collaboration among different actor's – research institutions, firms, and dedicated biotechnology firms. However, the total collaborative patents are only 6% of the total IOP patents, and 8% of the total FOP patents. The emerging scenario of 'open innovation' calls for increasing collaboration to attain strategic advantages over others. This should motivate Indian firms to collaborate more with others.

Comparison with BRIC countries

To broadly benchmark Indian activity, comparison with other BRIC countries was undertaken. The comparison was based on patents assigned to each country. Figure 5 illustrates patents grated to the four BRIC countries for the overall period (1975-2007).

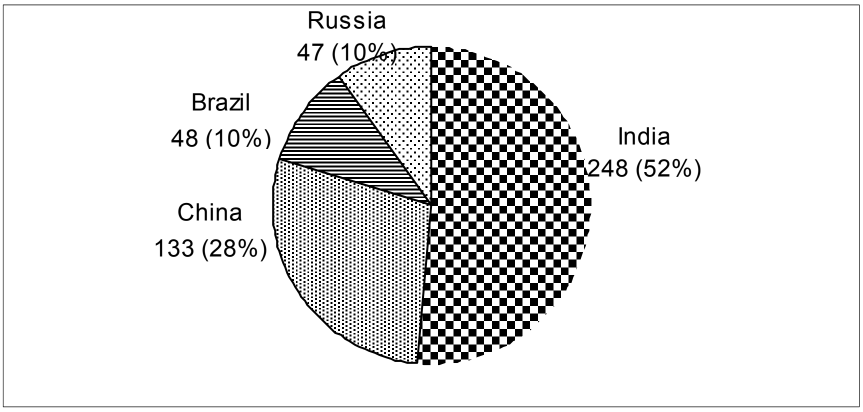

Figure 5: Patents Granted by the USPTO during 1975-2007 to the BRIC Countries*

*For each country, patents are included for those foreign subsidiaries who have provided assignment address in its subsidiary location.

Figure 5 shows that India leads the other three BRIC countries in terms of patents granted by the USPTO. The reason for its dominance was its high degree of patenting activity after 2000. China and Brazil also show positive trends. During the period 2001-05 the three countries India, China and Brazil had increased their patenting activity significantly in comparison to the overall period 1975-1990. The increase was 463%, 140%, and 256% for India, China and Brazil respectively. Russia however exhibits negative growth, its activity declined to 71% in 2001-05 in comparison to the overall period 1975-1990. One of the reasons for the increasing number of patents in these three countries was rise in the number of new classes entered i.e. increasing 'Breadth' of their patenting activity in biotechnology (Table 5).

Table 5: Exit- Entry Analysis

	75-90	91-95			96-00			01-05			2006-07		
	IPC*	**IPC**	**Entry**	**Exit**	**IPC**	**Entry**	**Exit**	**IPC**	**Entry**	**Exit**	**IPC**	**Entry**	**Exit**
India	2	4	3	1	11	8	1	18	8	1	19	1	2
China	3	5	4	2	9	4	1	17	9	3	16	2	3
Brazil	1	3	3		9	4		13	7	3	10	1	5
Russia	10	5	3	8	6	1		8	0	3	5	0	4

* IPC implies number of codes (technology classes) in which a said country was granted patents in a particular period. Entry implies technical areas where patents were granted for the first time. Exit is in the context of preceding period i.e. it signifies activity in this code in the earlier period.

Examining patent statistics it is also observed that these countries (India, China, Brazil) are deepening their activity (increasing Depth) in their traditional technological classes (classes in which they were active in earlier periods). For example from 1975-1990, India had 14, 10, 8 patents in C12P, A61K 39/00, and C12Q respectively. For the same three classes the number of patents for the period 2001-2005 was 56, 11, and 23 respectively. Similar, progression can be seen for China and Brazil. Thus, increase in number of patents in these three countries is due to increasing 'Breadth' as well as 'Depth'. However, it is more pronounced for India. Russia, erstwhile Soviet Union on the other hand had a high lead over other three countries during 1975-1990. Table 5 exhibit limited number of technology classes in which Russia is active in the later periods and also its inability to enter new technology classes. This is an important reason for its low patenting activity.

There were nine technological classes where India had no patenting activity. The technology classes mainly belong to 'Investigation' group and technology classes covering compounds of unknown constitution. It can be observed that all the above areas are niche areas with these areas being addressed by only a few leading countries. Among the BRIC countries, China and Russia each have one patent in G01N 33/74, and Brazil has one patent in C07G 11/00. In two technology classes namely CO7K 4/00 and C07G 11/00, foreign subsidiaries in India (FOP) exhibited patenting activity. India has entered in another area G01N 33/92 (Investigation group) as observed from examining patent applications filed from India in the USPTO.

Table 6 shows the results of Spearman rank correlation of BRIC countries with global patent landscape, and technological classes that experienced maximum growth w.r.t. the preceding period.

Table 6: Profile Matching with the Global Patent Landscape

	(Areas of High Growth) 2001-2005*	**Rank Correlation w.r.t World**	**(Areas of High Growth) 2006-2007****	**Rank Correlation w.r.t World**
World	G01N 27/327 C07K 17/00 C12M A01H 1/00		C07G 11/00 C07G 15/00	
India	C07K 14/00; C12P; C12Q	.413	C07K 16/00; G01N 33/54	.730
China	A61K 38/00; A61K 48/00	-.078	C07K 19/00; C12M; G01N 33/54; G01N 33/68	.919
Brazil	C07K 16/00; C07K 17/00; G01N 33/55; G01N 33/57	-.228	G01N 33/55	.624
Russia	C12P; C07K 14/00	.678	A61K 39/00	0

w.r.t. to 1996-2000*; * w.r.t. to 2001-05.*

As Table 6 shows, rank correlation except for Russia had improved in 2006-2007 in comparison to 2001-05. This implies that the three countries India, China and Brazil are showing similar levels of activity (however at a far lower intensity) with global patenting in biotechnology. Caution needs to be exercised in interpreting as rank correlation was among technology classes in which there was activity by BRIC countries with the global patent landscape. For example China was active in 16 technology classes in 2006-07 and thus the rank correlation with the world profile was only among these technological classes. Russia was active only in 5 technology classes in 2006-07 and thus its exhibiting nil correlation with global patent landscape was not surprising. Hence it is more proper to say a country with a high correlation with global patent landscape implies that in technology classes in which it is active matches the international trend.

From Table 6, it can also be observed that areas of high growth rates in the global patent landscape did not match with the BRIC countries. Among BRIC countries we observe areas of growth specific to each country.

Discussion

The paper shows significant positive rise in Indian patenting activity in applications filed as well as grants. There has been involvement of various actors in the patenting activity. Foreign MNCs are also becoming active with a substantial number of patents contributed by them. This shows that India is moving towards a higher R&D platform and attracting MNCs to conduct research in India. However, their activities are mainly concentrated in the areas where domestic entities are involved. Among the drawbacks was the involvement of a few entities in the patenting activity. Further, among them there were only a few who were active over the years. The skewed nature of activity can be gauged from the fact that approximately 76% of patents by Indian entities was accounted by a public funded research organization namely CSIR. Another matter of concern is low levels of collaborative activity. Only 6% of Indian granted patents were collaborative patents. In the era of increasing university-industry linkages, 'open innovation', global integration; calls for increasing collaborative activity particularly in niche areas where it is difficult for a country like India with limited resources to enter.

In spite of positive trends, India's patenting in biotechnology is still in an infancy stage in comparison to the global patent landscape. In the global patent landscape, significant positive changes were towards advanced areas of genetic engineering based patents such as stem cell (III generation). In biotechnology terminology India is still in I/II generation. Indian patenting activity compares well with other BRIC countries. It leads among the BRIC countries in patenting intensity. Exit-entry analysis shows that India is entering more rapidly into new areas then the other three countries. For example of the 30 IPC codes (technology classes) that define biotechnology, India was present in 19 technology classes, China in 16, Brazil in 10 and Russia only in 5 in 2006-07.

In summing up it can be said that indications derived from patent statistics show healthy trend. We have argued that this shows that a country is building up its technological capability; in this present case India. Pervasive applications of biotechnology across different industries can contribute to the improvement of many primary and industrial products. A few Indian firms have been able to cross the first stage in creating proprietary processes/products i.e. translating its R&D into patentable inventions. Translating from invention to innovation-creating novel industry processes or products that are proprietary is the next big task. That will put India in the League of Nations that are able to commercialize their biotechnology research.

Conclusions

It is difficult to judge a priori whether a particular function is simple or complex from IPC codes. Complexity typically has to be measured from the sort of activity from which capability arises. If it was possible to create a simple matrix of complexity vis-à-vis approvals under a particular patent class, an objective interpretation could be given of India's technological capability. Alas, this is not possible! To overcome this limitation, different indicators from patent statistics were constructed to provide some indication of judging technological capability. Also, a broad level categorization was undertaken to have a more informed understanding of the 30 IPC codes that define 'biotechnology'; allowing us to assess in crude way the capability question. Taking India as a case study, we have tried to demonstrate the usefulness of this approach in judging technological capability. The mainstay of this method is using patent as an indicator of technological capability. The caveat of patent as a relevant indicator in some fields then that in others do remain and is to be kept in consideration when assessing technological capability of a country using this approach.

Endnote

1. We define the global patent landscape in terms of patenting in the US patent system i.e. the USPTO. This definition has its own limitations as there are other two dominant patenting institutions namely the European and Japanese patent office. However, this limitation is overcome to a large extent in case of biotechnology patenting, as US is the hotbed of biotechnology innovation and biotechnology industry is shaped in the US.

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