DESIDOC Bulletin of Information Technology, Vol. 27, No. 1, January 2007, pp. 87-95

Delineating the Patent Data: A Case Study of Prolific Patenting Institutions of India and China†

Sujit Bhattacharya

National Institute of Science, Technology and Development Studies
Pusa Gate, Dr KS Krishnan Marg, New Delhi–110 012
E-mail: sujit@nistads.res.in

ABSTRACT

Technological capability/strength, market monopoly/success of R&D efforts are some of the indications, patents that belong to an entity signify. However, a simple patent count provides only a limited indication. Informetric analysis can be successfully applied to reveal the underlying hidden characteristics of the patent statistics. At the same time, caveats in analysing patent data and understanding the different attributes of a patent/patenting system is required to undertake a proper analysis. An investigation of prolific patenting institutions of India and China was undertaken to support the above argument. Their patenting activity in the US was investigated for the period 1998-2002. The attributes of the US patent system were used to distinguish the patent data. Patent profiles in terms of technological domains/applications were uncovered by informetric analysis. Effectiveness of the patenting activity, strategic and policy aspects were derived from this exercise. The paper attempts to make contribution towards integrating the features of the patent system, different aspects of patent statistics and tools of informetrics for deriving meaning that can be used by a wider audience.

Keywords: Patents, patent statistics, prolific institutions, patent system, patenting institutions

1. INTRODUCTION

Product differentiation is the key to compete and survive for high technology firms. At the same time, firms have to make proper safeguards to see that their innovation/invention is not infringed upon. The firms in the process have to compete with imitations of their own technology/product. Protecting its technology is one of the main reasons for which a firm wants to get patents. Patents attached to a product not only act as an indicator of reliability for the product but, also show the technological capabilities of the firm. Thus analysing patents of a country or organisation can reveal their technological capability, proprietary knowledge and possibility of creating novel patented products, etc. Inter-firm or cross-country comparisons based on patent analysis can indicate the monopoly a firm has within a technological area, and product differentiation it can undertake.

However, there are well known caveats associated with the use of patent statistics[1-3]. Patent is only one of the ways

† Part of this study could be undertaken because of the project sponsored by the Office of the Principal Scientific Adviser to the Government of India to NISTADS.

to protect an invention and thus suffers from incompleteness; secrecy, market lead, and technological complexity. Control of complementary assets are the other common modes that firms employ to protect its innovations. Importance and value of patented invention varies considerable as also the propensity to patented inventions varies across industries. Different patent laws that allow a particular type of patent, criteria in allowing a patent in a particular field, etc. make cross-country comparisons difficult.

Patents become an effective tool for an organisation (in terms of competitiveness, technology leadership, and proprietary knowledge that can be used for commercial gains, etc.) when it has a number of related patents in an application area. In other words an organisation holding a portfolio of patents in a technology domain can benefit from its patents more effectively[4,5]. Collaboration during technology development among firms possessing different complementary assets can turn out to be very useful for the product to be commercialised. High degree of collaboration/cooperation is indicated in joint ownership of technology developed and is reflected in joint patents.

Another useful approach is to have patents covering different attributes of the invention or to obtain patent in different types (an attribute of a patent system of a country). For example in the US patent system, patenting is possible under three different types: utility, design, and plant[6]. Different aspects, i.e., functional aspect (utility patent), design aspect (design patents) or the parts of a plant (plant patent) of the invention can be protected. Cited patents provides an indirect indication of the value of the patent as it helps to define the state of art in a technology field.

To derive meaning from patent statistics and apply it in policy perspective that can be used by a wider audience was the main objective of this study. Prolific patenting institutions of India/China in the US over a five year period (1998-2002) were analysed for the above objective. The extent these organisations are building up key portfolios, have different mix of patents to cover their innovation, linkages in their patents profile were also explored in the study. The granted patents were taken, as these were the intellectual property owned by the organisations. Analysing patent applications is equivalent in bibliometrics to analysing paper submitted rather then actually published[7].

Applications that are not granted patents cannot be counted as new, useful or non-obvious. Overestimation in measuring applications rather then patents granted and their non-uniform manner of distribution across countries has also been shown by Archambault[7]. This again underscores the necessity of using granted patents to show the effectiveness of patents for an organisation.

2. METHODOLOGY

Patents granted to India and China in US during 1998-2002 were downloaded from the online (USPTO) United States Patents and Trademark Office database. The downloaded data was suitably converted into a database. Prolific patenting institutions were identified, and were the focus of this study. The patents of these institutions were seggregrated under the three types: utility, design, and plant patents. Patents citing the granted patents of India/China in this period were also extracted from the USPTO database.

Each utility patent was assigned classification code (class/sub-class/groups/ sub-groups) based on International Patent Classification (IPC) (US Patent Office also assigns its own classification codes). The classification code attached to a patent define the technological class of the said patent. Each technological class is again a sub-set of industrial sector. Based on elaborate examination, Fraunhofer Research Institute has linked sub-classes of IPC into 44 industrial sectors[8].

The present study used this classification for identifying the industrial sectors that the patents addressed. The first assigned IPC code was used for attributing a patent to a particular sector (patent office also uses the first assigned code as the main technological

class of the patents). However, the other IPC codes were also taken into account for identifying those patents that address multiple sectors. Design patents protect only the ornamental features; 34 design classes defined by USPTO are there for classifying design patents[9]. Concordance scheme is not available for matching the design classes to the technological sectors. Intensity of patents being classified under a particular design class was used to measure the activity in each design class.

Further detailed investigation based on the combination of different approaches was done for identifying the technological domains and application areas of patents belonging to a particular sector. Co-word analysis of the patent titles[10] was primarily applied to uncover the technological domain/application areas. Co-word analysis was undertaken at two levels in this study.

The combination of words that extracted the maximum number of titles within a sector for each prolific institute was classified as the major technological domain within that sector, and within each technological domain, co-word analysis was again undertaken to extract the most important combinations. This defined the application areas. The result obtained were synthesised for easier representation and understanding. IPC groups and sub-groups of patents and in some cases claims were also examined to remove uncertainty/ possible outliers in the above co-word approach. In pharmaceutical patents, expert intervention was necessary to validate the results. Co-classification analysis was applied to uncover whether the said patent of a prolific institution had also addressed more then one technological sector.

In this study, sub-classes attached to each patent document were used for co-classification analysis (sub-classes were used for co-classification, as group of sub-classes was the basis of identifying a particular sector). Thus, patents that had sub-classes belonging to different sectors were identified as addressing multiple sectors.

3. RESULTS

China and India were granted 674 and 536 patents by USPTO, respectively during 1998-2002. There were a few organisations in both these countries that played a key role in the patenting process. Only eight organisations had more then ten patents during this period in India and accounted for more then 80 per cent of all granted patents. Even in China, there were only eight organisations that had at least ten patents during this period. These institutions were classified as prolific patenting institutions (Table 1).

Unlike India, the relative share of patents by the prolific institutions was considerably less in China (36 per cent) to the overall patenting. The patenting activity was spread across a number of institutions in China (314 organisations were involved in patenting activity) unlike India were only 89 institutions were involved. This may be the reason for prolific institutions accounting for relatively fewer shares of patents in the overall total in China. The marked difference between CSIR (accounting for 55 per cent of the total patents) and the rest of the prolific institutions in India highlights the skewed patenting activity in India unlike that in China were the differences in patenting activity among prolific institutions were much less. Prolific organisations in both the countries had majority of patenting activity in the later period.

A major difference was observed in the type of patents granted to the prolific institutions of the two countries. In India, except for CSIR, all the other seven prolific institutions had only utility patents. CSIR had 13 plant patents and the rest were utility patents. None of the prolific institutions of India had any design patents. In China, there was considerable difference among the patenting institutions in the type of patents they had. China Petrochemical Corporation and SINOPEC had only utility patents. On the other hand Dong Guan, Flying Dragon, C.C.& L, and Storm Electronics had only design patents. Haier Group Corporation had one utility patent and the rest design patents.

Table 1. Institutions with prolific patenting activity of India and China during 1998-2002

India		China	
Organisation/Industry	**Patents (% share in the total)**	**Organisation/ Industry**	**Patents (% share in the total)**
Council of Scientific & Industrial Research (CSIR)	295 (55%)	Dong Guan Bright Yin Huey Lighting Co. Ltd	62 (9%)
Dr Reddy' s Research Foundation	34 (6%)	China Petrochemical Corporation	59 (9%)
Ranbaxy Laboratories Ltd	29 (5%)	Flying Dragon Development Ltd	24 (4%)
Dabur Research Foundation	15 (3%)	Research Institute of Petroleum Processing SINOPEC	22 (3%)
Indian Oil Corporation Ltd	15 (3%)	C C & L Co Ltd	21 (3%)
National Institute of Immunology	12 (2%)	Storm Electronics Co Ltd	18 (3%)
Panacea Biotec Ltd	12 (2%)	Haier Group Corporation	16 (2%)
Lupin Laboratories Ltd	11 (2%)	HCT Ltd	10 (2%)

3.1 Collaborative Activity

Joint ownership of patents was indicated by more then one assignee of the said patent. CSIR, the most prolific Indian institution, had just eight patents jointly assigned. The linkages involved four research institutes and one university. Dr Reddy's Research Foundation had 29 out of its 34 patents in joint collaboration. This involved two industrial firms. However, majority of these, i.e., 23 were between its own subsidiary. Dabur had two patents in collaboration. One was with a university and another with NII (another prolific institute). Panecea Biotec had one patent in collaboration involving a university. None of the other prolific institutes had any jointly owned patents.

Out of the 59 patents of China Petrochemical Corporation, 51 had joint ownership involving three universities, eight industries, and four research institutes. Twenty-one out of 22 patents of SINOPEC were in joint ownership with China Petrochemical Corporation. This showed the strong linkages between the two oil majors in China. Haier Group Corporation had 11 of its 16 patents in joint collaboration with other entities. However, seven of these joint patents were between its own subsidiary. Unlike collaboration by other prolific firms, Haier's collaborative activity was in design leading to design patents involving collaborating partners.

3.2 Cited Profile

Cited patent indicates that it has contributed in defining the background/novelty of the invention/restricting the claim, i.e., scope of the invention (contributed in all the above aspects or at least in one of them) that had cited it[11]. Thus, intensity of citations received by patents belonging to an institution is an important indication of its invention/innovation getting noticed. The total citations received till 2003 of the patents granted during 1998-2002 to the prolific institutions increased with time. Thus, earlier patents have more chance of attracting citations. By using citation window, it is possible to nullify this effect. However, for this study this method was not used as the cited patents of an entity together were looked at. Table 2 exhibits the cited profile of the prolific institutions of India/ China.

It can be observed from Table 2 that the number of patents held by an organisation

Table 2. Cited characteristics of the prolific institutions in India/China

India			China		
Organisation/Industry (number of patents)	**Total citations received (% of self-citation)**	**Citation per patent (excluding self-citation)**	**Organisation/ Industry (number of patents)**	**Total citations received (% of self-citation)**	**Citation per patent (excluding self-citation)**
Council of Scientific & Industrial Research (295)	143 (38%)	0.5 (0.3)	Dong Guan Bright Yin Huey Lighting Co, Ltd (62)	17 (35%)	0.3 (0.2)
Dr Reddy' s Research Foundation (34)	53 (66%)	1.5 (0.5)	China Petrochemical Corporation (59)	42 (26%)	0.7 (0.5)
Ranbaxy Laboratories Ltd (29)	38 (5%)	1.3 (1.2)	Flying Dragon Development Ltd (24)	67 (7%)	2.8 (2.6)
Dabur Research Foundation (15)	15 (5%)	1(0.5)	Research Institute of Petroleum Processing SINOPEC (22)	8 (0)	0.4 (0.4)
Indian Oil Corporation Ltd (15)	23 (48%)	1.6 (0.8)	C C & L Co Ltd (21)	48 (10%)	2.3 (2.0)
National Institute of Immunology (12)	3 (0)	0.25 (0.25)	Storm Electronics Co Ltd (18)	63 (16%)	3.5 (2.9)
Panacea Biotec Ltd (12)	33 (27%)	2 (2)	Haier Group Corp (16)	27 (26%)	1.7 (1.3)
Lupin Laboratories Ltd (11)	5 (60%)	0.4 (0.2)	HCT Ltd (10)	28 (7%)	2.8 (2.6)

(size) does not have a bearing on the citations received by the prolific organisation in India/ China. Self-citations of some of the prolific institutions were also very high and can be interpreted in two different ways. It signals that there was continuity in technological developments by the organisation. However, high degree of self-citation may also indicate that other organisations were not interested in the firm's technology.

A detailed investigation was also undertaken of the type of organisations citing the patents of the prolific institutions. CSIR had been cited 55 times by itself. It had also attracted citations from multinationals like GEC, Philips, etc. However, except for Dabur, the other prolific institutions received a few citations from Indian entities. The number of distinct organisations that were citing patents of the prolific institutions in China was much higher. There were a number of multinationals as well as organisations within China who were citing patents of these prolific institutions. Table 2 also brings out the other details. An organisation's patent being repeatedly cited by another firm indicates the interest of that firm in its technology emphasising possibilities of licensing/co-licensing of the cited patents or plausibly joint technology development with the citing firm. Insignificant citations of each others patents among Indian organisations indicate that it is difficult to forge linkages for the co-development of technology.

3.3 Sector Profile

Based on utility patents (as elaborated in the methodology) it is possible to observe the patenting activity in various sectors. Tables 3 and 4 depict the detailed analyses of the technological profile of the prolific firms. 'Relative technology advantage' index was constructed to compare the activities of the organisations in the major technological sector with share of the country in the same sector[12]. Relative technological advantage of firms was defined as:

$$RTA_{IJ} = \sum_i \sum_j (Pij/Pj)/\sum i(Pi/P)$$

Table 3. Technology profile of prolific organisations/institutions of India

Organisation	Major technological sectors (no. of patents)	Relative specialisation	Major technological domains	Major application areas
CSIR	Basic Chemical (116)	1.4	Preparations of Chelates of Compounds	Catalyst, polyester, polypeptides, colloids
	Pharmaceuticals (112)	0.8	Medicinal Preparations Preparation of Hetrocyclic Compounds	Anti-bacterial Anti-fungal *Various Compounds (targeting multiple diseases)
	Food & Beverages (15)	2.5	Herbal formulations	Cosmetic treatment, insect repellents
Dr Reddy's Research Foundation	Pharmaceuticals (30)	1.6	Preparation of Hetrocyclic Compounds Medicinal Preparations Preparation of Monocyclic/ Tricyclic Compounds	*Various Compounds (targeting multiple diseases) Anti-diabetic Anti-hypertension Anti-cancer Dyslipedemia Anti-depressant
Ranbaxy Laboratories Ltd	Pharmaceuticals (25)	1.9	Medicinal Preparations Preparation of Hetrocyclic Compounds	Uro-selective adrenoreceptor blocker Anti-diabetic Cefuroxime (antibiotic) *Various Compounds (targeting multiple diseases)
Dabur Research Foundation	Pharmaceuticals (15)	2.2	Medicinal Preparations	Anti-cancer Anti-neoplastic Betulynic acid (anti-angeogynic acid)
IOCL	Basic Chemical (15)	1.2	Chemical process	Catalytic cracking catalysts
	Other Chemical (6)	1.4	Lubricating compositions	
	Petroleum products nuclear fuel (3)	20.0	Bio fuels	
NII	Pharmaceuticals (9)	1.6	Medicinal Preparations	Anti-cancer Immuno-supressive
Panacea Biotech Ltd	Pharmaceuticals (12)	2.2	Medicinal Preparations	Anti-allergy Anti-inflammatory Cyclosporin (immuno-suppressive)
Lupin Laboratories Ltd	Pharmaceuticals (12)	2.2	Medicinal Preparations	Cephalosporin (anti-bacterial agent)

where P_{IJ} is number of patents of firm J in sector iJ ; P_J is number of patents of firm j in all areas; Pi is number of patents of the country in sector i; P is number of patents of the country in all sectors.

RTA_{IJ} greater then one indicates that the organisation has higher activity/specialisation then the overall activity of the country in that sector, and vice-versa. RTA_{IJ} equal or nearly equal to one implies that the firm's specialisation matches with the specialisation of the country in that sectors/sub-sector. Thus higher the value indicated more the relative advantage of firm in a sector in the country (only the major sectors in which patents were addressed

Table 4. Technology profile of prolific firms of China

Organisation	Major technological sectors (No. of patents)	Relative specialisation	Major technological domains	Major application areas
China Petrochemical Corporation	Basic chemical (43) petroleum products, nuclear fuel (8)	4.0 6.5	Chemical process Cracking liquid hydrocarbon	Catalysts acrylic compounds Carboxylic compounds
SINOPEC	Basic chemical (22)	5.6	Chemical process	Catalysts

Co-word analysis had extracted various compounds. Meaning of terms in brackets, derived from expert inputs.

by the firms were only taken; hence index has high values).

In general, CSIR reflected the overall patenting activity of the IOP patents. It is interesting to note that in spite of high degree of activity in pharmaceuticals by CSIR, it had RTA less then one. CSIR exhibits leadership in the area of 'food and beverages'. Only 15 patents of CSIR in 'food and beverages' dominated the overall patenting activity of the country (in this area). High RTA_{IJ} value of IOC in 'petroleum products' indicated its dominance in this area in the country. Both the prolific firms holding utility patents in China (exception of one patent of Haier) had high degree of activity in basic chemicals. The other important salient points can be derived from Table 3.

A patent addressing more then one sector can have spin-off applications in different sectors/sub-sectors and thus can be much better appropriated. Co-classification analysis exhibited that only few patents had addressed multiple sectors. Out of 295 patents of CSIR, only 26 patents had addressed multiple sectors. Most of them were in pharmaceutical sector. The other sectors prominently linked with pharmaceutical were chemical (basic chemical, pesticides and agrochemicals), and food and beverages. Only two patents of NII and one patent of Dr Reddy's had addressed multiple sectors. Five patents of the China Petrochemical Corporation and three patents of SINOPEC were in multiple sectors. Basic chemicals had linkage with petroleum products and nuclear fuel in all the cases.

Using the approach as elaborated in the methodology section, the design areas in which patents were granted to Chinese firms were uncovered. Sixty-two design patents of Dong Guan Bright Yin Huey Lighting Co Ltd were covered within lighting. Similarly, Flying Dragon Ltd had 22 of its 24 design patents in the same class of lighting. Storm Electronics Co had design patents related to accessories of electronic devices, e.g., cover for mini computer or a gun for electronic games, etc. Co-word analysis of the titles of design patents of each organisation with more details is given in Table 5.

Table 5 essentially brings out the fact that large number of design patents have been taken by each of these firms to cover essentially identical variations of a single thing.

4. DISCUSSION AND CONCLUSIONS

It is difficult to uncover the strategy behind patenting activity of firms/research institutions by just examining the patent profile. But in spite of these limitations, critical examination reveals some important aspects and pointers. The results underscore the fact that some firms in India and China are seriously pursuing innovation/invention. Another encouraging sign is that efforts to obtain patent portfolio in some specific areas of technology/design are visible. Hopefully, this should translate into visible leads in some areas. Indian firms having no design patents are a matter of concern. However, except for CSIR all the other prolific firms have patents mainly in pharmaceuticals where design patents do not fall. CSIR has a number

Table 5. Design activity of prolific institutions of China

Organisation	Application area of design
Dong Guan Bright Yin Huey Lighting Co Ltd	Various lamp shades/type s (47) Lantern (2)
Flying Dragon Development Ltd	Torchlight related (8) Various lamp shades/types (4) Lantern (3)
C C L & Co Ltd	Calculator (5) Torchlight related (2)
Storm Electronics Co Ltd	Electronic games (9)
HCT Ltd	Cosmetic container (7)
Haier Group Corporation	Freezer with drawer below(2)

of utility patents in machinery, electrical tools, etc. Design patents in these areas by CSIR would have given them important protection.

In spite of similar technological profiles (pharmaceutical and chemical), no Indian prolific organisation possessed joint patents. For a research institute like CSIR, joint technology development is important as it can leverage the complimentary skills of a firm to translate the invention into commercial scale. Licensing, in general provides only a limited appropriation. Most of the prolific organisations in China are involved in design patents. This calls into question the level of invention/innovation of prolific Chinese firms as utility patents are in true sense the result of actual inventive/innovate activity. However, the two chinese prolific firms that have utility patents are both oil majors; their strategic linkage is reflected by the number of joint patents they have.

Organisations filing design patents or plant patents may have different reasons for doing so. It can be used to protect the functional aspect of the invention that is covered by the utility patent. Just like design patents add some sort of protection to a particular utility patent by means of protecting the design, similarly plant patents provide some kind of protection to the main utility patent protecting invention related to the plant. This may be true for an organisation that has a portfolio of patents in utility category. CSIR has taken some initiative in this regard by covering its utility patent in mint extraction with four plant patents in mint. The plant patents claims new and distinct variety of mint plant with high menthol content, high biomass, high oil yield, tolerance to rust, etc. Haier also has one utility patent in freezer and two design patents covering this utility patent.

In China, most of the prolific firms that have patents in design category are holding substantial number of design patents on one particular manufactured good. Design patents are very weak and appropriate only in limited circumstances. Nevertheless, design patents can be useful when overlapping protection is created[13]. For example a firm can focus its R&D efforts towards creating novel designs covering essentially identical variation of an artifact. The firm can then file for proprietary protection (design patents) on these different designs. Therefore, if competitors were to step in they would have to get around a large number of weak patents, a task not very easy to do so in many cases. The firm may have the required license to manufacture a particular product and thus wants to protect its innovative design. It seems Chinese firms are following this strategy. The study made an attempt of patent analysis along with understanding the different attributes of the patenting system. It reveals new insights that can help to access the technological capability of an organization/country and can

be important input for formulating technology policies.

REFERENCES

1. Pavitt, K. Patent statistics as indicators of innovative activities: possibilities and problems. *Scientometrics*, 1985, **7**, 77-99.

2. Basberg, B.L. Patents and the measurement of technological change: A survey of the literature. *Research Policy*, 1987, **16**, 131-41.

3. Tong, X. & Frame, J.D. Measuring national technological performance with patent claims data. *Research Policy,* 1994, **23**, 133-41.

4. OECD, Intellectual property: Technology transfer and genetic resources. An OECD survey of current practices and policies, 93-123.

5. Wakelin, K. Trade and innovation: Theory and evidence. Massachusetts, Edward Elger.

6. USPTO manual of patent examining procedure, Ed 8, Ch 600, 1500, and 1600. 2003.

7. Archambault, E. Methods for using patents in cross-country comparisons. *In* Proceedings of the 8th International Conference on Scientometrics and Informetrics, 2001 Sydney Bibliometrics & Informetric Research Group, UNSW. pp. 41-59.

8. Schmoch, U.; Laville F.; Patel, P. Linking technology areas to industrial sectors. Final report to the European Commission, 2003.

9. http://www.uspto.gov.go/classification.

10. Bhattacharya, S.; Kretschmer, H. & Meyer, M. Characterising `intellectual spaces between science and technology. *Scientometrics*, 2003, **58**(2), 369-90.

11. Meyer, M. What is special about patent citations? Differences between scientific and patent citations. *Scientometrics*, 2000, **49**(1), 93-123.

12. Debackere, K; Luwel, M. & Veugelers, R. Can technology lead to a competitive advantage? A case study of Flanders using European patent data. *Scientometrics*, 1999, **44**(3), 379-400.

13. http://www.ipwatchdog.com/design_patents.html.

Contributor

Dr Sujit Bhattacharya obtained his PhD from the Indian Institute of Technology Delhi, New Delhi for his work on Informetrics. He has a number of publications in international journals, has co-authored two books, and co-edited one book. He is a member of the International Collaborative Network, COLLNET; and also of the International Programme Committee for the biannual International Conference of Scientometrics, World Patent information and Research Policy. He has recently completed a study on Indian Patenting Activity for the Office of the Principal Scientific Adviser to the Govt of India. His areas of interest include Scientometrics and Informetrics (patent-related studies) and technology, trade and IPR. Presently, He is working as Scientist E1 at NISTADS.