Delineating the Patent Data: What Does it Reveal? A Case Study of Prolific Patenting Institutions of India and China[1]

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Abstract
Technological capability/strength, technological/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 analyzing 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 (*i.e. of prolific patenting institutions*) patenting activity in 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/application area 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 to deriving meaning that can be used by a wider audience.

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 and the firm in the process have to compete with imitation products of their own developed technology/product. Protecting its technology is one of the main reasons for which a firm wants to get patents. *But this may not be the only reason and sometimes the prime reason for which a firm goes for patents protection*. Patent attached to a product can act as an indicator of reliability for the product. Patents in a particular high technology area can show the technological capability of the firm. Thus analyzing patents of country or organizations can reveal the technological capability, proprietary knowledge it owns, 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, product differentiation it can undertake, its technology gap, etc.

However, there are well known caveats associated with the use of patent statistics (see for example Pavitt 1985, Baseberg 1987, Tong & Frame 1994): patent is only one of the methods in protecting an invention and thus suffers from incompleteness; secrecy, market lead, technological complexity, and control of complementary assets are the other common modes that firms employ to protect its innovation; importance and value of patented invention varies considerable; propensity to patent inventions varies across industries; different patent laws that allow a particular type of patent, criteria in allowing a patent in a particular field, etc. makes cross-country comparisons difficult.

Patents become an effective tool for an organisation (in terms of competitiveness, technology leadership, 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 appropriate from its patent more effectively (OECD, 1996b), (Wakelin, 1997). Collaboration during technology development among firms possessing different complementary assets can turn out to be very useful for the product to be commercialized. High

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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 (USPTO Examiners Manual, 2003). Different aspects of the invention can be protected i.e. functional aspect (utility patent), design aspect (design patents) or the parts of a plant (plant patent). 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

Objective of this study was to derive meaning from patent statistics and apply it in policy perspective that can be used by a wider audience. Prolific patenting institutions of India/China in the US over a five-year period, 1998-2002 was analysed to address this objective. The extent these organizations are building up key portfolios, have different mix of patents to cover their innovation and exhibit linkages in their patents profile were explored in the study. The granted patents were taken, as these were the intellectual property that was owned by the organizations. The author agrees with Archambault (2001) that analyzing patent applications is equivalent in bibliometrics to analyzing paper submitted rather then actually published. 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 (2001). This again underscores the necessity of using granted patents to show the effectiveness of patents for an organisation.

Methodology

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

Each utility patent is assigned classification codes (class/subclass/groups/subgroups) based on IPC (International Patent Classification) (*US patent office also assigns its own classification codes*). The classification codes attached to a patent define the technological class of the said patent. Each technological class is again a subset of industrial sector. Based on elaborate examination, Fraunhofer Research Institute has linked sub-classes of IPC into 44 industrial sectors (Schmoch, *et.al*. 2003). The present study used this classification for identifying the industrial sectors that the patents addressed. The first assigned IPC code was used (patent office also uses the first assigned code as the main technological class of the patents).

Design patents protect only the ornamental features and there exists thirty-four design classes defined by USPTO for classifying design patents (classes are described on the online USPTO web site; http://www.uspto.gov.go/clasification). 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.

The above exercise of identifying technology sectors was further supplemented with co-word analysis of the patent titles (Bhattacharya, 2003). This approach helped to uncover the technological domain and the application areas. The co-word analysis was undertaken at two levels. 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. Within each technological domain again co-word analysis was done to extract the most important combinations. This defined the application areas. The result obtained were synthesized for easier representation and understanding. Co-classification analysis was applied to uncover whether the said patent of a prolific institution had also addressed other technological fields. The co-classification was based on the multiple IPC classifications attached to each patent.

Results

China and India were granted 674 and 536 patents by USPTO respectively in the period 1998-2002. Figure 1 highlights the patents granted to them (by USPTO) in this period (1998-2002).

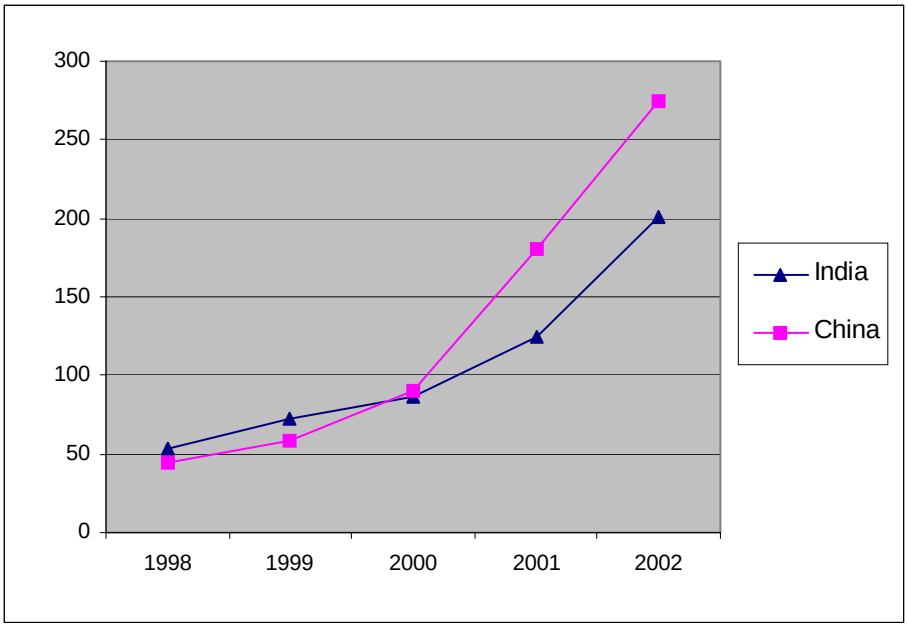

Figure 1 exhibits the increasing trend in patents being granted to both India and China during this period. There were a few organizations in both these countries that played a key role in the patenting process. Only eight organizations had more then ten patents during this period in India and accounted for more then 80% of all granted patents. Even in China, there were only eight organizations that had at-least ten patents during this period. *These institutions were classified as prolific patenting institutions and their patenting activity was examined in details in this paper.*

The table 1 below exhibits the prolific patenting institutions of these two countries.

Table 1: Institutions with prolific patenting activity of India & China (1998-2002)

India		**China**	
Organizations/ Industries	**Patents (% share in the total)**	**Organizations/ Industries**	**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 Limited	29 (5%)	Flying Dragon Development Ltd.	24 (4%)
Dabur Research Foundation	15 (3%)	Research Institute of Petroleum Processing SINOPEC	22 (3%)
Indian Oil Corporation, Limited (IOCL)	15 (3%)	C. C. & L Company Limited	21 (3%)
National Institute of Immunology (NII)	12 (2%)	Storm Electronics Company Limited	18 (3%)
Panacea Biotec Limited	12 (2%)	Haier Group Corporation	16 (2%)
Lupin Laboratories Limited	11 (2%)	HCT Limited	10 (2%)

Unlike India, the relative share of patents by the prolific institutions was considerably less in China and contributed 36% to the overall patenting. The patenting activity was spread across more 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 less share of patents in the overall total in China. The marked difference between CSIR (accounting for 55% 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 organizations 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.

Collaborative activity

Joint ownership of patents was indicated by more then one assignee of the said patent. Interesting picture emerged on examining this data. CSIR, the most prolific Indian institution had just eight patents jointly assigned. The linkages involved 2 ministries, 2 research institutes and 1 university. Dr. Reddy's Research Foundation had 29 out of its 34 patents in joint collaboration. This involved 2 industrial firms. However, majority of these i.e. 23 were between its own subsidiary. Dabur had 2 patents in collaboration. One was with a university and another with NII (another prolific institute). Panecea Biotec had 1 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 Corpn., 51 patents had joint ownership involving 3 universities, 8 industries, and 4-research institute. Twenty-one out of 22 patents of Sinopec were in joint ownership with China Petrochemical Corpn. 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.

Cited profile

Cited patent indicate 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 (Meyer, 2000). 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 in the period 1998-2002 by the prolific institutions were uncovered. The citations receive generally increase with time and thus earlier patents have more chance of attracting citations. By using citation window, it is possible to nullify this effect. However, for this study we have not used this method, as we are interested to look at the cited patents of an entity together. 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 organization (size) does not have a bearing on the citations received by the prolific organization in India/China. Self-citations of some of the prolific institutions were also very high (refer Table 2). Self citations can be interpreted in two different ways. On hand it signals that there is continuity in technological development by the organisation. However, high degree of self-citation may also indicate that other organisations are not much interested in the firm's technology.

Table 2: Cited characteristics of the prolific institutions India/China

India				China		
Organizations/ Industries (Number of patents)	**Total citations received (% of self citation)**	**Citation per patent (excluding self citation)**		**Organizations/ Industries (Number of patents)**	**Total citations received (% of self citation)**	**Citation per patent (excluding self citation)**
CSIR: 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 Limited (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, Limited (IOCL) (15)	23 (48%)	1.6 (0.8)		C. C. & L Company Limited (21)	48 (10%)	2.3 (2.0)
National Institute of Immunology (NII) (12)	3 (0)	0.25 (0.25)		Storm Electronics Company Limited (18)	63 (16%)	3.5 (2.9)
Panacea Biotec Limited (12)	33 (27%)	2 (2)		Haier Group Corporation (16)	27 (26%)	1.7 (1.3)
Lupin Laboratories Limited (11)	5 (60%)	0.4 (0.2)		HCT Limited (10)	28 (7%)	2.8 (2.6)

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

Sector profile

Based on utility patents (as elaborated in the methodology) it is possible to observe the patenting activity in various sectors. Table 3 and 4 depicts the results of the analysis. "Relative technology advantage" index was constructed to compare the activity of the organizations in the major

technological sector with share of the country in the same sector (inspired by earlier work, see for example Debackere et. al. 1999).
Relative technological advantage of firms was defined as:

$RTA_{IJ} = \sum_i \sum_j (P_{ij}/P_j) / \sum_i (P_i/P)$

P_{ij} = number of patents of firm j in sector i ; P_j= number of patents of firm j in all areas; P_i= number of patents of the country in sector i; P=number of patents of the country in all sectors

Table 3: Technology profile of prolific firms 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	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	Pharmaceuticals (25)	1.9	Medicinal Preparations Preparation of Hetrocyclic Compounds	Uro-selective adrenoreceptor blocker Anti-diabetic Cefuroxime (antibiotic) *Various Compounds (targeting multiple diseases)
Dabur	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	Biofuels	
NII	Pharmaceuticals (9)	1.6	Medicinal Preparations	Anti-cancer Immunosupressive
Panacea Biotech	Pharmaceuticals (12)	2.2	Medicinal Preparations	Anti-allergy Anti-inflammatory Cyclosporin (immuno-suppressive)
Lupin labs	Pharmaceuticals (12)	2.2	Medicinal Preparations	Cephalosporin (anti-bacterial agent)

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 (*it should be noted that we have taken only the major sectors in which patents were addressed by the firms; hence we have high values for this index*).

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

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

Table 3 & 4 was the resultant of the detailed analysis of the technological profile of the prolific firms. In general, CSIR reflected the overall patenting activity of the IOP patents. It is interesting to note that inspite of high degree of activity in pharmaceuticals by CSIR, it had RTA_{IJ} less then one. CSIR exhibits leadership in the area of "food & beverages". Only fifteen patents of CSIR in "food & 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 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 this table.

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 only few patents had addressed multiple sectors. Out of 295 patents of CSIR, only 26 patents had addressed multiple sectors. Most of them involved pharmaceutical sector. The other sectors prominently linked with pharmaceutical sector were chemical sectors (basic chemical, pesticides & agrochemicals), and food & beverages sector. Only two patents of NII and one patent of Dr Reddy's had addressed multiple sectors. Five patents of China petrochemical corpn. were in multiple sectors. Three patents of Sinopec were in multiple sectors. Basic chemicals had linkage with petroleum products & nuclear fuel in all the cases.

Using the approach as elaborated in the methodology section, we have uncovered the design areas in which patents were granted to Chinese firms. Dong Guan Bright Yin Huey Lighting Co. Ltd with all of it's 62 design patents showed that most of them 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 provides some more details. The table 5 below highlights this.

Table 5: Design activity of prolific institutions of China

Organization	**Application area of design patents**
Dong Guan Bright Yin Huey Lighting Co., Ltd.	Various lamp shades/Types**(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 Limited	Cosmetic container**(7)**
Haier Group Corporation	Freezer with drawer below**(2)**

The above table 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.

Conclusions and Discussions

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 some degree of efforts to obtain patent portfolio in some specific areas of technology/design is visible. Hopefully, this should translate into visible signs of 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 had a number of utility patents in machinery, electrical tools, etc. Design patents in these areas by CSIR would have given them important protection. Inspite of Indian prolific organisations having similar technological profile (pharmaceutical and chemical), there were no joint patents between any of them. For a research institute like CSIR, joint technology development (one of the indicators is joint patents) is important as it can leverage the complimentary skills of a firm to translate the invention into commercial scale. Licensing provides in general only a limited appropriation.

Most of the prolific organizations 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 prolific firms that have utility patents are both oil majors and their strategic linkage is reflected by the number of joint patents they have.

Organizations 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 organization 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 (*IPWatchdog.com*). For example a firm can take significant number of design patents to cover essentially identical variations of a single thing. Therefore if a competitor 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 had made an attempt to exhibit that patent analysis along with understanding the different attributes of the patent system reveals new insights. This can help to access the technological capability of an organization/country and can be important input for technology policy.

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