An Heuristic Analysis of Long-Life Leading Companies in Orders of Patent Applications

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Abstract : The numbers of unexamined publications of patent applications for Japan of every IPC sub-class and for every year from 1995 to 1998 were ordered according to their applications, and percentages. After comparing data for 1995 and 1998, it is found that some gaps with large decreases discriminate changes in the orders of applicants who cannot overcome the gap in some years in more than 70% of the cases. This analysis can predict long-life leading companies. The data also indicate the biased distributions of R&D among Japanese companies

1. INTRODUCTION

In 1992, Mr.Tadakazu TAJIMA counted pre-examined publications of patents in Japan and calculated the HHI of several fields (Tajima, 1992). At the, time he was interested in the Japanese industrial situation in order to resist the abolition of the Utility Model Law. In 1996, he found that Japanese industries were under hard competition as the HHI of every sub-class field of International Patent Classification was very low, and the Utility Model Law was still necessary.

I calculated the same data of uploaded database and obtained new HHI. Over several years I compared both and found there are some sub-classes which have distinguishable large gaps of percentages of applicants. Over a few years, there are changes of orders among applicants higher than the gap and among ones lower than the gap, but there are very few changes jumping over the gap. For these discriminatory gaps, there is some suitable value, and we can make an heuristic analysis and prediction of long-life leading companies from the data. We further wish to use the data for international comparisons of quality of R&D.

Before reporting our result, we must discuss the statistical characteristics of patent applications:

a) Patent applications are arbitrary according to the characters of applicants, their policy and different fields of industry.

b) There is no standard as to the economic value and the significance of each patent. Some patents have good capacity to monopolize the market, some do not even have the invented technology which can be very high, and there are differential prices of single patent applications.

c) Patents are influenced by science and technology, and the market. We cannot evaluate the changes of patent values from only the results of R&D, or from an influence of the economic situation.

We cannot use the value of patent applications as being similar to the value of money, populations, and so on. However, the values of patents (applications, registered, numbers of infringements) have a large relation to the economy, and we must use same kind of values.

Here we introduce the orders of the numbers of patent applications, which have large meanings when there are some distinguishably large differences in values.

This logical procedure is introduced as a heuristic approach in identifying long-life leading companies, which are often called "price-leaders".

2. LOGICAL PROCEDURE IN IDENTIFYING LONG LIFE LEADING COMPANIES

We know one or two of the important companies in every field of industry, which always make new products and keep a leading position in the competitive market. They have the largest market shares and are often called "price leaders" and their sale prices are the upper limit in the market. Other companies make similar products, but the prices must be lower than these of the price leaders.

Such a position of a company is based upon the capacity to exploit new products. The capacity is also based upon the R&D of the company, which can be evaluated with high-ranking patent applications.

We analyzed the patent applications for Japan from 1995 to 1998 by comparing the orders of both lists, and found there are some distinguishable gaps in the numbers of patent applications which discriminate the leading companies and following companies. The discrimination of the upper and lower companies substantially indicates the existence of Gulliver and Lilliputian companies, and also makes the industrial structure clear in respect of R&D.

3. DATA AND ASSUMPTIONS

We obtained the comma-separated-value files of the lists of names of patent applicants, and the numbers of applications of every sub-class on the International Patent Classification, from 1994 to 1998 of pre- examined publication.

An application is published one year and a half after its application, and applications from July 1993 to June 1994 are published in 1995 as a rule. In this paper, we call the published year the "application" year.

We used data from 1995 to 1998, as 1994 was a bubble age, and the number of the applications was too larges.

The range was as follows.

a) Sub-classes of IPC from A01B up to H05K.

b) Distribution of applications is compared between 1995 and 1998.

c) Values of patent applications were assumed to be equal.

The data were combined in two tables, with macro program of Lotus 1-2-3, i.e. Table I of a year (1995) and Table II for a sub-class.

The first page of Table 1 (available on request) used in the study is discussed below, with an explanation of letter references:

A: International Patent Classification (sub- class)

B: Sub-class applications (only main classification; for joint application, the number is duplicated for each applicant: the same as below)

C: Sub-class applicants

D: Sub-class applications (1/100), (the reason is discussed below.)

E: Sub-class applicants (1/100)

F: HHI within Sub-class

G No. of applications in 1998

H: Increase

I - R: Percentage of Applications from the Top to the 10th

T -U: Gap between Top & 2nd, 2nd & 3rd, and 3rd & 4th.

V: Threshold point (8.5% here, explanation in Section V.)

W: Sequence (number of applicants remaining higher than T)

AA - AJ: Rankings in 1998 of applicants who are in the top ten in each sub-class in 1995. (For example, an applicant who was 3rd in 1995 and became 7th in 1998 is shown with a figure "7" on the 3rd.) Data comparing 1995 and 1998 may be not very accurate for categories added or eliminated in the sub-class because the IPC was revised from the 5th edition to the 6th edition.

4. HYPOTHESIS AND CONDITION

Now we take an applicant of the "i-th" number of application of cases in "I" year is changed to the "j-th" in "J" year in a certain technical field. If there is a huge gap between the "n- th" and the "(n+1)- th" in "I" year of the field, rank order rarely changes between the two groups ranked before "n" and after "(n+1)", even if a change occurs within the group. Then we call the discriminating huge gap as "threshold". For "I" and "J" years, whichever comes first does not affect the result.

The following conditions and hypotheses are established.

Condition 1:

Applicants whose numbers of applications are less than 1/100 of the top applicant are not counted.

Condition 2:

Sub-classes whose applications number less than 30 are eliminated from the investigation, and the noise from less industrialized fields is omitted. In this case, the cell of V is 0.

Hypothesis 1:

We set a value of discriminatory gap of differences of percentage of patent application and call it "threshold".

In a case where a difference in the percentage of the number of applications exceeds a threshold in 1995, a change of an applicant's order does not exceed this point in 1998.

Hypothesis 2:

For subelasses which have no gap greater than the threshold level, the top applicants would be interchanged.

For the value of threshold, we explain in Section V. Here we temporarily set it to be 8.5%.

5. ANALYSIS

Comparing the cases of A01B and A01C in Table I, we see the percentages of applications of first to fourth applicants, and we find there is no gap in difference more than 8.5 in A01B, but there is such gap between the first and second of A01D.

	1st	2nd	3rd	4th
A01B	16.56	14.59	12.46	12.30
A01C	40.02	21.24	15.75	9.80

Checking Table 2, we find the first applicant of A01B changes between 1995 and 1998, but there is no change in A01C._Also from the AA column, we see the first applicant of 1995 of the A01B changes to third in 1998, but first of A01C keeps its position.

Applying Condition I and Hypothesis 1, we count 236 applicants above the gaps in 121 sub-classes with a difference of more than a threshold by the 6th rank, and there are 93 without changing the top company, scoring 40.4% of hits.

Applying Condition 2, the score increases to 76.86.

We also apply Hypothesis 2, making cells of V and W as 1, and values change to 132, sub-classes without changing the top company, with 250 whose top companies are replaced with others, scoring 65.33% of hits. Total points of Hypotheses 1 and 2 is 68.15%. Thus, these hypotheses are supported with high probability.

6. DETERMINING AN OPTIMAL THRESHOLD

We determine a threshold value of the discriminatory gap of the differences of percentages of patent applications.

Then we estimate the case of a threshold between "n"-th and "(n+1)"-th in 1995. I counted how many companies of 1995 high-ranking firms remained as top companies in 1998, which is considered as one score. If "q" companies of "p" companies remain, "q" scores are obtained from "p" scores. This is indicated in the V-X column; it is in the total of all sub-classes, respectively, which is 40%, or 93 of 244 when the threshold is 8.5%. Thus, this is the calculation of how many higher companies in 1995 remain as high-ranking firms in 1998.

The discriminating condition changes with the value of the threshold. The number of high-ranking companies decreases as the threshold increases by 3% from 0.5% to 20% and the maximum is 8.5% with an M-shaped distribution of hit ratios. Table 3 shows the relation of threshold values and hit-rates under the condition 2.

Table 3: Threshold value and hit-r ate

Threshold (%)	V	W	W/V*100 %
3	382	227	59.42
5	212	150	70.75
7	150	115	76.67
8	134	102	76.12
8.5	121	93	76.87
9	113	86	76.11
10	102	75	73.53

Here, the threshold is optimal at 8.5. When there is no difference exceeding a threshold before the 6th rank, the display of a sequence is vacant.

In addition, if the threshold is made small, it becomes a threshold immediately with early ranking, or higher ranking increases, and ranking changes can hardly be detected. If the threshold is enlarged too much, there is no point in any differences greater than the threshold, and there is no high-ranking Gulliver-type enterprise. It would become impossible to identify high-ranking firms for purposes of discussion here.

The 8.5 threshold value is optimal for the 3-year period between 1995 and 1998. The value can be changed, depending on the purpose and time period of research.

7. RESULTS

Using the data we obtained, the following results arise:

(i) In case a threshold exists between these high-ranking companies:

"i"-th –"(i+1)"- th > 8.5%

Then, companies above the threshold may be interchanged with each other. While companies below the threshold would also move irregularly within the lower ranks, they would rarely move to upper the threshold.

This clearly demonstrates that these high- ranking companies maintain their price-leaders as the status in the long-term, with a capacity to develop new technologies.

(ii) In sub-classes where there are no gaps larger than the threshold, competition become fierce and influences high-ranking companies to change frequently.

8. FURTHER FINDINGS

During the analysis, we found some additional results.

1) The HHI and some of the upper three companies are almost linearly related in this data.

2) HHI tends to become smaller as applications in a sub-class increase. There are 5 sub-classes whose HHI are higher than 1000. The highest two are:

G03C : 3170

A01D : 1666

3) The discriminating gaps are rarely in the IPC sub-classes, where HHI is very small.

4) There are some companies which have extremely large numbers of applications. In the case of G02B, Canon Company had 472, Olympus Optics 381, Nikon 388 in 1995, but in 1998 Nikon had 434, Canon 409, and Olympus 294. Olympus made glass fibers for medical use in the G02B field. The number of Canon was very large. Canon Company submits large numbers of applications. For instance, in B41J Canon made 1098 applications, whereas the top-share company Seiko-Epson only made 427. Considering the estimated shipment numbers of the products, Canon made 4 times the applications of Seiko-Epson. To calibrate those tendencies, we must use some weighting functions.

9. CONCLUSIONS AND IMPLICATIONS

(i) High-ranking companies maintain and secure Gulliver-type status as price-leaders with fundamental R&D, while other small businesses are relegated to a catching-up status.

(ii) The industry is clearly divided into two groups :

a) Gulliver-type price-leader companies, with an ability to undertake state-of-the-art technology, and

b) Dwarf-type companies, who try to catch-up.

10. ACKNOWLEDGEMENT

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11. REFERENCES

TAJIMA Tadakazu "Nihon no Kogyo - Shoyuken no Tokucho" Patento 45-4 (1992)

Table 1No. of patent applications and the changes of orders of applicants from A01B (available on request)

Table 2: Orders of Applicants and No. of applications from 1994 to 1998 (A01b and A01c)

A01B	1994		1995		1996		1997		1998	
1	Kubota Corporation	87	Kubota Corporation	81	Yanmar Co.,Ltd.	101	Kubota Corporation	87	Mitsubishi Agricultural Machinery Co., Ltd.	92
2	Iseki & Co.,Ltd.	42	Iseki & Co.,Ltd.	59	Kubota Corporation	89	Iseki & Co.,Ltd.	81	Iseki & Co.,Ltd.	69
3	Yanmar Co.,Ltd.	17	Yanmar Co.,Ltd.	57	Mitsubishi Agricultural Machinery Co., Ltd.	76	Mitsubishi Agricultural Machinery Co., Ltd.	72	Kubota Corporation	57
4	Mitsubishi Agricultural Machinery Co., Ltd.	16	Mitsubishi Agricultural Machinery Co., Ltd.	30	Iseki & Co.,Ltd.	75	Yanmar Co.,Ltd.	66	Yanmar Co.,Ltd.	39
A01C	1994		1995		1996		1997		1998	
1	Kubota Corporation	203	Kubota Corporation	248	Kubota Corporation	343	Kubota Corporation	239	Kubota Corporation	249
2	Yanmar Co.,Ltd.	100	Yanmar Co.,Ltd.	172	Yanmar Co.,Ltd.	182	Yanmar Co.,Ltd.	201	Iseki & Co.,Ltd.	119
3	Iseki & Co.,Ltd.	98	Iseki & Co.,Ltd.	161	Iseki & Co.,Ltd.	135	Iseki & Co.,Ltd.	111	Yanmar Co.,Ltd.	112
4	Mitsubishi Agricultural Machinery Co., Ltd.	46	Mitsubishi Agricultural Machinery Co., Ltd.	60	Mitsubishi Agricultural Machinery Co., Ltd.	84	Mitsubishi Agricultural Machinery Co., Ltd.	71	Mitsubishi Agricultural Machinery Co., Ltd.	88