Toward the patent thicket detection : an empirical study on Japanese ARIB patent pool

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Toward the Patent Thicket Detection: An Empirical Study on Japanese ARIB Patent Pool*

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Abstract

Patent pool may be the solution for dissolving the economic inefficiencies caused by the existence of the patent thicket. In order to determine whether this is the case or not, the index that clarifies the existence of the patent thicket is necessary. In this paper, using the simple index (which Clarkson(2005) proposed) focused on the citation relationship of the patent network, I examine whether there exists patent thicket over the patent space surrounding Japanese ARIB patent pool. On the contrary of Clarkson's results, the density of citation in the pooled patent intra-network is thinner than that in the patent space surrounding the pool. However, through focusing on the relationship between pooled patents and their "hull", it is verified that there exists patent thicket over the ARIB patent pool.

Keywords: Patent Thicket, Patent Pools, Antitrust
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1. Introduction

Innovation has the cumulative characteristics. As many observers pointed out, each scientist "stands on the shoulders of giants", and new invention depends crucially upon many previous scientific and/or technological findings.[1] Addition to this, in some industries such as ICT industries, the products rely on output of inventive activities across the various technological fields. In fact, to produce digital equipments, the firm should utilize not only the output of inventions about the electronic technology, but also the output of inventions about optic technology, and so on. So, the commercialization of new technology needs to the integration of the so many underlaid inventions.

On the other hand, the intangible assets such as the output of inventive activities have the public goods characteristics: non-rivalry and non-excludability. So, in almost countries, to promote inventive activities and innovation, the government grants the patents on the output of the inventive activities.

However, when the patent system is adopted, it faces the difficulties that the firm integrates the various inventions in order to achieve the commercialization of new technology. These difficulties are exacerbated especially when the patentees of the various inventions are dispersed. In this situation, as Shapiro(2001) pointed out, those seeking to commercialize new technology should "navigate the patent thicket" and obtain licenses from many patentees.

The existence of the patent thicket causes the various inefficiencies of the innovative activities. Firstly, because the firm which commercializes the product should bargain with the patentees to obtain licenses, the firm is forced to burden the huge bargaining costs. Secondly, the risk of hold-up problem may reduce the innovative activities. The firms often commit to the investment of the manufacturing facilities prior to the production of the goods. When there exists the patent thicket over the technologies which the firm utilizes in order to produce the goods, the risk of the patent infringement is increased. This risk may confer the fatal damages to the firm due to the injunction of the production and/or compensation for the patent infringement. Taking account of this risk, the firm may reduce the

[1] To this cumulative characteristics of invention, see Scotchmer(1991).

innovative activities. Thirdly, the existence of the patent thicket may bring about "the tragedy of the anti-commons" that is pointed out by Heller & Eisenberg(1998). As the above discussion suggests, the firm that navigates the thicket should obtain licenses from the multiple patentees. Because a pile of license fees decrease the supply of the goods which is produced using the licensed patents, not only the supplier of the goods but also the various patentees cannot gain the profit.

As these inefficiencies are brought about by the lack of the coordination among the patentees, the economic institutions which encourage the coordination may solve the inefficiency problems. In this meaning, as Shapiro(2001) emphasized, the institutions such as cross-licensing, the patent pool and standard-setting may promote the efficiency of innovative activities where there exists the patent thicket. In fact, in some industries such as ICT industries which so many patents are issued in the similar technology fields, we can observe the formation of the above institution. Of these institutions, I focus the patent pool in this paper.

However, because the patent pools are often formed by the competitors, antitrust authorities concern with the competitive effects of the patent pool. So, the antitrust authorities monitor the patent pool and judge whether the pool invites the monopolization of the product market and/or technology market. If the authority judges that the monopolization of the market is caused by the pool, the antitrust authority decides to dissolve the pool. In fact, as Carlson(1999) and Gilbert(2002) examined in detail, the patent pool had denied commonly by the FTC before 1980's in U.S.[2] In Japan, JFTC(Japan Fair Trade Commission) decided to dissolve the patent pool on the manufacturing of the "pachinko" machine, a Japanese upright pinball game, based on the discussion of the monopolization of the market.

So, from the standpoint of competition policy, it is necessary to divide the "efficient" patent pool with "monopolistic" patent pool. To this division, we should construct the measures that answer the following two questions empirically: 1) is the proposed patent pool the solution for the "patent thicket" problem? and 2) does the proposed pool bring about the anticompetitive effects?

Recently, Clarkson(2005) proposed the simple index for the patent thicket

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[2] Recently, FTC judges the patent pool by inquiring the terms of license and the relationship among the patents in the pool. See Gilbert(2002).

detection which is able to apply the judgment of the above question 1). Using the method of patent informatics, he constructed the index based on the density of the citation relationship of the patents. He determined whether there exists patent thicket, comparing the density of the patent pool with the density of the surrounding patent space. If the density of the pool is thicker than the density of the patent space surrounding the pool, it is concluded that there exists "patent thicket" .

In order to calculate the index, it is necessary to define "the network" comprised of many patents. The reasonable definition of the network is the following three networks, which Clarkson also adopted: 1) the network of the pooled patents, which is defined by a set of the patents that form the pool, 2) the network of the "snowball sample" or "near universe" of the pooled patents, which is a set of the patents that cite the pooled patents or are cited by the pooled patents (including the pooled patents), 3) the network of the "complete universe" of the pooled patents, which is defined by a set of the patents that have the same patent classes with the pooled patents. Clearly, when there exists patent thicket, it is expected that the density in the network 1) is thicker than that in the network 2), and that the density in network 2) is larger than that in the network 3). In fact, Clarkson has shown that this is the case in the MPEG patent pool and the PRK (photorefractive keratectomy) patent pool.

After defining the network of the patents, the index is calculated by focusing the citation relationship of the intra-network of the patents. The density of citation in the intra-network is interpreted as the ratio of the number of citations (g) to the possible number of citations. So, the index Clarkson proposed is calculated by dividing the former with the latter. Considering that the patent applied early cannot cite the patent applied later, in the network that is formed by n patents, the index Δp is derived as

$$\Delta p = g / [n(n-1)/2]. \qquad (1)$$

In this paper, using the index Δp, I examine the networks of the Japanese ARIB patent pool. Through this examination, I analyze whether ARIB patent pool is the solution for the "patent thicket" problem. In addition to this, I also consider the validity and the limitation of the above index. Through these examinations, I show that although the index is useful for patent thicket detection, it is irrelevant to focus only the comparison between the density of the pool and the density of the patent space

surrounding the pool. To detect patent thicket, we should examine not only the above comparison but also the relationship between the pooled patents and the "snowball sample" patents.

In the section 2, I review the Japanese ARIB patent pool, explain the sample of the networks of the patents and examine the above index over this patent pool. In section 3, I consider how the results derived in the section 2 are explained. Section 4 concludes.

2. The density of the citation in the networks of ARIB pool

2.1 Japanese ARIB patent pool

Japanese ARIB patent pool is comprised of the essential patents related to the production of the digital broadcasting equipments. This pool was advocated by 5 Japanese electrical appliance manufacturing firms (Sharp, Sony, Nippon Victor, Matsushita and Mitsubishi) and was formed in 2006. The pool is conducted by Nippon Uldage that is capitalized by the above 5 firms.[3]

Kato(2006) reviewed the background of the formation of this pool. In the ICT Industries, the formation of the traditional patent pools was based on each technological standard. For example, MPEG Video patent pool was concentrated to the video technologies, and MPEG4 Audio patent pool was comprised of the patents related to the audio technologies. But, because of the technology-based characteristics of the pools, the electric firm was forced to obtain licenses from the various patent pools in order to produce the goods. So, it was necessary for the electric firms to pool the patents across the technology-based patent pools. In this background, the electric firms advocated the formation of the "product-based" patent pool.

To achieve the formation of this kind of pool, only the patents that is indispensable truly to the production of the digital broadcasting equipments should be collected. To this purpose, the pool collected the essential patents across the technology fields. The essential patents that should be contained in the pool are judged by the third party, Japan Intellectual Property Arbitration Center. As a result, 218 essential patents on the production of the digital broadcasting equipments owned by 13 patentees are collected in

[3] On the formation of ARIB pool, see Doi, et.al. (2008).

the pool as of 2007/10/01.

The terms of license is determined by the meeting comprised of the 13 patentees. In the ARIB pool, the calculation of the license fee is based on the number of patents at present. More Importantly, the patents contained in the pool are licensed to the licensees based on the FRAND conditions.[4] So, the firm which enters to the production of the digital broadcasting equipments is able to obtain licenses all together from the pool. The Japanese antitrust authority, JFTC, permitted the formation of this pool, considering these characteristics of the pool.

2.2. The sample

In this subsection, I explain the sample that is used to calculate the index discussed in the Introduction. To this end, it is necessary to collect the systematic data of citation of each patent. So, I used the IIP (Institute of Intellectual Property) Japanese patent database constructed by Goto & Motohashi(2007).

Of the 218 patents contained in the ARIB patent pool, 130 patents are matched to the IIP Japanese patent database. I used these 130 patents and constructed the network of the pooled patents. As mentioned in the Introduction, in order to examine the existence of the patent thicket, the networks that are compared with the pooled patents should be constructed. As the comparative objects, I constructed two networks based on the 130 patents of the pool: the "snowball sample" network and "complete universe" network of the ARIB patents. To compare with the pooled patents correctly, the patents contained in these two networks are limited to patents applied between the earliest application date of the pool patents (1988/04/28) and the latest application date (2002/09/02). The "snowball sample" network of the pooled patents is comprised of the patents that cite the above pooled patents or are cited by the pooled patents (including the pooled patents). Based on the 130 patents of the pool, the "snowball sample" network has 316 patents. Third network, "complete universe" network is defined by the network of the patents that have the same IPC subclass with the pooled patents. As the result of calculating based on 130 patents, this network is comprised of 82,497 patents.

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[4] FRAND condition means fair, reasonable and non-discriminatory conditions of license.

To observe the characteristics of the ARIB pool, it is useful to check the 130 sample patents of the pool. Figure 1 shows the ratio of number of patents owned by each pool member in the ARIB pool sample. Clearly, the essential patents which are necessary to produce the digital broadcasting equipments are owned by several established electric firms. Especially, the ratio of the patents owned by 5 Japanese electrical appliance manufacturing firms, which advocated the formation of the ARIB pool, accounts for 60% of the pool. This suggests that the patentees of the ARIB pool patents are dispersed, and that the formation of the pool is necessary to solve the patent thicket problem.

By observing the IPC class which each pool patent has, we can see the other characteristic of the ARIB pool. Figure 2 shows the ratio of number of the patents classified by IPC subclass in three networks. The IPC subclass that was attached to the patents in the ARIB pool extends to 8 technological fields. This suggests that the technologies embodied in the patents in the ARIB pool are diversified. This fact shows us the "product-based" characteristic of the ARIB pool. In addition, figure 2 also shows that the ARIB pool is formed, focusing mainly on IPC subclass H04J (multiple communication).

2.3. The density of citation in the networks

In this subsection, I calculate the index shown in (1) and check whether there exists patent thicket surrounding the ARIB pool. Because the index shown in (1) refers the density of citation relationship in the networks, I show the citation relationship in the network visually.

Figure 3(a) and 3(b) show the citation relationship of the pooled patents and in the "snowball sample" intra-network, respectively.[5] In the figures, small circles express the patents in the network and lines between small circles refer the citation relationship between patents. At first glance, it is guessed that the density of citation of the pooled patents is thinner than that of the "snowball sample" network.

To calculate the index shown in (1), the number of citations in the intra-networks is necessary in addition to the number of the patents in the networks. So, after calculating these numbers, I derived the value of the index in each network. Table 1 shows the results.

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[5] These tables are drawn by the software for drawing the network, *Pajek*.

From table 1, it is verified that the density of citations of the ARIB pooled patents and in the "snowball sample" intra-network are statistically significant thicker than that in the "complete universe" of the pool. Therefore, it is suggested that there exists patent thicket over the patent space surrounding the ARIB pool. However, on the contrary of Clarkson's results on MPEG pool and PKR pool, the density of citation in the intra-network of the ARIB pool is thinner than that of "snowball sample" of the pool. In addition, this relation is statistically significant. So, by only comparing the pooled patents with the patent space surrounding the pool, the existence of the patent thicket is not identified.

How is the above result explained? And over the ARIB pool, does the patent thicket detected? If so, how? These questions are treated in the next section.

3. The Essentiality of the ARIB patents and the Density of the Citation

3.1. The hypothesis

As mentioned in the previous section, the Japanese ARIB patent pool collected only the essential patents which are truly dispensable to the production of the digital broadcasting equipments. In addition, the judgment on the essentiality of the patents is delegated to the independent and neutral third-party. So, technologically, it is interpreted that the patents on the output of the applied and/or development research are excluded from the pool. Rather, the patents on the technologies which secure the interoperability among the constituents of the product may be mainly included in the pool.[6]

Considering the cumulative nature of innovation, the applied and/or development research activities are carried out based on the output of the basic research. As far as the output of the basic research is expressed by the essential patent, the applied and/or development research activities are conducted by using performance of the essential patents. Therefore, the patents on the applied research which is located outside the pool are expected to cite the essential patents located in the pool.

Figure 4 represents this situation visually. In this figure, small circles

[6] On this point, I got the useful comment from Prof. Gavin Clarkson.

express the patents and the lines combined between the patents show the citation relationship. Moreover, the patents located at the lower (upper) position are the pooled patents (the patents on the applied research). Reflected the above situation extremely, patents at the upper position cite the pooled patents, while pooled patents does not cite the other patents at all.

Calculating the index Δp in this figure, the value of the index in the intra-network of the pool is 0. On the other hand, in the intra-network of the "snowball sample" of the pool, the value becomes $1/9$ ($=5/[(10\times9)/2]$). So, if the situation expressed in the figure 4 is established, the density of citation in the intra-network of the pool is thinner than that of the "snowball sample"!

3.2. Empirical Analysis

The crucial characteristics of the situation expressed in the figure 4 are that the pooled patents are essential, and are cited by many patents on the applied research. In order to examine the essentiality of the pool patents, I focus on the "snowball sample" of the pooled patents.

As well known, the candidate index that measures the essentiality of the patents are the average number of cited patents and the average number of claims described in the patent document.[7] Here, I check the essentiality of the pool patents using these measures. To do this check, it is necessary to show that the patents in the pool are more essential than the other patents belonged to the "snowball sample". By observing the "snowball sample" is comprised of two categories: the patents in the pool and the patents outside the pool, I examine the essentiality of the pooled patents.

Table 2 shows the average number of cited patents of the pool patents and of the patents outside the pool (called by outside ARIB) focusing to the intra-network of the "snowball sample". The average number is 3.34 in the ARIB pool patents and 2.05 in the patents outside ARIB pool. The hypothesis test about the mean reveals that the former is larger than the latter statistically significantly. As this result proves that the pooled patents are relatively more essential than the other patents, it is interpreted that the situation expressed in the figure 4 appears over the ARIB patent pool.

Table 2 also shows the average number of the cited patents of the patents

[7] On this point, for example, see Tradjenberg(1990).

in the intra-network of the "complete universe". The average number is 1.86 and is statistically significant smaller than the number of the ARIB pool and the "snowball sample" of the pool. Consistent with the measure of the density of citation, it can be observed that the patent space expressed by "snowball sample" become the ball combined by the citation relationship of the patents.

The results of second candidate measure, the average number of the claims, on the essentiality of the patents are expressed in table 3. Although the average numbers of the claims have no difference between the pooled patents and in the patents outside the pool, the numbers in the intra-network of the "snowball sample" is much larger than the number in the "complete universe" intra-network. In this meaning, over the "hull" patent space surrounding the pooled patents, essential patents are thickly distributed.

Considering the above observations and the fact which the patentees of the pooled patents are dispersed, it can be concluded that there exists the patent thicket over this patent pool.

4. Concluding Remarks

In this paper, I consider the measure which can detect the existence of the patent thicket using the method of the patent informatics. It is examined whether there exists the patent thicket over the patent space surrounding Japanese ARIB patent pool using the index which Clarkson(2005) proposed. On the contrary of Clarkson's results on MPEG and PRK pool, the empirical analysis shows us the following fact: although the density of citation of the pooled patents and in the "snowball sample" intra-network is thicker than in the "complete universe" intra-network, the density in the pool is thinner than in the "snowball sample". So, the comparison of the density between the pool and the patent space surrounding the pool may not produce the adequate detection of the patent thicket.

However, this result is caused by the characteristics of the ARIB pool which collects the essential patents. In fact, as examined in the previous section, this result is consistently explained by classified "snowball sample" patents into two categories and by checking the essentiality of the pooled patents. Therefore, the above examination using Clarkson's index suggests

that there exists "patent thicket" in the patent space surrounding ARIB pool. In the meaning of this, although the index proposed by Clarkson is still useful for detecting "patent thicket", to focus on the relationship between the pooled patents and its "snowball sample" is very important for the detection of "patent thicket".

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Figure 1: Number of patents owned by each pool member in the ARIB pool sample (ratio; %)

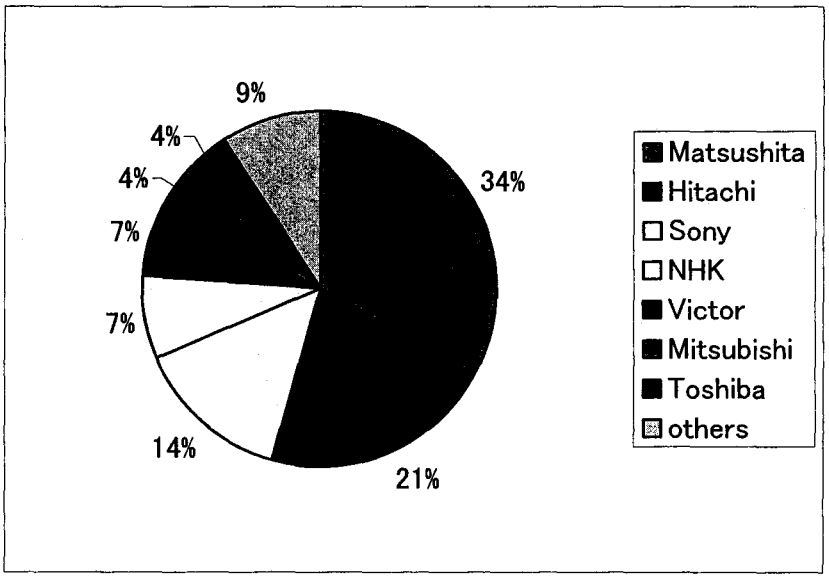

Figure 2: The number of patents contained in each network (clasified by IPC subclass); ratio(%)

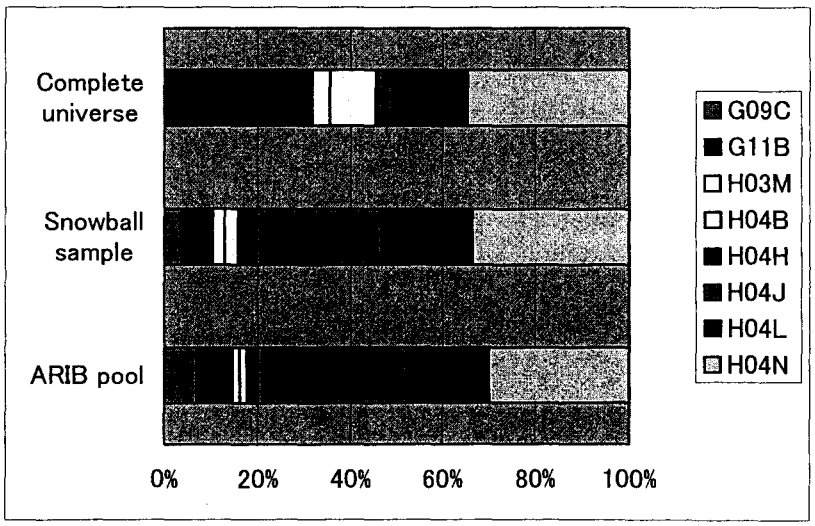

Figure 3(a): Citation relationship in the pool network

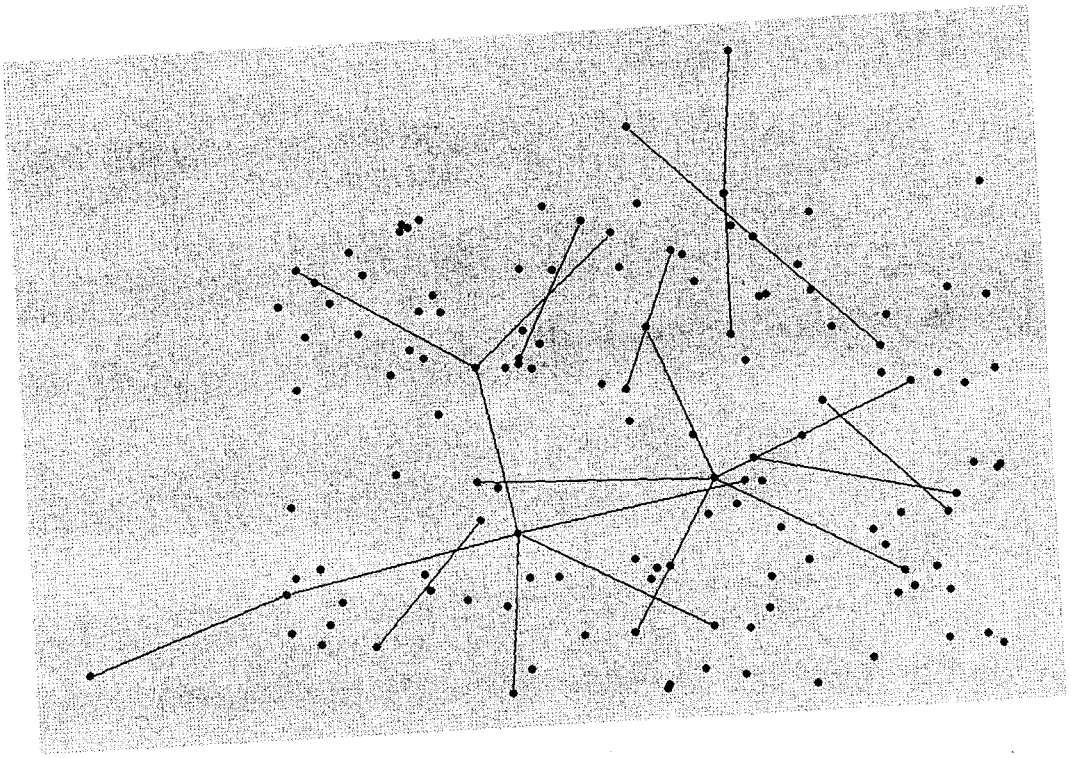

Figure 3(b): Citation relationship in the "snowball sample" network

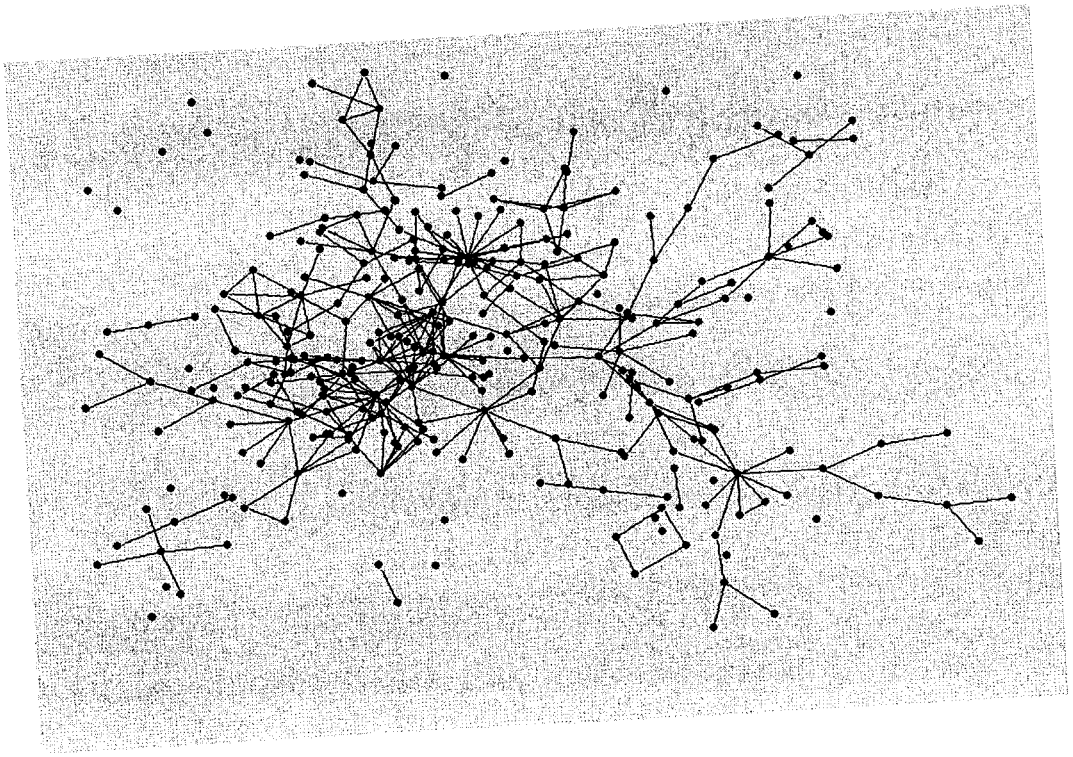

Table 1: The Density of Citation in each intra-network

network	ARIB POOL	Snowball sample	Complete universe
number of pat.	130	316	82497
number of citation	22	323	41590
Index of the densit	0.002624	0.006490	0.000012
ARIB POOL	--	-4.2648[a]	68.3844[a]
Snowball sample	--	--	411.7645[a]

Note: The values in the 2 rows from the bottom represent the t-value. Moreover, "a" shows statistically significant at 1% level.

Figure 4: The Illustration of the hypothesis

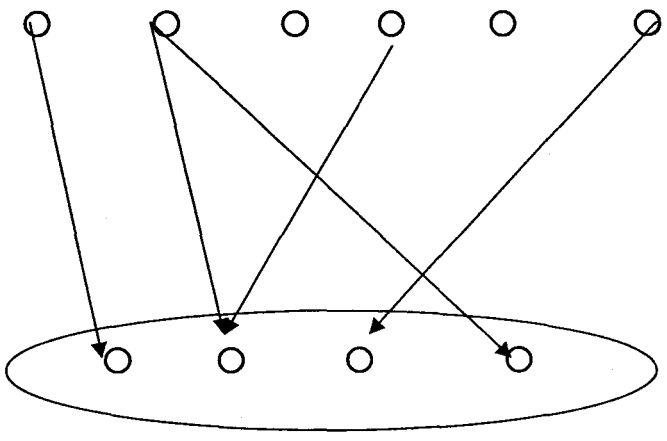

Table 2: The result about the number of the cited patents

	n	mean	ARIB Pool	Outside ARIB	Snowball Sample
ARIB Pool	44	3.3409	--	--	--
Outside ARIB	86	2.0465	2.2453[a]	--	--
Snowball Sample	130	2.4846	1.4425	-1.5471	--
Complete Universe	22658	1.8356	2.7374[a]	1.2138	2.8953[a]

Note: The values in the 3 columns from the right represent the t-value. Moreover, "a" shows statistically significant at 1% level.

Table 3: The result about the Number of the Claims

	n	mean	ARIB Pool	Outside ARIB	Snowball Sample
ARIB Pool	130	7.9077	--	--	--
Outside ARIB	186	7.4140	0.5489	--	--
Snowball Sample	316	7.6171	0.3400	-0.3048	--
Complete Universe	82497	4.3714	4.7766[a]	5.9484[a]	7.5839[a]

Note: The values in the 3 columns from the right represent the t-value. Moreover, "a" shows statistically significant at 1% level.