Implicit Patent Alliance Acquiring the Appropriability of Innovation: A Case Study on Inkjet Printer Companies

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Abstract--**This paper proposes a new innovation management scheme called "implicit patent alliance," and discusses its effectiveness and the conditions required to enact such a scheme with case study of inkjet printers.**

"Implicit patent alliance" is a patent management scheme in order to create appropriability of innovation. In many markets except a few such as medicine and chemicals, essential patents may not help patentees to dominate the market, because products consist of many essential patents distributed among companies. This situation gives opportunity for many companies to enter the market, and makes the existing patent system ineffective in the process of innovation appropriability.

If few companies have essential patents and they cross-license only among them and do not license to their competitors that have no essential patent, a collection of these cross-licenses would work as a virtual alliance which can occupy essential patents. We call this virtual alliance "implicit patent alliance". Implicit patent alliance is capable to create appropriability of innovation thanks to occupying essential patents even in the markets such as electronics and machinery where one product consists of many patents.

In the ink-jet printer market, three patentees of essential patents, Canon, EPSON and Hewlett-Packard, have been in the relation of cross-license only among them. They did not license to outside alliance and dominated the market.

I. INTRODUCTION

Innovators cannot sustain their motivation if they are unable to acquire profit from their innovative efforts. The appropriability of innovation, the process of creating innovation value and acquiring profit from that value, is a central issue in business management.

The exclusive rights that are supported by the patent system are effective with respect to innovation appropriability. However, certain reports and research papers claim that patent cost exceeds the benefit of patent proprietorship. Many examples are cited where tough patent walls did not result in profits for the patent holder.

This paper proposes a new innovation management scheme called "implicit patent alliance," and discusses its effectiveness and the conditions required to enact such a scheme.

II. THE DEFINITION OF IMPLICIT PATENT ALLIANCE

The exclusive rights offered by a patent system may enable a patentee's product to dominate the market. This is true with respect to chemicals and medicines where limited essential patents are provided for individual products, and those patents may be held by a single company. Such patents create the appropriability of innovation.

Many essential patents exist for one product within industry sectors such as electronics and machinery. This is because each product is composed of a number of complex technologies and a corresponding number of patents. Essential patents are distributed among companies, which are then able to enter the market. This situation makes the existing patent system ineffective in the process of innovation appropriability.

The patent system, however, may have the potential to encourage the appropriability of innovation if few companies are permitted to hold essential patents and they license their patent rights bilaterally, and only amongst themselves. This relationship acts as a virtual company group of essential patent holders. The group is able to completely occupy essential patents and prevent companies outside the group from entering the market, by using their exclusive rights to these essential patents. This virtual group of essential patent holders does not require one explicit agreement signed by all patentees because cross licenses can be contracted bilaterally, and the collection of independent cross license agreements forms the virtual group of essential patent holders. This research paper names this virtual group an implicit patent alliance and defines it as the following:

> *If there are relatively few essential patent holders and they employ a contract cross license bilaterally only among themselves, the collection of independent cross license agreements forms an implicit patent alliance that is able to occupy the execution rights of patents*.

III. PRIOR RESEARCH

Innovation is widely recognized as an engine for economic growth and a central issue in business management. Although innovation may succeed in creating new value, it may fail to provide enough profit for innovators to compensate for the expense of innovation [1] . Certain research papers describe examples of cases where innovation expenses exceed the profits that the innovation creates. These examples include cases such as quartz wristwatches [2], digital television sets [2], and optical disks [3]. Therefore, the appropriability of innovation is a central issue concerning innovation management [2]. The patent system, which provides exclusive rights of invention for a certain term, is

expected to support appropriability.

Certain reports claim that the patent system does not contribute to the appropriability of innovation: Carnegie Mellon Survey [4], NISTEP Survey [5] and Barkley Survey [6]. These surveys showed competitive factors such as early marketing, business secrecy, patent systems, and inquired business farms, which is the most effective factor with respect to the appropriability of innovation. These reports claim that the patent system contributes less than business secrecy and early marketing. The book *Patent Failure* calculated the cost of patent litigation and found that company value increased because of patents; however, the book insists that the patent system is not worthwhile because patent litigation exceeds company value [7].

The research papers and the book claim that the contribution of patents to the appropriability of innovation varies depending on the industry. For example, *Patent Failure* illustrates that the contribution of patents is significant in the chemical industry, particularly with respect to medicine, but is minimal in other industries.

This paper proposes the patent management scheme, an implicit patent alliance that will create the appropriability of innovation utilizing patents even in industries where many essential patents already exist. This paper examines the scheme's effectiveness using an inkjet printer case study.

This paper proposes a new innovation management scheme and names it an implicit patent alliance. This scheme may be one style of alliances among firms. Yoshino and Rangan defined a strategic alliance as processing simultaneously the following three characteristics[8]:

- The two or more firms that unite to pursue a set of agreed upon goals remain independent subsequent to the formation of the alliance.
- The partner firms share the benefits of the alliance and control over the performance of assigned tasks.
- The partner firms contribute on a continuing basis in one or more key strategic areas, e.g. technology, products, and so forth.

An implicit patent alliance may satisfies some parts of the definition by Yoshino and Rangan but does not other parts of the definition as this paper describes in the following sections in detail. The partner firms of an implicit patent alliance remains independent subsequent to the formation of the alliance, but do not share an explicit agreement upon goals. The partner firms of an implicit patent alliance share the benefits of the alliance, but do not control explicitly over the performance of assigned tasks. These differences cause to adopt "implicit alliance" to name the new management scheme, and distinguish an implicit patent alliance from other alliance schemes proposed up to now.

A patent pool is a well-known patent alliance among essential patent holders, and satisfies the definition of strategic alliance by Yoshino and Rangan. It is defined as a scheme for one-stop licensing to license all patents of the patent pool members with one license agreement [9]. Patent pools function effectively for the licensing of standard essential patents and may promote the popularization of innovations [10]. Rayna and Striukova reported that a patent pool does not provide extra profit for patent holders who have initiated innovation and possess many essential patents, although it may provide profit for poor patent holders who possess patents and cannot afford licensing expenses with their licensing income [11]. This analysis indicates that an implicit patent alliance differs from a patent pool in terms of objective and function.

This paper describes a case study concerning inkjet printers. Because an inkjet printer is a well-known example of innovation, many research papers study inkjet printers [12] [13] [14]. However, no paper describes an implicit patent alliance of an inkjet printer. Because patent management is essential for business, many papers and books study patent management [15] [16]. However, no paper describes an implicit patent alliance as a patent management scheme.

IV. RESEARCH QUESTIONS

If the implicit patent alliance is formed and functions effectively, it can occupy all essential patents and provide a basis for the appropriability of innovation. However, no prior research exists that describes similar implicit patent alliance. This paper addresses two research questions to examine appropriability through an implicit patent alliance.

RQ1: Is the implicit patent alliance able to create appropriability of innovation?

RQ2: What are the conditions required for the development and ongoing performance of an implicit patent alliance.

Bilateral cross licenses are common in patent licensing. RQ1 will examine whether the cross licensing scheme can be employed to create appropriability. RQ2 will examine the conditions required for the development and ongoing performance of an implicit patent alliance. Following the establishment of an implicit patent alliance, other companies are still able to create new essential patents for advanced technologies and to enter the market. These emerging essential patents can render the occupation of essential patents by the implicit patent alliance ineffective. RQ2 will examine how the implicit patent alliance can compete with newcomers to the market.

V. RESEARCH METHODS

This paper focuses on a case study concerning inkjet printers because they represent a widely recognized and typical example of innovation. First, inkjet printers provide high-quality color printing devices for personal use. Before

the introduction of inkjet printer technology, a convenient way of printing photographic-quality color documents from personal computers did not exist. Inkjet printers represent a societal innovation. Second, inkjet printers emerged from the electronics industry in which there are many essential patents awarded to one product. The appropriability of innovation is, therefore, considered difficult within the existing patent system. Third, the number of essential patent holders is three, which is a relatively small number but minimum number to form an alliance. This case provides an ideal background for the examination of an implicit patent alliance.

This paper utilizes extensive accessible information such as published reports and papers. Because inkjet printer technology has developed into a substantial revenue-providing industry, there are many reports and papers on the topic of implicit patent alliance including a paper written by patent professionals from a particular company [17]. This paper describes a list of essential patents and the patent strategy. Disclosed patent information is useful in the examination of a possible scheme to create and maintain an implicit patent alliance. International patent classification (IPC) contributes to an analysis of patents filed by companies.

The background of inkjet printers is reviewed in the next section, to highlight the process of establishing and maintaining an implicit patent alliance.

VI. A CASE STUDY OF INKJET PRINTING COMPANIES IN JAPAN

This section describes the development of inkjet printers, objectively, to provide a background from which to analyze the development and ongoing performance of an implicit patent alliance.

Inkjet printers eject small drops of ink to print characters on printing material. This fundamental principle was known and patented prior to 1950s; however, the technology was not established to the extent that it could be applied to commercial products. Two breakthroughs marked the introduction of inkjet printers. The first breakthrough was the on-demand inkjet head that could eject ink drops small enough to print characters, and only when the printer required it. The second breakthrough was the multi-nozzle inkjet head that could accommodate a number of tiny nozzles in a small area of the printer head. The inkjet head contained independent nozzles that could eject different color ink independently and facilitated high-quality color printing and high-speed printing.

Two different systems were developed to implement the on-demand and multi-nozzle inkjet head described: the thermal system developed by Canon and Hewlett-Packard and the piezoelectric system developed by Epson. Both systems are still adopted in current products. The principle behind the thermal system is that each nozzle contains a small heater that heats ink liquid within an ink channel to make bubbles. These bubbles then push the ink to an outlet in the nozzle that ejects drops of ink. The principle behind the piezoelectric system is based on the piezoelectric element. When voltage is applied to the element, it changes form and generates force. Each piezoelectric element is small and can be mounted on a tiny inkjet nozzle. The piezoelectric element on each nozzle pushes the liquid to eject tiny drops.

The historical development can be divided into two stages [18] described in Section VI.A.

A. The First Generation of Inkjet Printers

Canon invented a new thermal system (bubble jet) for inkjet printers in 1977, and filed several patent applications in 1977 and 1978. The bubble jet printer head heats ink liquid within an ink channel to make bubbles, which pushes ink to an outlet in the nozzle and ejects drops of ink. There are two types of boiling mechanisms, namely, nucleate boiling and film boiling. Nucleate boiling is a popular method in industry, for example, boiling a kettle or boiling using an industrial boiler are examples of nucleate boiling. However, nucleate boiling is not effective in controlling bubbles because it generates random proportions of bubbles at random times. Film boiling occurs when liquid is rapidly heated. Bubbles form a thin film over a heating surface and delay heat transfer to the liquid. This mechanism is more efficient in controlling bubble volume. The inventor discovered that bubble jet utilizes film boiling and wrote his patent applications based on this discovery. This discovery led to fundamental essential patents that were not replaced by newer patents.

Although the invention of the bubble jet was innovative, there remained many technical obstacles to practical inkjet printer application. Canon succeeded in resolving these problems systematically.

Hewlett-Packard began the development of inkjet printers based on similar technology and filed their first patent application for thermal inkjet technology in 1981. Hewlett-Packard delivered their first commercial inkjet printer, the ThinkJet, in 1984. Canon delivered a trial product in 1983 and a completed product, the BJ-80, in 1985.

Epson was developing another inkjet, featuring the piezoelectric inkjet head, and filed their first patent application for a piezoelectric element inkjet in 1978. Epson filed the first patent application for a layered piezoelectric element inkjet in 1983. In 1984, the company delivered their first inkjet printer, the IP-130K.

These products were historically significant; however, they were too expensive to succeed as commercial products. The price of the ThinkJet was ¥120k, the BJ-80 was priced at ¥170k, and the IP-130K was priced at ¥500k. The structure of the inkjet head was too complex for production technology at that time to produce at a reasonable cost.

B. The Second Generation of Inkjet Printers

Canon organized a company-wide project to develop inkjet printers that would appeal to a large market in 1987 [12]. Canon applied plastic molding and an excimer laser to construct a massive production system that was capable of producing precise inkjet heads at a significantly lower cost. Using this production system, Canon delivered a BJ-10V printer in 1990 with a printing resolution of 360 dpi and at a reasonable price. Hewlett-Packard delivered the DeskJet500 with a resolution of 300 dpi.

Epson began a new project, the KH project, in an effort to implement a small inkjet head that could compete with Canon [19]. They succeeded in reducing the inkjet head by one tenth of its existing size, and delivered the MJ-500 with a 360dpi resolution.

In addition to the production system, another innovation concerned inkjet printer technology and involved the precise ejection of ink drops. High-quality color printing requires that the inkjet printer control the ink drops precisely so that drops are ejected in an accurate and stable direction and the ink drop size is controlled. Uncontrolled ejection direction and size degrades the printing resolution and color quality.

Canon invented an ejection control method for bubble jet based on fluid dynamics and filed their patent applications during the period 1990 to 1999. Epson invented an ejection control method based on electric pulses that drive the piezoelectric elements. Epson filed their patent applications in 1992.

Full color printers were implemented as a result of these innovations. Canon delivered the BJC-820 in 1992, and Epson delivered the MJ-700V2C in 1994. The MJ-700V2C provided printing resolution of 720dpi but its price was less than ¥100k. It sold out at 300,000 units. The demand for inkjet printers increased rapidly in 1990s and market size reached ¥4,000 million, as indicated in Figure 1.

Inkjet printers matured in the second generation, and their core technologies are classified below.

1. The structure of the multi-nozzle head.
2. The control of ink drop ejection.
3. The ink for inkjet printers.
4. The protection against the clogging of ink channels.

It is difficult to identify essential patents that work as a barrier with respect to competitors because each competitor uses different technologies and different essential patents. A group of patent professionals who worked for a company that belonged to an implicit patent alliance published a paper concerning their patent management scheme for inkjet printers. This paper indicates major patents that "constructed patent barriers" and "prevented other companies from entering the inkjet printer market for a long time" [17]. Table 1 is based on the information in this paper, and lists the essential patents. Table 1 explains that the "constructed patent barriers [17] " cover whole areas of core technologies of ink jet printers and suggests that these patents should have worked as barrier against the competitors that attempted to enter the market.

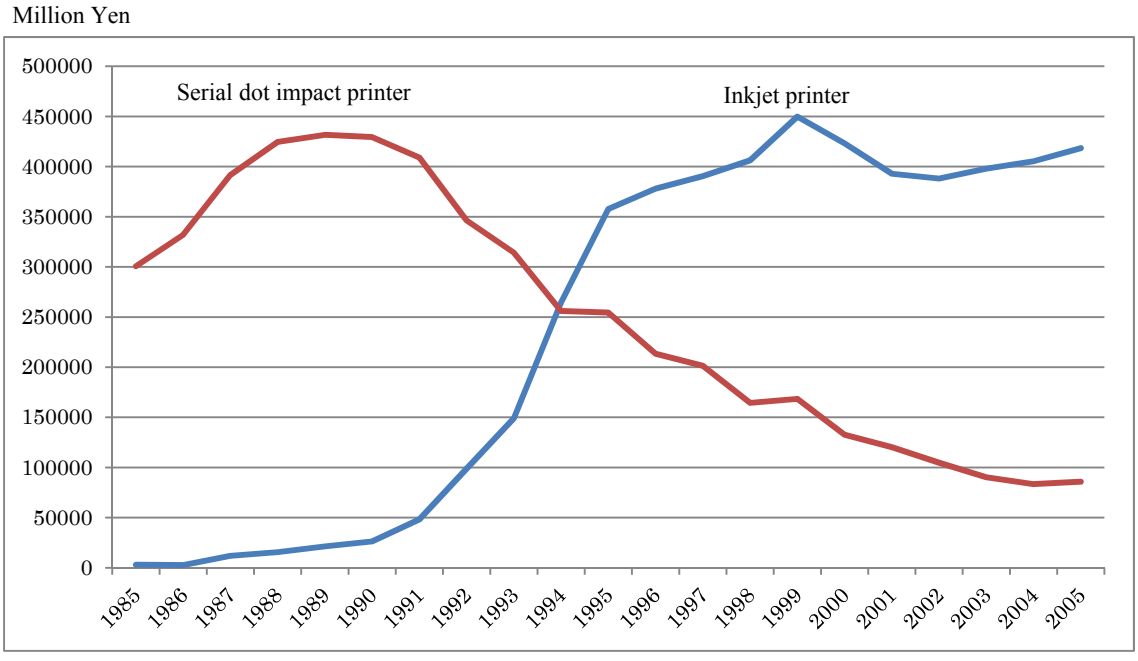

Figure 1: Shipment of Inkjet printer and Serial dot impact printer in Japan

TABLE-1 ESSENTIAL PATENTS FOR BUBBLE JET INKJET PRINTER

Purpose of patented invention	Patent no.	Outline of Patented invention	Year to file
Principle of bubble jet	Pat1389594	Inkjet ejecting ink drops with boiled bubbles.	1977
	Pat.1389595		1977
	Pat.1396884	Film boiling produces bubbles to eject ink drops.	1978
	Pat.1389608		1978
Structure of inkjet head	Pat.1265874	Inkjet printer head withstands chemical erosion and cavitation caused by bubbles.	1979
	Pat.1918345		1983
	Pat.1817038		1983
	Pat.1425475		1984
	KokokuNo.2-42669		1981
	Pat.13896608	Heat transfer design for high frequency drive.	1978
	KokokuNo.59-43312	Wave form of heater input and ejection	1982
	KokokuNo.62-5967	Structure and production system of printer head that implements high resolution, high reliability, long life, and low-cost multi nozzle.	1980
	KokokuNo.2-25335		1981
	KokokuNo.63-4406		1981
	KokokuNo.2-42670		1981
	KokokuNo.2-24220		1981
	KokokuNo.6-2414		1983
	Pat.2659250		1989
	Pat.2575205	Printer head embedded with ink tank.	1989
Ink drop ejection control : 2nd generation fundamental patent of Bubble through Jet	Pat.2783647	Ink drop ejection control scheme based on nozzle pressure and atmosphere before and after ejection.	1990
	Pat.3957851		1997
	Pat.3563999		1999
Ink for bubble jet	Pat.1343229	Principle patents for ink of inkjet printer.	1978
	Pat.1413606		1978
	Pat.1074027		1978
	KokokuNo.55-18751		1978
	KokokuNo.60-3499	Ink composition to prevent clogging of ink channel.	1980
	KokokuNo.58-6752		1979
	Pat.1926280	Ink composition does not burn and stack.	1984
	Pat.1926281		1984
	Pat.1784015		1984
	Pat.1928199		1984
Protection of clogging ink channel	KokokuNo.4-64312	Preliminary ejection mode.	1984
	KokokuNo.4-77670	Cleaning of cleaning device.	1985
	Pat.2516901	After ejection, head cap is vacuumed	1985

(*Kokoku* :examined patent publication of Japanese patent system)

VII. DISCUSSION

A. The Formation of Implicit Patent Alliances

The implicit patent alliance is not designed to be established in advance and is developed according to circumstance. There is no explicit agreement or contract among alliance members. This section will examine how the implicit patent alliance for inkjet printers was formed.

Canon and Hewlett-Packard agreed to collaborate in the R&D of inkjet printers and signed a cross license for patents. The companies chose to collaborate because they recognized the difficulties that a single company might face in the development of new technologies and the creation of a completely new market [20].

Canon and Epson reached an agreement concerning a cross license in 2008. A significant period had passed since they had started their inkjet printer business in 1980s, and the companies had maintained a strained relationship with respect to inkjet patents [17]. However, the companies did not sue each other and did not license their inkjet patents to other companies outside the alliance. Consequently, Canon and Epson have maintained an implicit patent alliance. It is likely that Canon has used Epson's patents and vice versa.

B. The Appropriability of Innovation

This section provides an answer to the research question RQ1: Are implicit patent alliances able to create appropriability of innovation? Although personal computers and digital cameras grew in popularity during the 1990s, the color inkjet printer market grew more rapidly. Certain companies besides Canon, Epson, and Hewlett-Packard attempted to enter this emerging market and filed patent applications. These three companies, however, had established their competitive advantage in the market. "Other companies had no way to enter the inkjet printer market without OEM (original equipment manufacturing) products supplied by these three companies" [12]. In the Japanese market, Canon and Epson had consistently held a high market share as Figure 2 illustrates, and they held in excess of 80% of market share from 1993 through 2003. This fact suggests that companies in the implicit patent alliance enjoyed substantial profits.

Although the implicit patent alliance created appropriability of innovation, the following section describes their appropriability in detail.

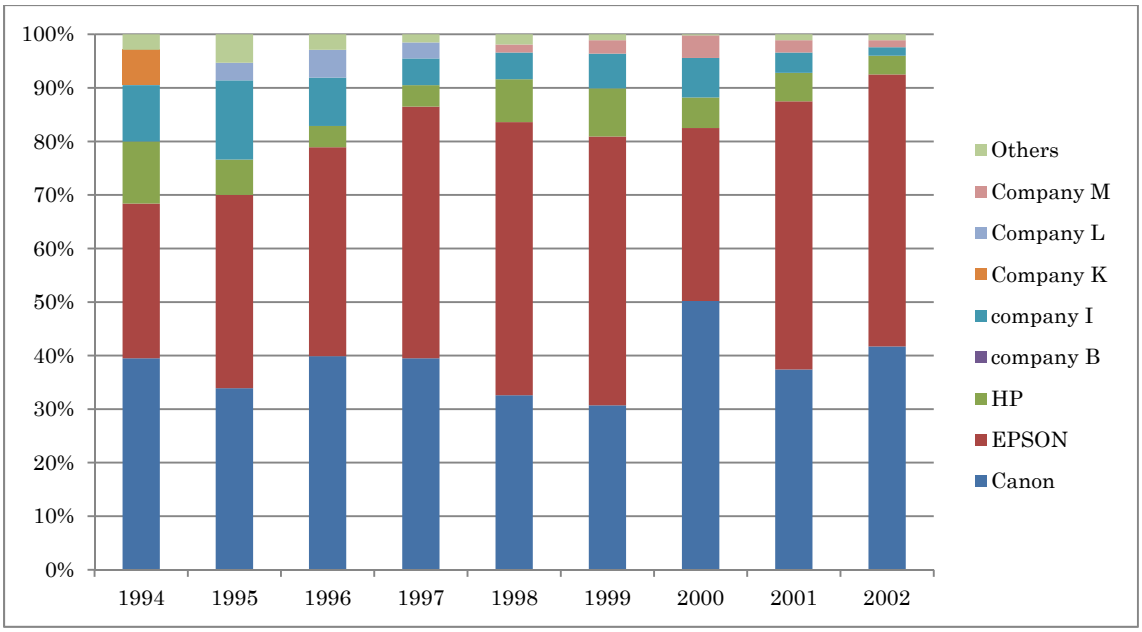

Figure 2 :Market share of inkjet printer in Japan

TABLE 2 : NUMBERS OF PATENT FILINGS AND INNOVATORS FROM 1977 TO 2010

Company	Number of filings	Number of inventors
Canon	21,063	14,363
EPSON	18,565	9,324
Hewlett-Packard（US patent）	3,145	6,095
Hewlett-Packard（Japan patent）	1,496	3,249
Company A	6,697	3,725
Company B	5,026	2,131
Company C	4,408	1,789
Company D	4,297	2,113
Company E	2,604	1,921
Company F	1,850	1,610
Company G	1,295	1,208
Company H	1,208	1,005
Company I	1,112	683
Company J	1,011	793

1) Companies entering the market

This subsection analyzes the disclosed patent applications to examine the existing companies that developed inkjet printers and tried to enter the market. Table 2 presents the top 13 inkjet printer companies, in terms of the number of Japanese patent applications and the number of inventors from 1977 to 2010. The number of inventors in Table 2 is the summation of the number of individual inventors whose names were proclaimed by patent applications each year from 1977 to 2010. This number reflects the scale of development because it approximates the level of human resources.

Both the number of patent applications and the number of inventors are sufficient for the development of new commercial products but are excessive for fundamental research purposes. These numbers suggest that the top ten companies, companies A through J, excluding members of the implicit patent alliance, made efforts to enter the inkjet printer market.

2) The achievements of the top ten companies

This subsection examines the achievements of the top ten companies, companies A through J, excluding members of the implicit patent alliance. Table 3 indicates their business achievements announced on company Web sites. Company B entered the inkjet printer business because it adopted an original printing system that was different from that adopted by the implicit alliance companies. Because this original system caused difficulty for company B to produce commercial products, Company B did not obtain significant market share [21].

TABLE 3: ACHIEVEMENTS OF TEN COMPANIES OUTSIDE THE ALLIANCE CONCERNING THE INKJET MARKET

company	Achievement
Company A	Entered industrial printer market in 2004. Entered home printer market in 2013.
Company B	Start of personal printer business in 1992. Market share is less than 10%.
Company C	Enter printer business in 2007.
Company D	Entered industrial printer business for textile printing and printer heads.
Company E	Same as Company C.
Company F	Entered non-PC and industrial printer business in 2001.
Company G	Entered personal printer market in 2000 using technology of Company E.
Company H	Entered industrial printer head industry and production systems.
Company I	Attained market share maximum of 6% of domestic market, but finally exited.
Company J	Announced thermal in line inkjet printers in 2003

Company A, and Companies C through J, did not enter the major market of inkjet printers while the inkjet printer market was profitable. Companies A, D, F, and H entered the industrial printer market or printer head market only. These markets were small and less profitable than the inkjet printer market for personal use in which the implicit patent alliance companies dominated.

Company A entered the personal printer market in 2013. Companies G and J entered the market of personal printers in 2000 and 2003, but failed to obtain sufficient market share to threaten the implicit patent alliance, as indicated in Figure 2. The year of market entry, after 2000, is significant because the market scale was saturated around the year 2000, as Figure 1 illustrates. This means that the inkjet printer market changed from an emerging market to an unprofitable market around the year 2000.

Company I entered the inkjet printer market but exited.

The achievement of the top ten companies is summarized as follows.

1. Certain companies exited the market, or they obtained limited market share.
2. Certain companies entered a limited market segment such as industrial printers and inkjet heads.
3. Certain companies entered the market after the market was saturated and became unprofitable.

3) The appropriability of the implicit patent alliance

The discussion of (1) and (2) indicates that three companies belonging to the implicit patent alliance dominated the market and possessed considerable market share as Figure 2 illustrates. The discussion also shows that ten companies external to the alliance struggled to gain market share for inkjet printers. The three companies had invested substantial business resources to achieve their domination; however, it was difficult to claim that they enjoyed appropriability of innovation. This paper will estimate the investment amount of the alliance companies as follows.

Figure 3 illustrates the share of patent filings for the three alliance companies. The amount of patent filing correlates with the amount of development resources. The patent filing share of the three companies is 65% at maximum and 30% at minimum and is less than the market share of the three companies, which is 80% at minimum and 90% at maximum, as indicated in Figure 2. The large difference between the patent filing share and the market share shows that the three alliance companies enjoyed adequate profit.

All discussions in (1), (2), and (3) imply that the implicit patent alliance of inkjet printer realized appropriability of innovation.

C. The Required Conditions for Implicit Patent Alliance

This section provides answers to RQ2: What are the required conditions for the development and ongoing performance of an implicit patent alliance.

1) Condition 1: A small number of alliance members with a similar business model.

The implicit patent alliance for inkjet printers consisted of three companies, Canon, EPSON, and Hewlett-Packard. If the alliance included as many as 10 companies, the amount of profit created with the alliance strategy would have to be distributed and each company could not enjoy sufficient profit. Moreover, it is difficult to maintain a similar strategy among a significant number of companies because the implicit patent alliance does not share any explicit agreement.

Three companies, Canon, Epson, and Hewlett-Packard, had been driving their inkjet printer business based on a similar business model. They had been manufacturing real products and desired a greater market share. The companies did not wish to pursue patent license income as their main business. If certain companies had licensed patents to others, the implicit patent alliance would be rendered ineffective.

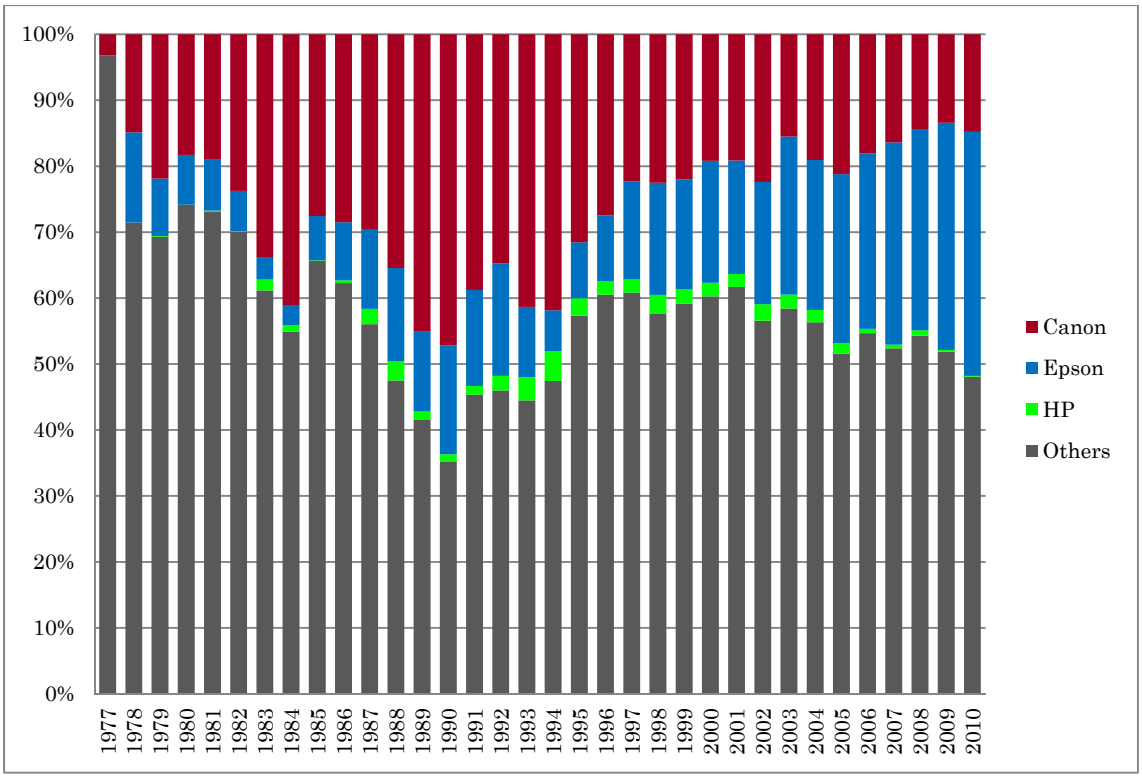

Figure 3: Share of patent filings of three alliance companies

2) Condition 2: The continuous acquisition of essential patents.

Three members of the implicit patent alliance innovated inkjet technology and became essential patent holders in the early stages of product development. They strived to maintain these essential patents. There are two main reasons why current essential patents will not be essential patents in the future. The first reason is the patent system itself. Patent systems grant only a twenty-year term for patent rights. Any patentees of essential patents will lose those rights if they do not acquire new essential patents. The second reason that a current essential patent will not be essential in the future is that new technologies emerge that replace current essential technologies and essential patents.

The essential patents created in the second generation of inkjet history helped three companies maintain their position as essential patent holders. For example, the patents for controlling precise ink drop ejection were invented and filed ten years after the first-generation essential patents, as described in Section VI.B. These patents are essential for photography-quality color printing; they transformed the inkjet printer into a primary printer for personal use.

3) Condition 3: The prevention of new essential patent holders.

Although the ten companies not included in the implicit alliance might find an opportunity to invent and file patent applications that would be considered essential patents, they failed to acquire essential patents, and the three members of the implicit alliance succeeded in maintaining their position. The three company members of the implicit alliance followed a clear strategy to ensure the occupation of essential patents.

Figure 4 shows the number of patent filings and the number of inventors by Canon and Epson for each year. Figure 5 shows similar information for those companies not included in the implicit alliance. A comparison of these data suggests that the three alliance companies had been investing heavily in human resources and budget to submit patent applications and to be early applicants. This activity reduced the likelihood that other companies outside the implicit alliance would be able to file earlier than them and acquire essential patents. The sheer number of patent filings from the three companies is an indicator of the difficulties faced by other companies trying to compete with those in the implicit alliance.

The paper that was written by the patent professional within the implicit alliance explains that this action was the result of a clear patent strategy [17].

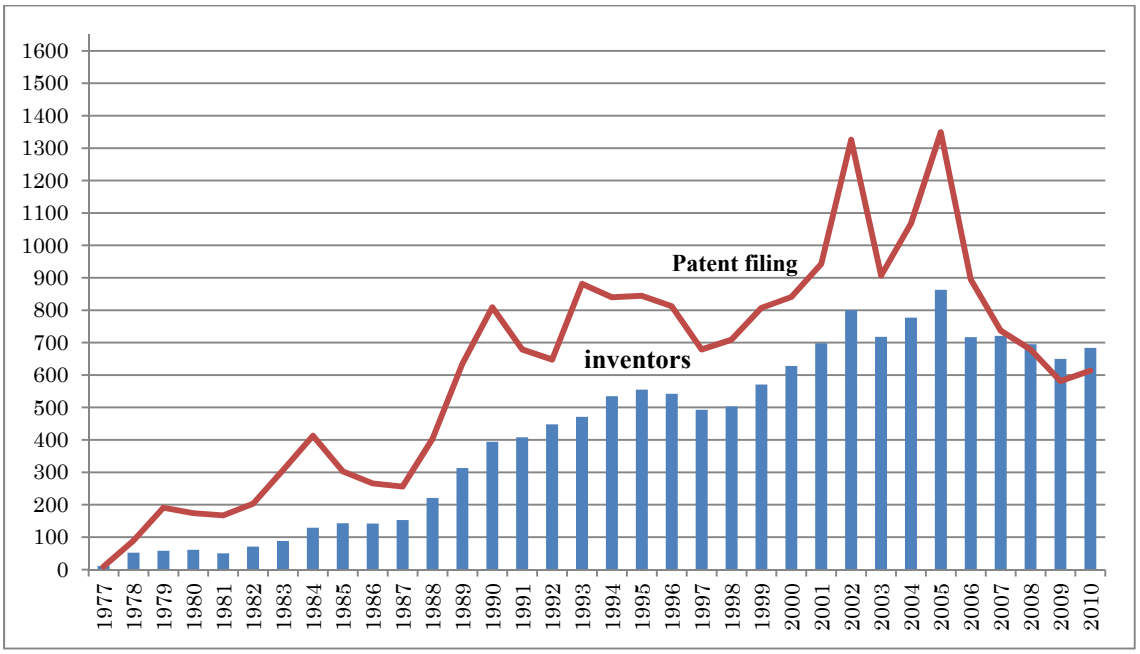

Figure 4a: Numbers of patent filings and inventors of Canon

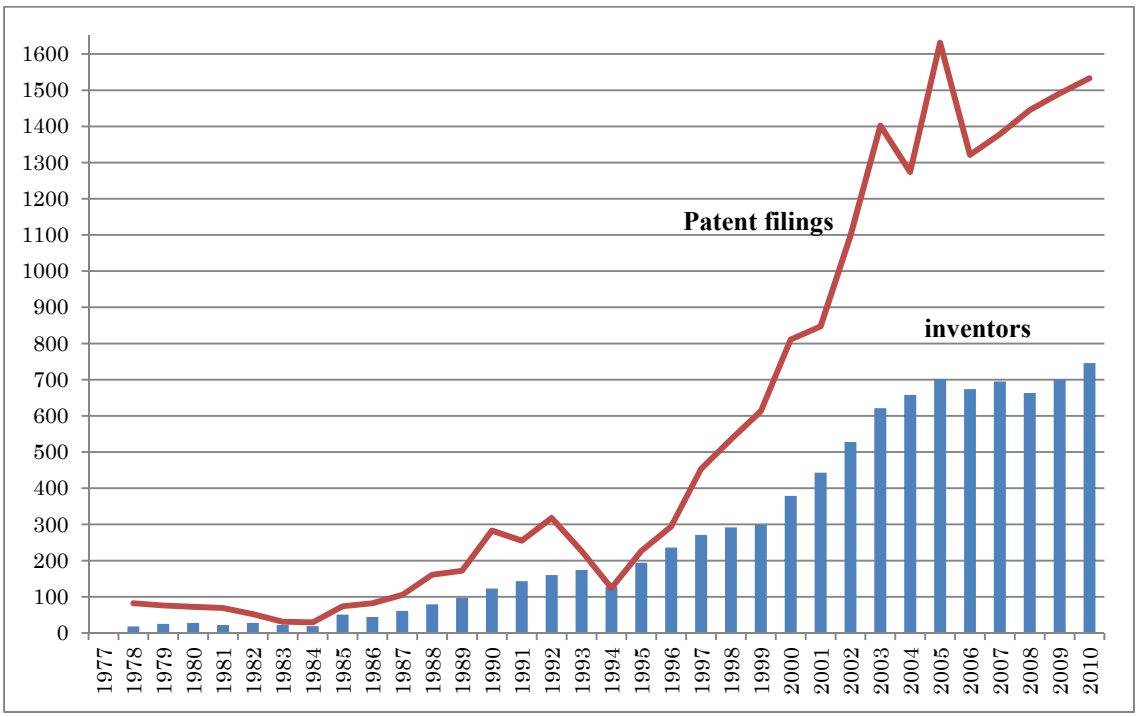

Figure 4b: Numbers of patent filings and inventors of Epson

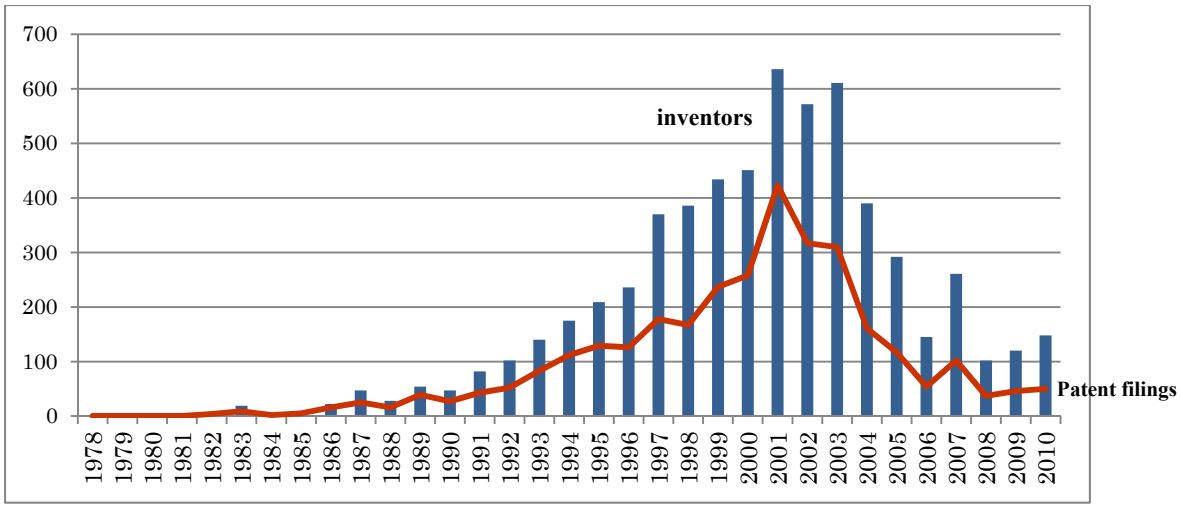

Figure 4c: Numbers of patent filings and inventors of Hewlett-Packard

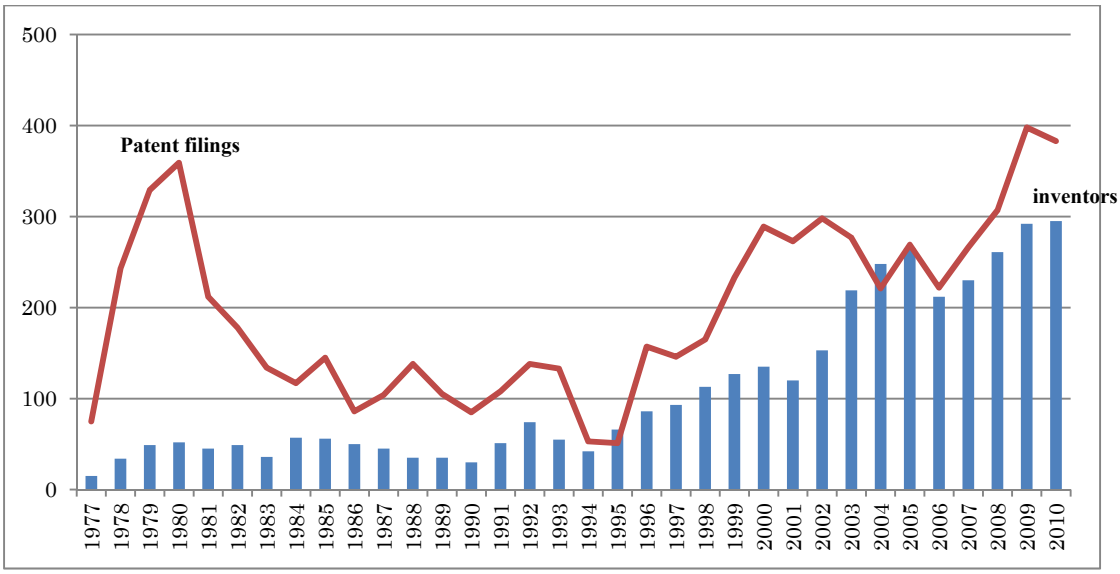

Figure 5a: numbers of patent filings and inventors of Company A

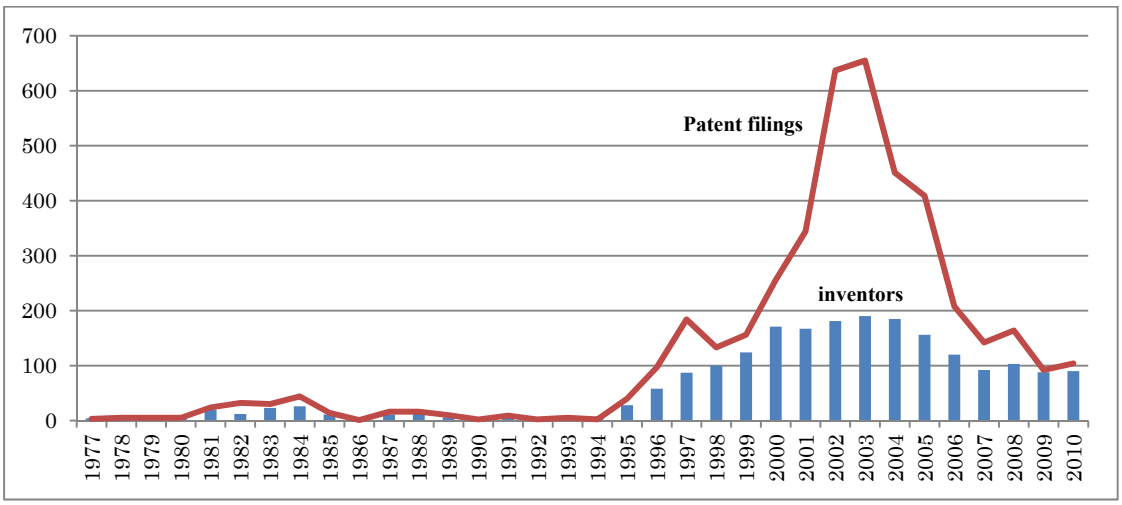

Figure 5b: numbers of patent filings and inventors of Company D

4) Condition 4: The prevention of infringed products.

The implicit patent alliance does not function effectively if any company disregards patent rights and manufactures infringed products that are subsequently brought to market. Three inkjet printer alliance companies possessed an additional protective strategy in addition to patent rights.

The implicit alliance companies developed high-precision production technology and expertise that was necessary for the manufacture of inkjet heads and held this intellectual capital within their companies. Canon, for example, developed original leaser machining technology to produce inkjet nozzles. The nozzles were small and were high in density on the surface of the inkjet heads. Their shapes were precisely circular and their diameters identical so that inkjet heads were able to eject ink drops accurately in terms of volume and direction. Epson owned the expertise in fine mechanics originally developed for the manufacture of mechanical watches and applied it to the processing of layered ceramic elements mounted on their piezoelectric inkjet head [22].

These technologies and expertise were maintained within the implicit alliance companies and were not transferred to other countries where patent rights were frequently infringed.

D. The Innovation of Intellectual Property Rights Management

The invention of inkjet printers marks significant innovation in printing technologies and society. The implicit patent alliance of inkjet printers has innovated patent strategies in the following two ways:

1) An implicit patent alliance acts as a management scheme for the occupation of essential patents.

Within the electronics industry to which inkjet printers belong, cross licensing is are common concerning the use of essential patents, and it has been considered difficult to occupy and control essential patents under one strategy. The implicit patent alliance, however, provides one scheme that can manage many essential patents and create appropriability of innovation.

2) An implicit patent alliance acts as part of business strategy

Subsection VII.C explains four conditions that are required for the formation of an alliance and to maintain alliance performance. The establishment of these conditions requires patent management and several strategic issues beyond patents. The excessive patent filings, for example, required human resources and budgets that were excessive for development. This decision was made as part of patent management and corporate business strategy.

VIII. CONCLUSION

A company's competitive strategy has been discussed from many perspectives in existing literature, and patents are typically expected to contribute to patentee profit. Certain research papers, such as the Carnegie Mellon survey, report that the existing patent system does not create additional competitive advantage for companies, with the exception of companies in the chemical and health industries [4].

This paper employs a case study of inkjet printer technology companies, to propose the implicit patent alliance and demonstrate that it is able to stimulate the appropriability of innovation. The paper explains the conditions that are necessary to form an implicit patent alliance and protect it from external competition. These conditions are the following:

1. A limited number of alliance members that follow a similar business model.
2. The continuous acquisition of essential patents.
3. The prevention of new essential patent holders.
4. The prevention of infringed products.

This paper studies three companies, Canon, Epson, and Hewlett-Packard as members of an implicit patent alliance. These companies have innovated printing technology and developed substantial demand in the market. These companies are considered to be innovators in both technology and the market. Additionally, the companies created a new patent strategy (the implicit patent alliance), and should be considered innovators in intellectual property management.

The implicit patent alliance requires traditional patent management and strategic management of other factors such as R&D and production. This may be one reason why implicit patent alliances are uncommon. The four conditions of the implicit patent alliance, however, may be possible in the case of other products. Future research will determine them.

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