Follow or Find Another Way?: "De-Opponent" Trend of Patent Acquisition between Apple and Samsung Smartphones

Ming-Chung Yang[1,2], Yu-hsin Chang[1], Ping-Chun Chang[1], Kung-Ling Ho[1]
[1]National Yunlin University of Science and Technology, Dept. of Business Administration, Douliou, Yunlin, Taiwan, ROC
[2]National Chin-Yi University of Technology, Dept. of Business Administration, Taiping, Taichung, Taiwan, ROC

Abstract--**The current competition among technology firms is centered on initiating patent litigations which conduct the planned acquisition of patents to enhance patent portfolios and planning. These methods are commonly employed between dynamic competitive rivals. The topic of this study is the evaluation of patent acquisition. To examine firm intentions regarding patent acquisition for technological network planning , a technology network constructed by patent citations and the concepts of technology enhancement and expansion was used to perform structural analysis. Apple and Samsung smartphones were adopted as the subjects of analysis. In particular, the patent litigations and information prior to and following the patent acquisition and transfer of the Apple and Samsung smartphones were investigated. A modified PCA was employed for technology classicification and to identify technological trends for patents. The results indicated that the external acquisition of patents for the original co-opetition upstream and downstream firms becoming rival intended to "de-opponent" technically.**

I. INTRODUCTION

The consumption demand for mobile devices has triggered intensive competition in the smartphone market, which subsequently induced a trend of competitive patent litigations among various large-scale mobile phone firms worldwide [2]. Consequently, questions have been raised regarding how to respond to the current dynamic competition caused by the emergence of the smartphone market [3-5] and how to conduct strategic planning for patent protection. Addressing these questions is crucial for managing smartphone firms. The recent popularity of patent litigations among smartphone firms has caused first-mover and followers to continually compete with each other because they possess distinct strategic intentions, motivations, and abilities[4]. The majority of these firms acquire patents to gain patent protection and respond to pressure caused by the technology and product markets [6-8]. Patent acquisitions reveal the strategies that smartphone firms adopt in a dynamic competitive environment: enhance patent portfolios through patent strategies, apply certain defensive and attack, disrupt the product launch schedule and progress of rival firms, and retaliate against patent litigations proposed by the competition. Thus, the aforementioned purposes of patent acquisition differ from those of the past trend involving damage claims. The current objective of acquiring patents emphasizes responding to the competition strategies of rival firms in a dynamic competitive environment, thereby easing product and market competition pressure[9, 10]. Therefore, two crucial research topics regarding patent planning were considered: (a) how to maintain dynamic advantages from patent acquisitions and (b) what paths and methods can be used to evaluate potential patents for acquisition.

Firms that use patents as a strategy are attentive to strategic responses in a dynamic environment. Because the first mover and followers of technology possess distinct strategies for patent acquisition, their strategies for enhancing patent portfolios differ. In the present study, we employed a patent network analysis to address the following questions: which patents should these firms acquire, and what methods and strategies can be used to identify patents for acquisition? The foundation of technology communities is similar to that of social structures in that interdependency exists among technology communities. The field of technology can be explored from thepatent citation networks (PCN). Consequently, PCN analysis can be used to identify and evaluate targets of acquisition[11, 12], and patent citation information can be employed to identify potential targets for acquisition or cooperation [13]. Therefore, firms are inclined to use self-developed core technology as a center for seeking external acquisition targets and enhancing patent portfolio planning. In the present study, we argue that using patent citation network information derived from self-developed patent citations to identify potential patent acquisitions is a crucial strategy implemented by technology firms that is worth investigating.

The collaborative relationships among industrial organizations can be used to determine the functions of various corporate activities, such as knowledge-, technology-, or product-related management activities [8, 14]. Regarding the enhancement of patent portfolios and the comprehensive development of patent planning, the collaborative and competitive relationship between technology networks can be analyzed from the perspective of technology enhancement and expansion[11, 12, 15]. Therefore, we adopted the viewpoint of technology enhancement and expansion to examine primary questions involving patent protection activities conducted by the first mover and followers: (a) what types of technology and development trends are involved in the patent citation network for patent litigations between the first mover and followers?; (b) are the acquired patents of the first mover and followers correlated with fluctuations in the development trend of various technology types?; (c) based on preexisting technology, do the acquired patents of the first mover and followers develop in dissimilar fields of technology?; (d) what managerial implications are exhibited in the co-opetition development resulting from

patent portfolios and strategies between the first mover and followers? We adopted patent litigations presented by Apple and Samsung as samples for patent search and analysis to address these questions.

A modified patent co-citation analysis (PCA)[16] was employed based on the aforementioned analysis methods and procedures to identify the types and development trends of technology in the pattern of patent development. This facilitated the analysis of the technology development context of patents. The classification and distribution of critical technology in the first mover and followers assisted the observation of target firms, which was then used to clarify patent planning and the technology status in the technology network of mobile device patents. The following sections of this study present the research method (including patent search strategies), technology classification, data analysis results, and discussion.

II. RESEARCH METHOD

A. Research subjects and data collection

Apple and Samsung were used as the research subjects of this study. Patent data were collected from the point in time when the two mobile device firms accused each other of patent infringement (2011–2012). A total of 42 patents were selected based on data obtained from LexisNexis and news stories published between April 15, 2011 and April 18, 2012 (Fig. 1). Subsequently, the patent numbers of the 42 patents were used as a basis to identify cited and citing patents for all 42 patents using the United States Patent and Trademark Office (USPTO). We identified 1,422 smartphone-related patents, which formed the data set for patent analysis.

B. Patent co-citation analysis

The concept of PCA, proposed by Lai & Wu (2005), was used in the present study for patent analysis. Technology classification was conducted based on the Taboo search (TS) algorithm cluster analysis method [17] was used for technology classification. Using this method prevents the repeated classification that occurs in factor analysis. In addition, cluster analysis was used to identify and analyze the composite structure of the primary technology types in the patent database. The operation of this method is based on the correlation coefficient matrix $[\gamma_{jj'}]_{n\times n}$ produced by Ucinet software. Consequently, the TS algorithm was used for patent clustering. This is an optimized portfolio approach that is used extensively in numerous fields[18]. In addition, assessments of the optimal number of clusters were based on the degree of variation and stability of the R-square value for the various technology clusters[17]. Finally, the research team manually interpreted and summarized the patent technology content of the various clusters. The results were then discussed with a technology consultant, and the patent clusters were classified and named according to their technical efficiency.

III. DATA ANALYSIS AND RESULTS

Data for the 1,422 analyzed patents were screened and processed following the analysis procedure of the PCA. Thus, we first established a patent citation network matrix, $[\alpha_{ij}]_{1422x1422}$. Subsequently, the threshold for the number of citations for a single patent was set to 4. Patents that were cited less than 4 times were eliminated. The relevant citations among the 459 remaining patents was then used to develop an unclassified patent citation matrix, $[\varepsilon_{ij}]_{459x459}$. In this matrix, citing and cited patents were respectively presented in rows and columns. The number of patent co-citations is crucial for analysis; thus, a total of 292 patents (including 289 patents cited less than 2 times and three citations of network islanding) were identified. An additional 236 patents that were cited 0 times were also discarded, and the matrix was modified as $[\varepsilon_{ij}]_{223x167}$. This matrix was then used as the data structure for extracting crucial technological information.

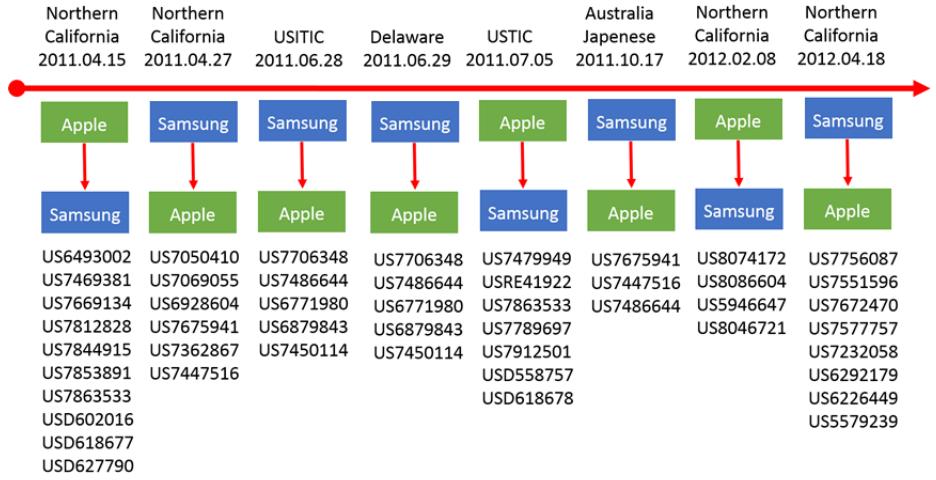

Figure 1. Information regarding patent litigations between Apple and Samsung. from [1]

A. Patent cluster classification

The results for the optimal number of clusters selected as evaluation basis for the unclassified matrix $[\varepsilon_{ij}]_{223x167}$ are shown in Fig. 2, which illustrates the comparison between the number of patent clusters and the R-square values. We determined that six clusters is the optimal number of clusters. The correlation between data structure and patent clusters is presented in Fig. 3. The technology clusters were named as follows:

TF1: Human sensor control interface technology
TF2: Wireless signal transmission/reception processing technology
TF3: Technology that facilitates convenient use
TF4: Touchpad signal input processing technology
TF5: Image movement overlap display processing technology
TF6: Data transmission processing for mobile devices and accessories

B. The technology development trend of patent clusters and primary firm distribution

After conducting advanced PCA and patent classifications, the relevant development between the patent years and the accumulated number of patent applications observed in the patent clusters is shown in Fig. 4.

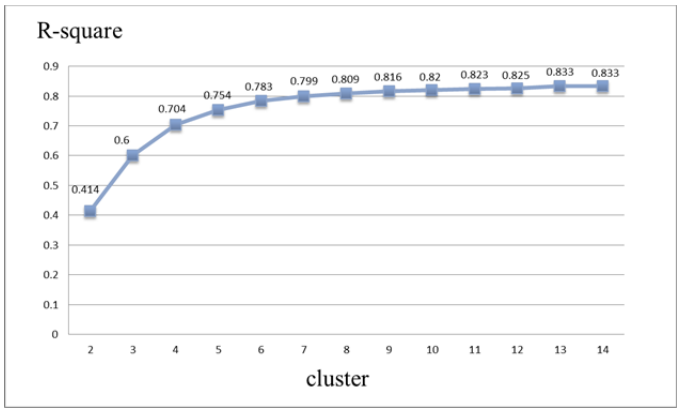

Figure 2. Comparison between the number of patent clusters and R-square values.

Figures 4 and 5 show that among the types of technology involved in patent litigations between Apple and Samsung, TF1, TF2, TF4, TF5, and TF6 exhibited the highest relevance and the respective portfolios were subject to the most investments and patent productions. This indicates that patent competition is most active in these five technology clusters. Specifically, the demand for laptops and tablets increased the number of patents in these technology clusters. Excluding the TF2 and TF4 patents, which exhibited temporary growth between 1993 and 1996, the three remaining clusters (TF1, TF5, and TF6) grew rapidly between 1995 and 2003. Among these clusters, TF1 was the basis for mobile communication devices. As shown in Fig. 5, the distribution of TF6 patents was segmented into two separate spatial locations. This is because technology applications that were developed between l996 to 2002 were centered on the audio and visual data processed by laptops and tablets, whereas the smartphone trend increased the number of data transmission technology patents between 2008 and 2010. In addition, patent US5666502 (Apple) was a crucial patent that bridged TF1 and TF6. Furthermore, patents relevant to the TF3 cluster emerged early. However, TF3 patents involve auxiliary technology that is unnecessary for general computer operations (e.g., rapid and simple search functions, digital image categorization, and voice recorders), they exhibit a relatively slow growth trend unless new demands emerge.

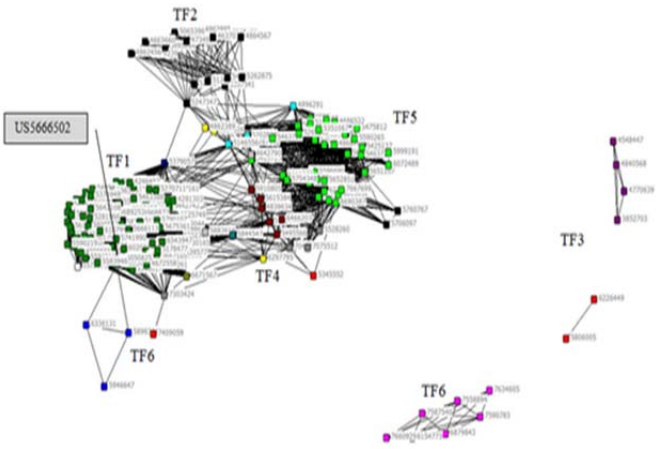

Figure 3. The correlation structure between datasets and patent clusters.

The statistical data regarding TF1–TF6 firm distribution indicate that the primary advantaged firms following transactions and transfers in the various patent clusters were (a) TF1: Apple (12 patents) and Synaptics (7 patents); (b) TF2: Samsung and AT&T (1 patents, respectively); (c) TF3: Apple and ADC Telecomm (2 patents, respectively); (d) TF4: Apple (2 patents); (e) TF5: Xerox (7 patents) and IBM (5patents); and (e) TF6: Apple (6 patents). Thus, the largest number of patents acquired following transactions and transfers in the six technology clusters were primarily those of Apple, IBM, AT&T, Synaptics, Samsung, and Xerox; among which Apple possessed a substantial technological advantage. The greatest technological advantage that Apple possesses involves the clusters of human sensor control interface technology and data transmission processing for mobile devices and accessories. Samsung began developing mobile devices after Apple; therefore, the patents acquired by Samsung are more recent than those of Apple. Samsung purchased patents related to remote image transmission systems in 2011; therefore, the patents belonging to Samsung are limited to the cluster of wireless signal transmission and reception processing technology. IBM and Xerox possess a number of advantages regarding image movement overlap display processing technology, whereas Synaptics and Apple possess advantages in the cluster of human sensor control interface technology (Fig. 5).

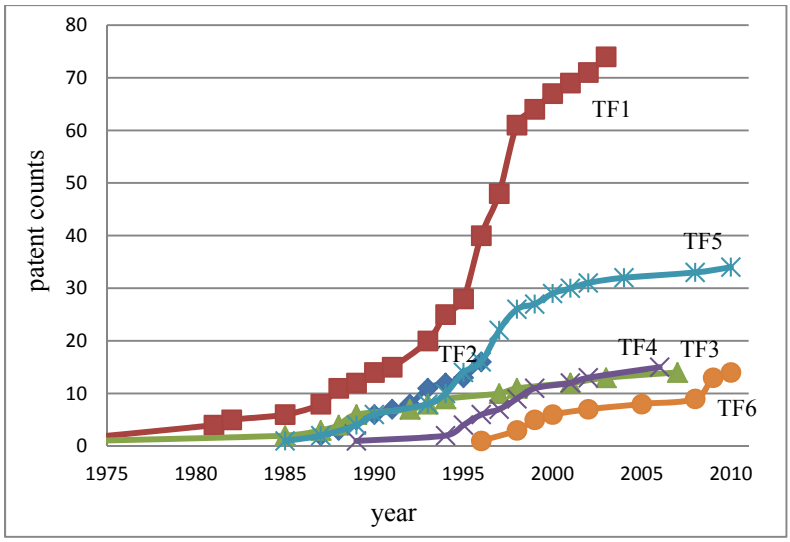

Figure 4. Technology development trend for patent clusters TF1–TF6.

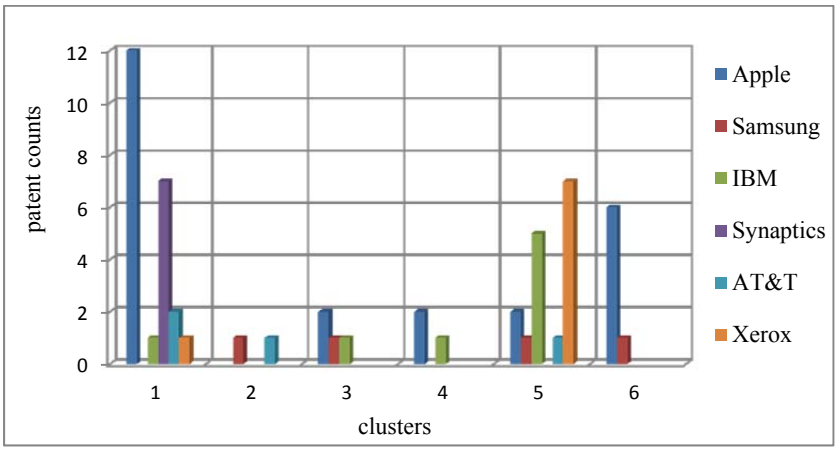

Figure 5. The number of patents that major firms possess in various clusters.

TABLE 1: THE NUMBER OF PATENTS DISTRIBUTED BY APPLE AND SAMSUNG IN THE VARIOUS CLUSTERS.

Cluster / Firm	TF1	TF2	TF3	TF4	TF5	TF6
Apple	11(1)	-	2	1(1)	2	6
Samsung	-	0(1)	0(1)	-	0(1)	1

Note: The data shown in the table refers to the total number of patents prior to the transfer (acquired patents), and "-" indicates that no patents existed in a specific cluster before or after the transfer.

The analysis conducted in the present study focused on two firms, Apple and Samsung. The statistical data regarding the number of acquired patents and the change in the number of patents for Apple and Samsung are shown in Table 1.

The statistics and current acquisition data shown in Fig. 5 and Table 1 indicate that Apple possesses a large number of critical patents in the various technology clusters (excluding TF2). Furthermore, the number of patents that Apple holds in TF1, TF3, TF4, and TF6 are substantial. The data in Table 1 also show that Apple acquired one patent in both TF1 and TF4, thereby achieving technology enhancement. Although Samsung possesses one patent in TF2, TF3, TF5, and TF6, Samsung remains disadvantaged compared with Apple in all fields expect for TF2. Table 1 also suggests that of all four patents that Samsung possesses, three were acquired and were patents of TF2, TF3, and TF5. Despite not having produced critical patents, Samsung acquired one patent from each of these three fields. By acquiring these three patents, Samsung was able to expand the range of technology field patents. To further elucidate this phenomenon, we examined the points in time when patents were acquired and litigations were initiated for the two firms, as shown in Fig. 6.

Apple and Samsung acquired five patents which had more citations than average citations of all collected patents except

patent US5844547, as shown in Table 2. This result shows that these two companies acquire, indeed, more valuable patents with more citations, especially forward citations. Apple acquired two technology enhancement patents before initiating infringement litigations against Samsung. Observations of TF4 indicate that Apple's various fields of technology exhibited an increasing trend. Samsung also acquired a patent before facing litigations from Apple, and acquired two additional patents after Apple initiated an infringement litigation in response to Apple's accusations. The technology trends shown in Fig. 6 indicate that of the three technology expansion patents acquired by Samsung, Patent US7450114 (TF5) was a new patent with growth potential and was acquired prior to the litigation, whereas the other two patents were acquired after the litigation, and were older patents with static or decreasing growth. This phenomenon suggests that, concerning the technology fields involved in the mobile communication device litigations between the two firms, Apple's R&D output, patent planning, and patent output performance are superior to that of Samsung.

The present study examined six firms with a substantial number of patents after patent transcation and transfers were completed. Table 3 shows the number of patents for the various firms before and after patent transfers. Prior to the transfers, the number of patents for the various firms were, in sequential order, 22 for Apple, 13 for IBM, 8 for Xerox, 7 for Synaptics, and 5 for AT&T. After the patent transfers were completed, the number of patents for the various firms were, in sequential order, 24 for Apple, 8 for IBM, 8 for Xerox, 7 for Synaptics, 4 for Samsung, and 4 for AT&T. In addition, Table 3 shows that Apple and Samsung were the only firms with an increased number of patents after the transfer, whereas the number of patents for IMB and AT&T decreased after the transfer, and the number of patents for Xerox and Synaptics remained consistent. Figure 8 shows the development trend and current situation of patent inventory for these firms. The patent output of Apple indicated absolute advantages and continuous growth in technology development. The number of patents for IBM exhibited no change because the transfers were conducted in 1995. After conducting transfers, Samsung has experienced a substantial increase in the number of patents since 2009. Following the transfers, the other three firms have maintained a stable trend since 1997.

We proposed that the technological applications produced by Apple and Samsung prior to the patent transfers possessed a similar and consistent knowledge structure. This is because

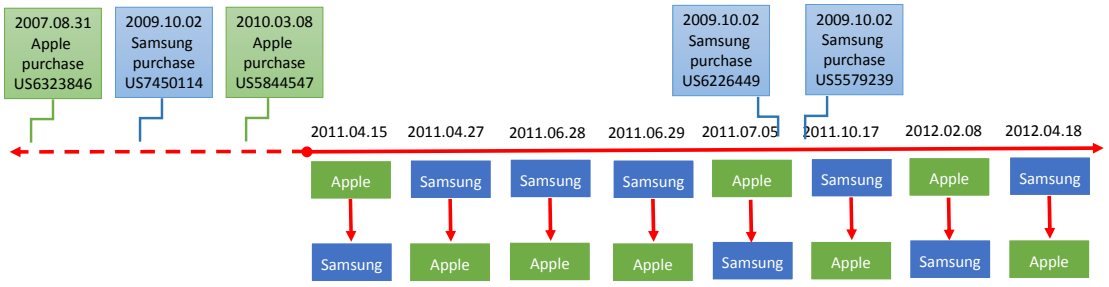

Figure 6. Time of patent acquisition and litigation. from [1]

TABLE 2: CITATION OF PATENTS PURCHASED BY APPLE AND SAMSUNG

	forward citation	backward citation
US6323846 purchased by Apple	25	25
US5844547 purchased by Apple	5	5
US7450114 purchased by Samsung	21	21
US6226449 purchased by Samsung	49	56
US5579239 purchased by Samsung	57	56
Average of all collected patents	11.71	13.81

TABLE 3: THE PRODUCT CHARACTERISTICS AND EVALUATION INDICATORS FOR THE SIX MAJOR FIRMS.

Item	Firm	Primary Products	Number of patents	
			Before transfer	After transfer
1	Apple	Mobile communication products, tablets, personal digital products	22	24
2	IBM	Information technology services and comprehensive hardware and software services for various industries	13	8
3	Xerox	Wireless control systems and relevant services for digitized photocopy products	8	8
4	Synaptics	Original equipment manufacturer for computer and laptop touchpads	7	7
5	Samsung	Mobile communication devices and consumer electronics	1	4
6	AT&T	Fixed-line telephone and mobile broadband services	5	4

Samsung was a loyal follower of Apple technology before Apple initiated infringement litigations. Furthermore, Samsung was a leading electronic component manufacturer that provided Apple equipment for the development of certain products. Thus, the two firms shared a close technology partnership and interdependence. However, the market share of Apple's products faced severe threats when Samsung launched smartphones that used the Google Android as an operating system. Consequently, Apple initiated a series of patent litigations against Samsung. In response to these patent litigations, Samsung began acquiring patents to expand their patent inventory, enhance their technological influence, and reinforce their chance of success when negotiating with Apple. Samsung's enhancement of mobile device patents suggests that the firm is developing patent plans in the technology field of wireless network data transmission while creating opportunities to collaborate with and provide support for Apple.

Based on the previous analysis and observation of the patent planning and strategies used by Apple and Samsung, the perspectives of technology enhancement and expansion can be used to determine the optimal patents that should be acquired. Technology enchancement means that firms acquire patents in the field of technology they are already in and technology expansion represents that firms acquire patents expanding into the field of technology they do not have yet. Based on the empirical results, the following points are proposed:

a. When a first-mover firm and a follower in the patent network that originally possessed a collaborative relationship become involved in patent litigations against each other, the patents they acquire and the technology fields pertaining to the acquired patents differ between the firms. Furthermore, the two firms intend to decline reliance on the competitor technically. We proposed that when collaborative relationships transform into patent litigations, technology planning becomes urgent for the firms involved. Thus, the two firms should be independent to a certain degree regarding shared technology and knowledge of previous collaborations. We call this strategy as "de-opponent".
b. Prior to initiating litigations against followers, the technology fields pertaining to patents acquired by the first mover in the patent network demonstrate a trend of continuous development of firm-owned technolegy and a tendency toward technology enhancement. This indicates that the first mover in the patent network continue the R&D of relevant technology and adopt an optimistic outlook on the development trend of relevant technology.
c. When followers in the patent network face patent litigations initiated by the first mover, patent acquisitions are often used to expand fields of technology that were originally insufficient. This is because during the litigation process, followers emphasize balanced development in patent planning and search for insufficiencies and negligence in the patent plans of the first mover. The followers try to avoid overlapping the first mover and find another way.

IV.CONCLUSION

Global technology firms use patent litigations as a commercial strategy to respond to changes in the global market. Planned patent acquisition has become a common strategy used in dynamic competition. Therefore, we focused on how firms acheive patent protection by conducting patent acquisition that enhances or expands the technology that they already use[19]. The majority of previous studies on patent portfolios have adopted various perspectives such as financial performance, technology development, and corporate competition perspectives [20-23]. However, few studies have examined patent portfolios from the viewpoint of patent acquisitions [11, 12]. The present study adopted a research perspective distinct from that of traditional patent analysis, and we proposed practical management methods for patent acquisitions, such as technology patent planning, monitoring, and immediate responses. These methods facilitate firms in identifying potential patents that should be acquired or those that may be acquired by rival firms, thereby improving the quality of decisions regarding patent acquisition.

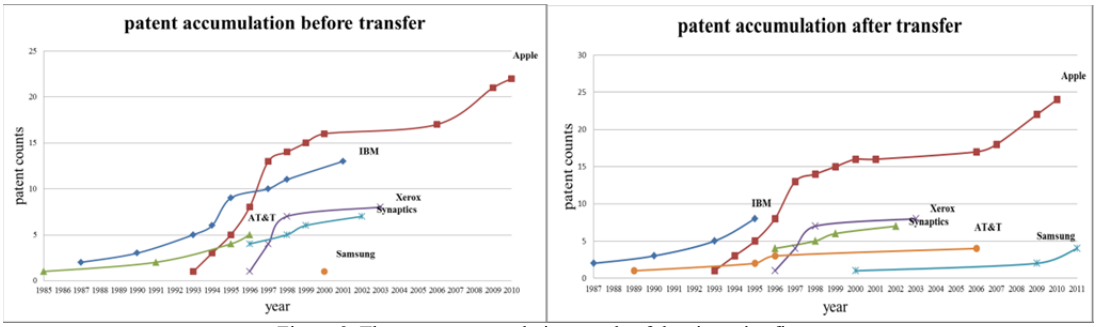

Figure 8. The patent accumulation trends of the six major firms before and after patent transactions and transfers.

The result shows that the first mover enhance the technology field they are already in and followers expand the technology field they are insufficient for by patent acquisition. Followers adopt "de-opponent" strategy trying to find another way to avoid face-off with the first mover in technology competition. Because the present study examined data on Apple and Samsung between April 15, 2011 and April 18, 2012, the most recent information concerning the litigations between the two firms was not considered. Future studies are recommended to expand the research scope to obtain more comprehensive data. In addition, we suggest that all of the manufacturers involved in the litigations be included as research subjects. Future studies can also consider targeting a certain firm and analyzing the affiliated firms, upstream and downstream manufacturers, and collaborating and competing firms to clarify the relationship of the firm with its self-developed technology network. The attributes of the firms examined in the present study differ; therefore, future studies can analyze various types of firms using the model provided in the present study, and establish a reference for academic and practical corporate usage.

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