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Using patent analysis to establish technological position: Two different strategic approaches

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ABSTRACT

Discussions on business strategy formation in the past 50 years can be separated into two categories: the inside-out and the outside-in approach. Technology is a critical factor when manager formulate their business strategy, and patents have served as an important indicator of technology. A patent portfolio can be used to understand the capabilities of a firm, as an inside resource pattern; and the patent citation of firms can be used to find the relationship of a firm, as an outside dependency. This study uses patent information to establish an effective model for the technological position of business methods. The 5 by 6 matrix was generated and four situations between firms were induced. Researchers and managers can use that matrix and situations to recognize the real competitors or cooperators, and formulate the technological strategies which include competition, cooperation, or complementary cooperation.

1. Introduction

Internet technology has been sweeping the world in the last decade; there are huge impacts on business operations. Many new business methods based on Internet technology have become critical to the success of enterprises. These business method technologies have been applied to many industries, not only Internet relevant industries such as software, hardware, communication; but also some service industries such as finance, retailing, entertainment, and so on.

However, it is difficult for enterprises to determine where their real competitors come from, what capabilities they have, and what position they are located in. Because the conception of industry has changed, the boundaries of industry have become blurred. The phenomenon is called digital convergence [1] or industry convergence [2,3], which means a similar product or service could be supplied by different industries. Also, some technologies and knowledge can be applied to different industries, or the firms of different industries can enter the same markets becoming competitors. It is therefore more difficult to define the boundaries of the industries [4]. This phenomenon will affect a firm in formulating their business strategy, especially in their technological strategy.

Discussions on business strategy formation in the past 50 years can be separated into two categories [5]. The first category is the inside-out approach, that is, the resource-based view [6,7]. The second category is the outside-in approach, that is, industry/organization or the resource-dependent view [8,9]. Few studies have discussed both approaches simultaneously. Technology is a critical factor when manager formulate their business strategy, and patents have served as an important indicator of technology in many studies [10–15]. A patent portfolio can be used to understand the capabilities of a firm [16–19], as an inside resource pattern; and the patent citation of firms can be used to find the relationship of firms [20,21], to explore the trajectory of technology diffusion [22–24], and can be regarding as an outside dependency. These two analytical methods are just fitting the

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inside-out and outside-in approaches to business strategy formation. Therefore, this study use patent information to establish an effective model for the technological position [25] of business methods, and provides firms with a method to formulate a technological strategy.

The Internet is the major cause of digital convergence, and heightens the blurred boundaries of industries. This study discusses the technological field of business method, which is highly related to the Internet and has been the most rapidly developing technological field in the last decade. We use patent portfolios and patent citation data to establish a model of technologic position and technologic groups. The purpose of this paper is to propose a framework to know technological strategy of targeted firms and to support business strategy formation of a firm, which uses a two dimension matrix by patent portfolio and patent citation analysis. If the firms belonged to the same group in the matrix, they have similar technological capabilities, and more interdependent relationships. On the other hand, if the firms were not located in the same group, highly different technological capabilities existed or they had a less interdependent relationship. The research model of this paper is illustrated on Fig. 1.

The rest of this paper is organized as follows. Section 2 describes business method patents which are the goal technology of this paper; Section 3 introduces how to retrieve the patents and select the firms; Sections 4 and 5 are inside-out and outside-in approaches analysis using patent information, respectively; Section 6 is the discussion; and Section 7 has conclusions and suggestions.

2. Business method patent

Since Internet technology began sweeping the world, every company has come to view it as a new stage on which to compete in the 21st century. Business methods based on Internet technologies have become the weapons in this battle for success. Following the announcement of the “Examination Guidelines for Computer-related inventions” by the USPTO [26], a business method patent White Paper named “Automated Financial or Management Data Processing Methods” was published [27]. Also, several legal precedents in the U.S. Court of Appeals for the Federal Circuit (CAFC), such as State Street Bank & Trust Co. v. Signature Financial Group, Inc. and Amazon.com v. Barnes & Noble, clearly illustrated business methods could be patented. These phenomena have made the competition for patenting business methods very intense.

To cooperate with the management of business method patents, before the announcement of the business method patent White Paper, the USPTO 2760 work group had already adapted the definition of U.S. patents Class 705 in March, 2000, and namely “Data processing: Financial, business practice, management, or cost/price determination”. Class 705 was defined:

> This is the generic class for apparatus and corresponding methods for performing data processing operations, in which there is a significant change in the data or for performing calculation operations wherein the apparatus or method is uniquely designed for or utilized in the practice, administration, or management of an enterprise, or in the processing of financial data.

This meant the design of US Class 705 is just for business method technology. Although Class 705 is designed for business method in contemporary technology, some early patents were also redefined to Class 705 if these patents dealt with financial or

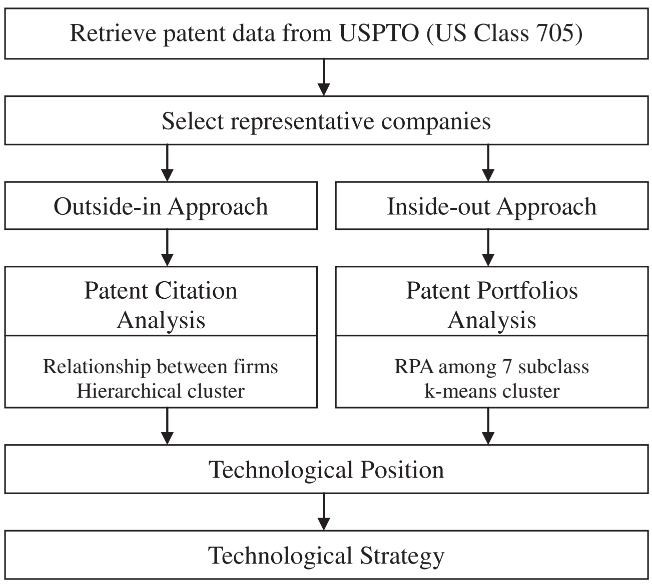

Fig. 1. Research model.

Table 1
Business method patents in early stage.
Source:http://www.uspto.gov Business Methods White Paper.

Patent Number	Issue date	Inventor	Title
X2301	1815.04.28	Kneas	Bank note printing
395,781	1889.01.08	Hollerith	Art of compiling
209,827	1878.11.12	Moss et	Ticket printing and recording-machine
915,090	1909.03.16	Fuller	Cash register
1,710,691	1929.04.30	Carrol	Combined sorter and tabulator
2,594,865	1952.04.29	Bumstead	System for making reservation

management issues, no matter whether it was mechanical or electronic. The White Paper listed many past patents which were thought to be business method patents. Table 1 lists some of the business method patents in early stage.

US Class 705 sub-classes can be divided into 3 major sub-classes and 95 minor sub-classes. The major sub-classes are Automated electrical financial or business practice or management arrangement; Business processing using cryptography; and for Cost/Price. The minor sub-classes are the hierarchy structure from the major sub-classes. Appendix A only spread to the first layer of 25 sub-classes.

In the last decade, the numbers of patents of US Class 705 have rapidly grown. Fig. 2 lists the issued patents from 1993 to 2009. This points out that business method technologies are growing in importance year by year. Therefore, this study selected business method patents as the research subject to analyze the technology position of firms.

There are few studies discuss about business methods although business methods patent grew rapidly in recent 10 years. Some of these studies aimed at law viewpoint to discuss business methods patent, such as the patent's limitation and claim construction [28], and the standard of patentability [29]. Other studies focused on technology management to discuss business methods, such as an empirical study compared business methods patents with other patents [30]; Hall discussed business method patents with innovation and policy [31]; and Wagner analyzed business method patents in Europe and discussed their strategic use [32]. Chang et al. found the critical business method patents from USPTO and explored technology diffusion trajectory to classify business methods [22]. But none of papers discuss technology strategy from business method patents. This study is the first research to discuss technological position and strategy using business method patents from USPTO.

3. Data retrieval

This study focuses on the field of business methods technology and draws on the largest patent database in the world, the USPTO, as its source of information. Because the countries of assignees not only belong to US, but also come from many countries outside of America, such as Japan, German, Korea, and Taiwan, etc., and United States has the most advanced e-commerce technology and the most e-commerce transactions in the world. Additionally, this study considers business method technologies that were applied to

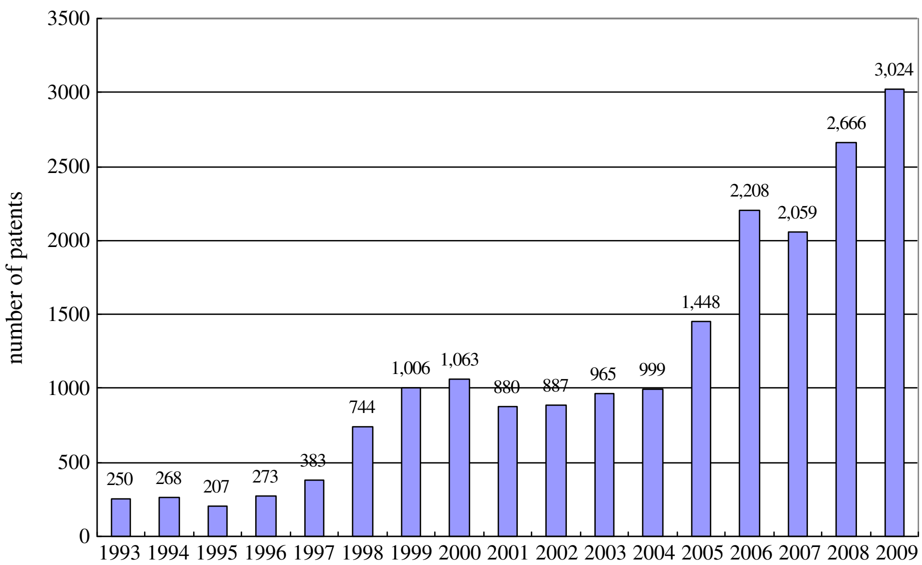

Fig. 2. Issued patent on US Class 705 from 1993 to 2009.

e-commerce. The year 1993 was an important milestone because the first business browser Mosaic was invented. This moment could be considered the beginning of e-commerce. Therefore, this study establishes the retrieval criteria as follows.

a. The "Current US Class" of patents must include US Class 705. The title of Class 705 is "Data Processing: financial, business practice, management, or cost/price determination". Class 705 was designed for the Business Methods Patent White Paper (2000) which was titled "Automated Financial or Management Data Processing Methods".
b. The "Applied Date" of patents was set to be after January 1, 1993 which was the emergence of e-commerce. The retrieval time was during July and August of 2006, so the "Issued Date" was set to be before June 30, 2006.

Based on the above two criteria, this study obtained 9848 patents from USPTO database, and the assignees were over 3000. Further, the analysis units of this study are firms; the following are some criteria to filter the represent firms.

a. Inventor and Assignee: This paper discusses the patent portfolio and citation between firms, so we deleted individual inventors. If the assignee of a patent was blank or people, it was excluded.
b. Minimum number of patents: If a firm owns few patents, it is pointless to analyze the portfolio of that firm. Therefore, we selected firms that owned at least 30 patents.
c. Number of patents cited: If a firm owns few patents which were highly cited, it implies the patents of that firm are important. We selected the firms owning at least 10 patents, and the average of number of patents cited was greater than 10.

Finally, thirty-eight firms were selected and 3154 patents were included in this study.

4. Inside-out approach

A patent portfolio can be used to understand the capabilities of a firm [16–19], as an inside resource pattern. Ernst is the early scholar to discuss patent portfolio [17], and he with Fabry et al. used patent activity and patent quality to formulate patent strength as the patent portfolio, to apply on the nutrition and health industry [33]. Lin et al. uses patent portfolio of six technology categories to examine the firm's diversity and technology strategy [34]. Lichtenthaler considered a firm's patent portfolio that constitutes an important determinant in gaining a technology-based competitive advantage, and he used patent portfolio size and quality to examine the relationship of technology strategy [35]. Su et al. thought that companies should consider performing patent portfolio as a means of integrating their patent strategy to shape their overall business strategy; this paper used patent family as a proxy of patent portfolio [36].

Comparing with above papers, this study detected the sub-class of US class 705 of each patent, and found seven sub-classes of US class 705 were major technologies of business methods. These sub-classes included Operations Research, POS terminal or electronic cash register, Electronic shopping, Finance, Usage protection of distributed data files, Secure transaction, and Postage metering system (Cost/Price). The patent frequencies of each sub-class are listed in Table 2. Therefore, this study used the number of these seven sub-classes as the technology categories to measure the patent portfolios of firms.

4.1. Revealed patent advantage

Due to the differences in R&D strategies and company scale of firms, it was not suitable to use the patent quantities as an indicator to distinguish the technology related advantages of the companies. Therefore, it had to change the patent quantity into the related patent indicators of specific technology capabilities to measure different companies and show the related technology advantages of the company. This study used an indicator, Revealed Patent Advantage (RPA), proposed by Schmoch in 1995 [37]. The definition is listed in Eq. (1).

$$RPA_{ij} = 100 \times \tanh\left(\ln\left(\frac{P_{ij} / \sum_j P_{ij}}{\sum_i P_{ij} / \sum_i \sum_j P_{ij}}\right)\right), \text{ when } P_{ij} \neq 0 \qquad RPA_{ij} = -100, \qquad \text{when } P_{ij} = 0 \tag{1}$$

P_{ij} is the number of patents in sub-class "j" of company "i", where $i = 1 \ldots 38$ and $j = 1 \ldots 7$.

Table 2
Major sub-class of business methods.

705 Sub-class	Title	Abbrev.	Patents	Ranking
7–11	Operations research	OR	497	4
16–25	POS terminal or electronic cash register	POS	319	7
26–27	Electronic shopping	e-Shop	519	3
35–45	Finance	Finance	574	1
51–59	Usage protection of distributed data files	Protection	572	2
64–79	Secure transaction	Security	416	5
401–411	Postage metering system(cost/price)	Postage	381	6

Based on the seven sub-class of US class 705, this study summarizes the patent portfolio of 38 firms (P_{ij}) as the input data for the inside-out analysis, Table 3 shows part of the input data matrix P_{ij} .

Table 3
Patent portfolio of 38 firms (P_{ij}).

	Finance	Protection	e-Shop	OR	Security	Postage	POS
IBM	77	82	111	183	70	2	44
Pitney_B	14	14	9	5	32	251	5
Fujitsu	37	40	30	29	22	1	30
NCR	42	2	32	15	9	1	94
Hitachi	36	0	22	36	22	1	13
Microst	22	46	29	27	30	0	5
Sony	11	0	27	3	9	0	8
HP	13	22	19	23	18	3	5
Matsu	4	59	7	6	12	0	16
:	:	:	:	:	:	:	:

Table 4
Revealed patent advantage of 38 firms (RPA_{ij}).

	Finance	Protection	e-Shop	OR	Security	Postage	POS
IBM	−27.911	0.242	16.762	61.224	−7.048	−99.828	−26.598
Pitney_B	−89.503	−83.979	−94.663	−98.171	−29.913	95.146	−95.645
Fujitsu	8.234	36.853	−3.696	−2.756	−12.525	−99.612	41.910
NCR	17.617	−98.987	−0.369	−61.571	−78.219	−99.635	91.501
Hitachi	40.477	−100.000	2.707	51.010	24.332	−99.181	−1.543
Microst	−25.851	60.394	10.161	7.368	34.264	−100.000	−82.501
Sony	5.076	−100.000	77.748	−80.580	16.018	−100.000	29.693
HP	−34.206	37.643	11.280	33.429	27.331	−88.866	−62.802
Matsu	−91.291	87.931	−71.381	−76.400	−13.389	−100.000	39.301
:	:	:	:	:	:	:	:

RPA can describe the technology intensity of a specific company in a specific patent class and the value is between −100 and +100. If the RPA is positive, it represents related high capability in technology; otherwise, its related technology capability is low. If the difference in the two RPA values reaches 15 or more, it means these two technology capabilities (different classes or companies) have a significant difference. This study transferred P_{ij} to RPA_{ij} by Eq. (1). Table 4 shows part of the result matrix RPA_{ij}.

4.2. Cluster analysis

There are two methods for cluster analysis: hierarchical and k-means. Some studies use two steps cluster which combines both methods. This study used k-means method in the inside-out approach, and hierarchical cluster in the outside-in approach. Because the classified variables of the former are metrics (RPA_{ij}), researchers can try different clusters and use these variables to examine the validity of cluster; but the input data of the latter are the correlation matrix, researchers only observe the process of aggregation and determine the suitable cluster.

In this section, the k-means method was used for cluster analysis; and four to eight groups were tested at a time. One-way MANOVA and discriminant analysis were employed to examine the validity of cluster analysis. The ideal result appeared to be a six-group cluster, so this paper only discusses six groups in the following analysis, and the validity of cluster will be described in Section 4.3.

Thirty-eight firms were separated into six groups as Tables 5 and 6 list the cluster centroids. The shadow cells are a large positive value which means the group owns the specific sub-class technologies. There are three groups with unique technology: Group 2 uses

Table 5
Result of the cluster analysis in patent portfolio.

Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
NCR	Pitney Bowes	Diebold	Matsushita	i2	Toshiba
Hitachi	Franc.-Post.	MasterCard	Canon	GE	Kodak
Sony	Neopost	First Data	NEC	EDS	Xerox
Amazon	E-Stamp	Verifone	Nokia		Intel
priceline		Citibank	Contentgd H.		IBM
Walker D.		VISA	InterTrust Tech.		HP
AT&T		Open Markt	Fujitsu		Microsoft
			Lucent		Sun
			Motorola		
7	4	7	9	3	8

Table 6
Centroids of the cluster analysis.

Sub-Class	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
Finance	32.277	−76.690	70.113	−46.430	−52.903	−33.175
Protection	−90.809	−88.331	−91.979	62.084	−98.510	36.131
e-Shop	45.311	−98.666	−38.833	−23.373	3.709	16.540
OR	−38.101	−99.543	−94.886	−38.823	87.937	7.107
Security	−32.989	−79.909	50.207	4.165	−93.477	11.984
Postage	−99.491	96.111	−100.000	−96.762	−100.000	−86.101
POS	3.177	−98.911	−41.350	−9.843	−68.247	−66.997

Postage; Group 4 uses Protection; and Group 5 uses OR technology. This means three groups develop their technology in a pure manner. Contrarily, the other three groups use mixed technologies: Group 1 combines Finance and e-Shop technologies; Group 3 links Finance with Security technology; and Group 6 integrates Protection, e-Shop and Security technologies. From another dimension, Postage is only employed in Group 2, and OR is only employed in Group 5, other technologies are used in more than one group. This means there are some technologies overlapping in Groups 1, 3, 4, 6. For example, Finance is employed in Groups 1 and 3, which imply that the firms in Groups 1 and 3 applied similar methods in Finance technology. For POS, all values of the cluster centroids are negative or very small, which means POS is not a significant technology in a specific group and none of the groups using POS is stronger than using other technologies.

4.3. Validity of cluster analysis

One-way MANOVA is frequently applied for examining the validity of cluster analysis. The overall and marginal tests are listed in Appendix B1. All the p-values of overall and marginal test are below 0.05, which means that the RPA indicators of the seven technology sub-classes have significant differences among the six groups.

Discriminant analysis is also applied to confirm the group's validity. Five discriminant functions are generated from six groups, as listed in Appendix B2. According to Appendix B2, p-values of discriminant functions are below 0.05 and the canonical correlation is greater than 0.5, meaning the discriminant effects are good [38].

Another indicator is hit rate that signals the consistency between cluster analysis and discriminant analysis. The comparison table is listed in Appendix B3. The result shows that only one sample of 38 firms is inconsistent, and the hit rate reaches 97.37%. Therefore, the RPA indicators of the seven technological sub-classes have high validities as grouping variables.

5. Outside-in approach

The patent citation of firms can be used to find the relationship of firms [20,21], to explore the trajectory of technology diffusion [22–24], and can be regarded as an outside dependency. Lai & Wu combined bibliometrics with patent analysis to classify semiconductor technology [39]; Daim et al. [11] also used bibliometrics to forecast emerging technologies; Oda et al. employed co-citation analysis to build a framework for technology transition and patent strategy [40]. Bibliometrics and co-citation is a collateral relationship as brothers and sisters. Another lineal relationship is like father and son, or grandfather and grandson. Chang et al. used patent lineal relationship to found the critical business method patents and explored technology diffusion trajectory to classify business methods [22]. Lee et al. also used patent citation network to build technology-driven roadmapping to discuss the business planning. [41]. Therefore, patent citation is a useful raw data to establish the relationship between firms or technologies.

This study considers that Outside-in approach is another view to group the interdependent firms in business method technology. This approach uses patent citation data between 38 firms to establish a similar matrix, and hierarchical cluster analysis to separate 38 firms into several groups.

Table 7
Patent citation of 38 firms (C_{ij}).

No.	Number of patent NP_j	Cited firms	Citing firms no. C_{ij}									
			1	2	3	4	5	6	7	8	9	...
1	578	IBM	223	18	30	15	23	49	22	22	10	...
2	319	Pitney Bowes	14	618	2	1	0	1	0	15	1	...
3	191	Fujitsu	33	1	35	13	16	5	9	5	18	...
4	174	NCR	19	0	7	153	1	0	2	3	1	...
5	167	Hitachi	38	5	6	5	23	2	3	3	0	...
6	137	Microsoft	52	7	9	2	10	28	7	10	6	...
7	132	Sony	4	0	1	0	9	0	21	2	17	...
8	111	HP	41	1	2	3	4	4	2	9	0	...
9	109	Matsushita	1	0	1	7	3	1	9	0	36	...
:	:	:	:	:	:	:	:	:	:	:	:	...

Note: The notation (:) and (...) represent "and so on".

5.1. Measurement of patent citation

Based on 38 firms and 3154 patents, this section built a citation matrix between 38 firms. Table 7 lists part of the patent citation matrix C_{ij} which means the frequencies of firm *i* patents have been cited by firm *j*. The value of C_{ij} will depend on the number of patents of firm *j*. In general, the number of patents of firm *j* is larger, the greater the value of C_{ij} is bigger. This study uses Eq. (2) to transfer C_{ij} to CR_{ij} and eliminate the bias. The value of CR_{ij} means that the average rate of one patent of firm *j* cites the patents of firm *i*. If the value of CR_{ij} is bigger, it means firm *j* more strongly depends on firm *i*.

$$CR_{ij} = C_{ij} \,/\, NP_j \tag{2}$$

where NP_j is the number of patents in firm "*j*".

The CR_{ij} matrix is not a symmetrical matrix. This study considers the interdependence of two firms, and does not discuss who is a leader or follower. Then we build a symmetrical matrix by Eq. (3) which is a simplest method to transfer an asymmetrical matrix to symmetrical matrix [42]. If the value of CCR_{ij} is bigger, it means the interdependence relationship of firm *i* and *j* is higher.

$$CCR_{ij} = CCR_{ji} = CR_{ij} + CR_{ji}. \tag{3}$$

In general, if the input data for cluster analysis is a symmetrical correlation matrix or a similar matrix, the domain values of matrix are between −1 to +1 and 0 to 1. In this study, the maximum value of matrix CCR_{ij} is 3.875 and the minimum value of matrix is 0. To make cluster analysis suitable, the matrix CCR_{ij} was transferred to a new matrix $NewCCR_{ij}$ by Eq. (4).

$$\begin{aligned} NewCCR_{ij} &= \sqrt{CCR_{ij} \,/\, Max\left(CCR_{ij}\right)}, \text{if} i \neq j \\ NewCCR_{ij} &= 1, \text{if} i = j \end{aligned} \tag{4}$$

where the $Max(CCR_{ij})$ is the maximum value of matrix CCR_{ij} or 3.875. The purpose of division is to transfer the domain value between 0 and 1, and the square root is to decline the bias of tiny values. This study set 1 to the diagonal of $NewCCR_{ij}$ means that the relationship of firm's oneself is equal to 1. The $NewCCR_{ij}$ matrix is an input data for cluster analysis from the outside-in approach.

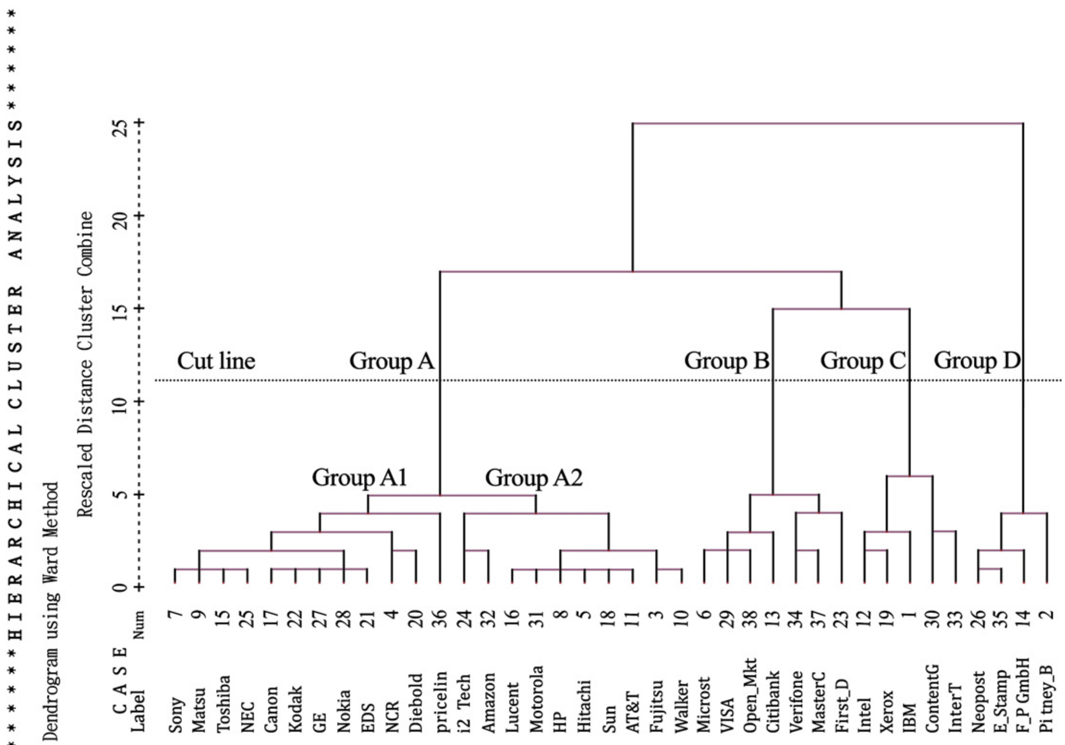

Fig. 3. Tree diagram of hierarchical cluster analysis.

Table 8
Result of the cluster analysis in patent citation.

Group A		Group B	Group C	Group D
Group A1	Group A2			
Sony	i2	Microsoft	Intel	Neopost
Matsushita	Amazon	VISA	Xerox	E-Stamp
Toshiba	Lucent	Open Markt	IBM	Franc.-Post.
NEC	Motorola	Citibank	Contentgd H.	Pitney Bowes
Canon	HP	Verifone	InterTrust Tech.	
Kodak	Hitachi	MasterCard		
GE	Sun	First Data		
Nokia	AT&T			
EDS	Fujitsu			
NCR	Walker D.			
Diebold				
Priceline				
12	10	7	5	4

5.2. Hierarchical cluster analysis

The cluster method differs from the inside-out approach because the classified variables of the patent portfolio are metrics (RPA_{ij}). Researchers can try different clusters and use these variables to examine the validity of the cluster. The input data of the outside-in approach are the correlation matrix ($NewCCR_{ij}$). Researchers only observe the process of aggregation and determine the suitable cluster. Therefore, this study uses hierarchical cluster analysis with Ward's method and squared Euclidean distance to classify thirty-eight firms into four groups (Group A to D). Fig. 3 is the tree diagram of hierarchical cluster analysis.

Because the input data $NewCCR_{ij}$ matrix is transferred from the citation relationship which represents the outside dependence, the firm within the same group from cluster analysis means these firms have a higher citation rate or closer dependent relationship.

Based on Fig. 3, we can find the process of aggregating firms. If the cut line is near 10 in the *rescaled distance cluster combine*, this analysis produces four groups (Group A to D). But the Group A is too large with 22 firms, then, this study separated Group A into Group A1 and Group A2. Table 8 lists the firms of five clusters (Group A1, A2, B, C and D).

As above result, this paper produced six technological groups from the patent portfolio, and separated the firms into five groups based on the patent citations. Table 9 is a cross table generated by the two dimensions. There are 30 technological groups in the business method technology field in theory, but there are only 14 group content firms. If the firms belonged to the same group, they have similar technological capabilities, and highly interdependent relationships. On the other hand, if the firms were not located in the same group, highly different technological capabilities existed or they had a less interdependent relationship.

6. Discussion

This study integrated two strategic approaches to group business method firms by patent information analysis. We used the patent portfolio and patent citation data to establish a model of technological position and technologic groups. Based on Table 9, this section discusses four situations between firms.

Table 9
Technological group of business methods.

		From patent portfolios (inside-out view)						
		1	2	3	4	5	6	Total
From patent citation (outside-in view)	A1	Sony NCR priceline		Diebold	Matsushita Canon NEC Nokia	GE EDS	Toshiba Kodak	12
	A2	Amazon Hitachi AT&T Walker D.			Fujitsu Lucent Motorola	i2	HP Sun	10
	B			Citibank VISA MasterCard First Data Verifone Open Markt			Microsoft	7
	C				Contentgd H. InterTrust Tech.		Xerox Intel IBM	5
	D		Pitney Bowes Franc.-Post. Neopost E-Stamp					
	Total	7	4	7	9	3	8	38

6.1. Situation I: similar portfolio and highly interdependence

Firms located in the same cell on Table 9. These firms have similar technological capabilities, and highly interdependent relationships. For example, there are four firms (Pitney Bowes, Franc.-Post, Neopost and E-Stamp) in Group D*2 (Group D cross Group 2). These four firms are most similar in not only technological capabilities but also interdependent relationships in the postage metering technology. Another typical group is Group B*3 which include six firms (Citibank, VISA, MasterCard, First Data, Verifone and Open Market). Referring to Table 7, the major technologies are finance and security. The former three firms belong to finance industry which always emphasizes security. The latter three firms also make more effort with security which can apply to the finance service. Therefore, these six firms were clustered into one group implying they may be competitors with one another or cooperators.

6.2. Situation II: similar portfolio and lower interdependence

This situation is similar to firms located in the same column but not in the same cell on Table 9. This means firms own similar technological capabilities, but these technologies have less interdependent relationships. Because these firms have similar technological capabilities, they become competitors in product or service more frequently. For example, Sony (in Group A1*1) vs Hitachi (in Group A2*1); Nokia (in Group A1*4) vs Motorola (in Group A2*4); and HP (in Group A2*6) vs IBM (in Group C*6); each pair is direct competitors in their product or service. As regards to lower interdependence, maybe each firm owns its technological contexts which differ from other firms (EDS vs i2), or only have one-way technology flow (priceline vs Walker D.). These reasons cause the citation rate or interdependent relationship to be lower between these firms.

6.3. Situation III: different portfolio and highly interdependence

This situation is similar to firms located in the same row but not in the same cell on Table 9. This means firms have highly interdependent relationships, but their technological capabilities differ. This study finds most Japanese firms are located in Group A1, Sony is in Group A1*1; Matsushita, Canon and NEC are in Group A1*4; and Toshiba is in Group A1*6. Although these Japanese firms have different patent portfolios, they cite other firms more frequently. Then, the area or region is an important factor for firms' interdependence. Hitachi (in Group A2*1) and Fujitsu (in Group A2*4) are the same condition. Another finding is that Microsoft and the finance industry (Citibank, VISA and MasterCard) are highly interdependent, which implies different industries can use patent citation or cross licensing to form a cooperation strategy.

6.4. Situation IV: different portfolio and lower interdependence

This situation is similar to firms located neither in the same column, nor in the same row on Table 9. This means firms have different technological capabilities, and these technologies are less interdependent relationships. In this situation, firms have less direct competition and cooperation, but they can create complementary alliances. For example, Amazon (in Group A2*1) can connect with the capabilities of Citibank (in Group B*3), Microsoft (in Group B*6), or IBM (in Group C*6) to strengthen the e-commerce business model; Sony (in Group A1*1) can alliance with Contentgd H. or InterTrust (in Group C*4) to protect digital content or establish DRM (Digital Right Management).

Based on the discussion, Fig. 4 summarizes the four situations between firms; and lists the adoptable technological strategies in each situation.

7. Conclusion and suggestion

This study combined two strategic approaches to group business method firms by patent portfolio and patent citation data. We used cluster analysis to establish a 5 by 6 matrix to represent the technological groups. If the firms belong to the same group, they have similar technological capabilities, and more interdependent relationships. On the other hand, if the firms are not located in the same group, either there are highly different technological capabilities, or they have lower interdependent relationship. Finally, we draw some conclusions and provide some directions on future study below.

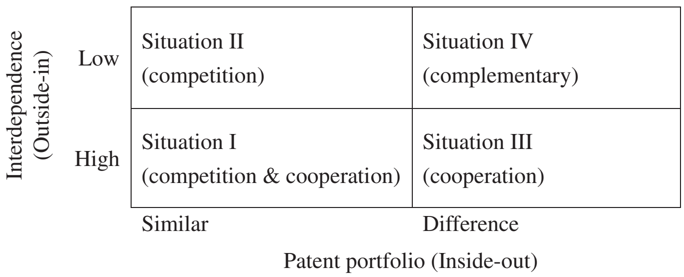

Fig. 4. Four situations between firms.

7.1. Conclusions

There are three conclusions of this paper.

1. Business method is an important technology in the Internet era. This technology not only has many sub-class technologies, but also applies to many industries. It is difficult for firms to recognize the real competitors or cooperators. This study uses both the patent portfolio and patent citation data to establish the technological groups that can provide firms to find relevant enterprises and formulate their technological strategies.
2. Based on the inside-out approach, business method firms were separated into six groups using the patent portfolio. From another outside-in approach, business method firms were separated into five groups by the patent citation. Combining two different approaches, this study generates a $5*6$ matrix to represent the technological groups. If the firms located in the same cell, they have similar technological capabilities and highly interdependent relationships; if the firms located in the same column, they own similar technological capabilities but these technologies are less interdependent relationships; if the firms located in the same row, they have highly interdependent relationships but their technological capabilities differ.
3. Using the similarity of capabilities and strength of interdependence, this study generates a 2 by 2 matrix. This matrix can support firms to recognize the real competitors or cooperators, furthermore, assist manager to formulate their technological strategies which include competition, cooperation, or complementary cooperation.

7.2. Contributions

There are few competitions between different industries before Internet era. After 2000, it is more difficult for enterprises to determine where their real competitors come from, what capabilities they have, and what position they are located in. Because the conception of industry has changed, the boundaries of industry have become blurred. The phenomenon is called digital convergence industry convergence. This paper proposes a framework to know technological strategy of targeted firms and to support business strategy formation of a firm, which uses a two dimension matrix by patent portfolio and patent citation analysis.

This paper analyzed the business method technology which is a generic class for apparatus and corresponding methods for performing data processing operations, which can be used in many industries such as software, hardware, communication; finance, retailing, entertainment, and so on. This study is the first research to discuss technological position and strategy using business method patents from USPTO. Through the patent analysis, author found four situations between different companies, even in different industries. This situation can help enterprise manager make a suitable decision to form an alliance with other company.

In the academic viewpoint, this paper is the first study to use patent portfolio and patent citation analysis simultaneously. These two methods reflect the different approaches of strategy formulation. This methodology not only elaborates the patent information but also expresses the strategy opinion, that provides a useful framework to future study about patent analysis and strategy planning.

7.3. Suggestions for future study

This study provides two directions of future study to help firms formulate technological strategies more clearly.

1. Although firms may have similar situations, with any technological group technological strategies differ. These strategies depend on many other conditions, such as whether the firms are new entrants or incumbents, the type of products and services, the level of familiarity with the market and technology, and possession of the complementary asset capabilities [21,43–46]. Therefore, these issues offer some directions for future studies.
2. Longitudinal research. Although business method patents were announced in 2000, since 1993, some technologies of business method for the Internet have already been developed. In the last decade, information and Internet technologies have been progressing daily. However, have those technologies effectively stimulated the business method development? How does one influence the business method with those technologies? Is there any change in the technologic position? In the study by Stuart & Podolny [47], they looked at the change in technological position in the semiconductor industry, with 1982, 1987 and 1992 time period data being studied. This is a typical example applying the business method longitudinal study.

7.4. Limitations

There are two limitations in this study; they are also the perplexities for future study to try to break.

1. This study defined the technology scope is business method that the patents were retrieved only US Class 705. It means that all patents belong to US 705 in this study. Actually, it is possible for one patent in US 705 to be cited by another patent that does not belong to US 705. That relevant patent did not be included in this analysis.
2. This paper did not distinguish between patent citing and cited because author just considers the interdependence of firms, and use a symmetrical matrix to present the relationship. If future study wants to examine the knowledge in-flow or knowledge out-flow, researcher should build a non-symmetrical matrix to measures the relationship.

Appendix A. US class 705 and sub-classes

Source:http://www.uspto.gov.

705 Sub-class	Title
1–45	Automated electrical financial or business practice or management arrangement
2-3	Health care
4	Insurance
5–6	Reservation, check-in, booking
7–11	Operations Research
12	Voting or election arrangement
13	Transportation facility access
14	Distribution or redemption of coupon, or incentive or promotion program
15	Restaurant or bar
16–25	POS terminal or electronic cash register
26–27	Electronic shopping
28–29	Inventory management
30–34	Accounting
35–45	Finance
50–80	Business processing using cryptography
51–59	Usage protection of distributed data files
60–62	Postage metering system (Cryptography)
63	Utility metering system
64–79	Secure transaction
80	Electronic negotiation
400–418	For cost/price
401–411	Postage metering system (cost/price)
412	Utility usage
413	Fluid
414–416	Weight
417	Distance
418	Time
500	Miscellaneous

Appendix B1. The statistics of 1-way MANOVA test

Overall test			Marginal test		
Statistic	F-value	p-value	Sub-class	F-value	p-value
Pillai's trace	10.092	0.000	Finance	12.489	0.000
Wilks' lambda	30.820	0.000	Protection	96.027	0.000
Hotelling's trace	57.193	0.000	e-Shop	6.994	0.000
Roy's largest root	199.574	0.000	OR	13.512	0.000
			Security	8.991	0.000
			Postage	219.680	0.000
			POS	3.673	0.010

Appendix B2. The statistics of Discriminant analysis

Interpretation ability of Discrim. functions				Significant of Discriminant analysis				
Discriminant function	Eigen value	Canonical correlation	Acc. variance%	Function	Wilks' lambda	Chi-square	d.f.	p-value
Fun. 1	46.567	0.989	56.8	Fun. 1–5	0.000	303.484	35	0.000
Fun. 2	29.608	0.984	92.9	Fun. 2–5	0.002	185.689	24	0.000
Fun. 3	4.659	0.907	98.5	Fun. 3–5	0.069	81.341	15	0.000
Fun. 4	.759	0.657	99.5	Fun. 4–5	0.393	28.474	8	0.000
Fun. 5	.446	0.555	100.0	Fun. 5	0.691	11.254	3	0.010

Appendix B3. Comparisons between discriminant analysis and cluster analysis

Actuality		Prediction of Discriminant analysis						
		Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Total
Results of Cluster analysis	Group 1	1	0	0	0	0	0	7
	Group 2		4	0	0	0	0	4
	Group 3		0	7	0	0	0	7
	Group 4		0	0	9	0	0	9
	Group 5		0	0	0	3	0	3
	Group 6				1		7	8
	Total	7	4	7	10	3	7	38

References

[1] S. Chen, Strategic Management of e-Business, John Wiley & Sons, Inc, 2001, pp. 183–212.
[2] C.S. Curran, S. Broring, J. Leker, Anticipating converging industries using publicly available data, Technological Forecasting and Social Change 77 (2010) 385–395.
[3] B.W. Wirtz, Reconfiguration of value chains in converging media and communications markets, Long Range Planning 34 (2001) 489–506.
[4] G. Hamel, Killer strategies that make shareholders rich, Fortune (June 23 1997) 70–88.
[5] H. Mintzberg, B. Ahlstrand, J. Lampel, Strategy safari — A Guided Tour through the Wilds of Strategic Management, Free Press, New York, 1998.
[6] J.B. Barney, Firm resources and sustained competitive advantage, Journal of Management 17 (1991) 99–120.
[7] R.M. Grant, The resources-based theory of competitive advantage: implications for strategy formulation, California Management Review 33 (1991) 114–135.
[8] R.E. Hoskisson, M.A. Hitt, W.P. Wan, D. Yiu, Theory and research in strategic management: swings of a pendulum, Journal of Management 25 (1999) 417–456.
[9] J. Pfeffer, G.R. Salancik, The External Control of Organizations: A Resource Dependence Perspective, Harper and Row, New York, 1978.
[10] N. Corrocher, F. Malerba, F. Montobbio, Schumpeterian patterns of innovative activity in the ICT field, Research Policy 36 (2007) 418–432.
[11] T.U. Daim, G. Rueda, H. Martin, P. Gerdsri, Forecasting emerging technologies: use of bibliometrics and patent analysis, Technological Forecasting and Social Change 73 (2006) 981–1012.
[12] Z. Griliches, Patent statistics as economic indicators: a survey, Journal of Economic Literature 28 (1990) 1661–1707.
[13] K. Pavitt, Uses and abuses of patent statistics, in: A.F.J.v. Raan (Ed.), Handbook of Quantitative Studies of Science and Technology, Elsevier, Amsterdam, 1988, pp. 509–536.
[14] J. Schmookler, Invention and Economics Growth, Harvard Univ. Press, Cambridge, MA, 1966.
[15] C. Watanabe, Y.S. Tsuji, G.B. Charla, Patent statistics: deciphering a 'real' versus a 'pseudo' proxy of innovation, Technovation 21 (2001) 783–790.
[16] Y.S. Chen, K.C. Chang, The relationship between a firm's patent quality and its market value — the case of US pharmaceutical industry, Technological Forecasting and Social Change 77 (2010) 20–33.
[17] H. Ernst, Patent portfolios for strategic R&D planning, Journal of Engineering and Technology Management 15 (1998) 279–308.
[18] R.J. Mann, T.W. Sager, Patents, venture capital, and software start-ups, Research Policy 36 (2007) 193–208.
[19] G. Park, Y. Park, On the measurement of patent stock as knowledge indicators, Technological Forecasting and Social Change 73 (2006) 793–812.
[20] F. Narin, K.S. Hamilton, D. Olivastro, The increasing linkage between US technology and public science, Research Policy 26 (1997) 317–330.
[21] T.E. Stuart, Network positions and propensities to collaborate: an investigation of strategic alliance formation in a high-technology industry, Adiministrative Science Quarterly 43 (1998) 668–698.
[22] S.-B. Chang, K.-K. Lai, S.-M. Chang, Exploring technology diffusion and classification of business methods: using the patent citation network, Technological Forecasting and Social Change 76 (2009) 107–117.
[23] M.C. Hu, Knowledge flows and innovation capability: the patenting trajectory of Taiwan's thin film transistor-liquid crystal display industry, Technological Forecasting and Social Change 75 (2008) 1423–1438.
[24] H.J. No, Y. Park, Trajectory patterns of technology fusion: trend analysis and taxonomical grouping in nanobiotechnology, Technological Forecasting and Social Change 77 (2010) 63–75.
[25] A.B. Jaffe, Characterizing the 'technological position' of firms, with application to quantifying technological opportunity and research spillovers, Research Policy 18 (1989) 87–97.
[26] USPTO, Examination Guidelines for Computer-related inventions, 1996.
[27] USPTO, A USPTO WHITE PAPER, Automated Financial or Management Data Processing Methods (Business Methods), 2000.
[28] N.A. Smith, Business method patents and their limits: justifications, history, and the emergence of a claim construction jurisprudence, Michigan Telecommunications and Technology Law Review (Fall 9 2002) 171–209.
[29] S.D. Locke, W.D. Schmidt, Business method patents: the challenge of coping with an ever changing standard of patentability, Fordham Intellectual Property Media and Entertainment Law Journal 18 (2008) 1079–1094.
[30] S.D. Hunter III, Have business method patents gotten a bum rap? Some empirical evidence, MIT Sloan School of Management Working Paper 4326-03, July 2003; Social science research network electronic paper collection, http://ssrn.com/abstract=424081.
[31] B.H. Hall, Business method patents, innovation, and policy, Institute of Business and Economic Research, Department of Economics, UCB (University of California, Berkeley) Working Paper No. E03-331, May 2003;
This paper is posted at the eScholarship Repository, University of California, http://repositories.cdlib.org/iber/econ/E03-331.
[32] S. Wagner, Business method patents in Europe and their strategic use—evidence from franking device manufacturers, Economics of Innovation and New Technology 17 (3) (2008) 173–194.
[33] B. Fabry, H. Ernst, J. Langhols, M. Koster, Patent portfolio analysis as a useful tool for identifying R&D and business opportunities — an empirical application in the nutrition and health industry, World Patent Information 28 (2006) 215–225.
[34] B.-W. Lin, C.-J. Chen, H.-L. Wu, Patent portfolio diversity, technology strategy, and firm value, IEEE Transactions on Engineering Management 53 (1) (2006).
[35] U. Lichtenthaler, The role of corporate technology strategy and patent portfolios in low-, medium- and high-technology firms, Research Policy 38 (2009) 559–569.
[36] F.P. Su, K.K. Lai, R.R.K. Sharma, T.H. Kuo, Patent priority network: linking patent portfolio to strategic goals, Journal of the American Society for Information Science and Technology 60 (11) (2009) 2353–2361.
[37] U. Schmoch, Evaluation of technological strategies of company by means of MDS maps, International Journal of Technology Management 10 (Nos 4/5/6) (1995) 426–440.
[38] J.F. Hair Jr., R.E. Anderson, R.L. Tatham, W.C. Black, Multivariate Data Analysis, 5th ed Prentice-Hall, 1998.
[39] K.-K. Lai, S.-J. Wu, Using the patent co-citation approach to establish a new patent classification system, Information Processing and Management 41 (2) (March 2005).
[40] T. Oda, K. Gemba, K. Matsushima, Enhanced co-citation analysis using frameworks, Technology Analysis and Strategic Management 20 (2) (2008) 217–229.

[41] S. Lee, B. Yoon, C. Lee, J. Park, Business planning based on technological capabilities: patent analysis for technology-driven roadmapping, Technological Forecasting and Social Change 76 (2009) 769–786.
[42] J. Lattin, J.D. Carroll, P.E. Green, Analyzing Multivariate Data, Thomson, Canada, 2003, pp. 230–232.
[43] W. Abernathy, K.B. Clark, Mapping the winds of creative destruction, Research Policy 14 (1985) 3–22.
[44] A. Afuah, Innovation Management: Strategies, Implementation, and Profits, Oxford University Press, New York, 1998, pp. 14–31.
[45] E.B. Roberts, C.A. Berry, Entering new businesses: selecting strategies for success, Sloan Management Review 26 (1985) 3–17.
[46] D.J. Teece, Profiting from technological innovation: implications for integration, collaboration, licensing and public policy, Research Policy 15 (1986) 285–306.
[47] T.E. Stuart, J.M. Podolny, Local search and the evolution of technological capabilities, Strategic Management Journal 17 (1996) 21–38.

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