日本 MOT 学会による査読論文（2011-3）

新産業における提携の企業価値への影響 : 日本における有機 EL の事例

The Impact of Alliance Formation on Firm Value in an Emerging Industry: The Case of Organic Light Electric Diode in Japan

小関　珠音／岡村　浩一郎
Tamane OZEKI ／ Koichiro OKAMURA

要　旨

本研究は、新産業における企業提携が提携企業のパフォーマンスに及ぼす影響を、イベント・スタディの手法を用いて分析した。日本の有機 EL 産業の 126 の企業提携データから得られた 90 のイベント・データを分析し、企業提携の性質（提携の種類と製品技術の複雑さ）、及びそれらの相互作用がどのようにして企業パフォーマンスに影響を与えるのか、株式市場における企業価値の観点から解析した。その結果、新産業において企業提携、とりわけ製品製造を目的とした企業提携が有効な戦略であることが明らかになった。しかしその一方で、提携の目的となる製品に必要となる技術の複雑さは企業価値にあまり影響を与えないことが分かった。ただし、大きな市場と利潤が期待される製品の研究開発を目的とした企業提携は例外であり、株式市場は、他の研究開発を目的とする企業提携と比較して、より高く評価していることが明らかになった。

ABSTRACT

This study examines firm-level performance implications of alliances in an emerging industry, using a standard event study methodology. It analyzes how alliance characteristics (i.e., alliance type and complexity level of focal products) and their interactions influence firm performance in the stock market. The study uses a sample of 90 event data from 126 alliances in the organic light emitting diode industry in Japan for the assessment. We found that forming an alliance is, all in all, a valuable strategy in an emerging industry. This is particularly so for manufacturing alliances. The complexity level of the products in which alliances are interested generally does not have a significant effect on stock market performance. However, the market does show sensitivity to the expected introduction of highly complex products with potential large market and profits.

キーワード：有機 EL、企業提携、イベント・スタディ、新産業

1．Introduction

The last decade has witnessed the replacement of tube-based televisions and monitors with flat panel display (FPD) monitors. Now the competition has shifted from tube-vs.-FPD to the different set technologies for FPDs. Major FPD technologies include liquid crystal display technology, plasma display technology and organic light electric diode (OLED) technology. This study focuses on OLED technology

小関　珠音　　東京大学大学院　工学系研究科　先端学際工学専攻
岡村　浩一郎　関西学院大学　商学部
（受領日：2010 年 9 月 11 日、受理日：2011 年 2 月 3 日）

since it is still in its infancy but rapidly advancing and has the largest market potential, as it has applications not only in conventional monitors but also in new products such as electric papers, which would be unattainable with other competing technologies.

An OLED is a film made of organic compounds and a structure that is fabricated with lithography technology from the semiconductor industry. The idea of the OLED was conceived in the 1960s and has been studied since then. However, it was Ching W. Tang and Steven Van Slyke at Eastman Kodak who made a breakthrough in 1979, leading to the first diode device, which was based on low-molecular polymers. In the 1980s, Kodak launched an in-house research and development (R&D) project to move toward commercialization of the technology. However, the company could not overcome technical problems and decided not to proceed with commercialization. Tang and Van Slyke reported their seminal work in Applied Physics Letters in 1987. Their study was the impetus for the current OLED R&D. Soon after the publication of Tang and Van Slyke' s work, a research group at Cambridge University that had been independently pursuing development of an OLED using high-molecular polymers published a paper about its accomplishments, which later led to the founding of Cambridge Display Technology (CDT), a major developer of OLED technology (Johnstone, 2001; Kido, 2003).

The OLED technology is a combination of a wide range of knowledge and technologies, such as organic chemistry, semiconductor devices, and the semiconductor lithography manufacturing process, which opens a window for alliances and collaborations among firms, universities, and other organizations. In fact, Kodak decided not to continue the product development in-house in the mid-1980s, but it licensed its technologies to or collaborated with other firms, the majority of which were Japanese firms such as Pioneer, NEC, TDK, Sanyo, and Idemitsu Kosan Co. CDT also licensed its technologies to or collaborated with Sumitomo Chemical and Panasonic. Accordingly, many alliances have been formed among firms and other organizations in the OLED industry in the past twenty years or so, which provides a research opportunity to examine the impact of alliances on firm performance in an emerging industry.

The industry has been growing rapidly. The global OLED market was expected to grow to 109 billion yen (1.4% share of the whole FPD industry) in 2010 from 54 billion yen in 2008 (0.56%), and it is projected to grow to 470 billion yen (5.5%) in 2016 (New Energy and Industrial Technology Development Organization, 2010). The industrial structure has changed during the past 10 years. Japanese firms were major players in the OLED industry 10 years ago, but they have been replaced by Korean firms today. Tohoku Pioneer had a 91% share of the 7.6 billion-yen worldwide OLED module market in 2002, and Samsung Mobile Display captured 92% of the 50 billion-yen market in 2007 (Fuji Chimera Research Institute, 2003, 2010).

This study applies a standard event study methodology (Inoue & Kato, 2006; Mitsui, 2009), which uses the market response to an event as an indicator of the impact of the event on firms and on alliance formation in the OLED industry. Specifically, this study examines whether alliances have an impact on firm performance in an emerging industry and what kinds of alliances influence firm performance, either positively or negatively.

We found that an alliance is, all in all, a valuable strategy in an emerging industry. The market favors manufacturing over R&D and marketing alliances, suggesting that the OLED industry is still in its infancy. In contrast, the complexity level of the focal products does not have a significant impact on the market. Instead, the focus on manufacturing matters. Although the market has an attitude unfavorable to R&D in general, it shows high expectations with potential large market such as OLED TV and lighting.

The rest of the paper is structured as follows. Section 2 reviews the extant literature on alliances with an emphasis on the relationship between alliance characteristics and firm performance. Section 3 describes the data and methodology, and this is followed by the empirical results in Section 4. Finally, Section 5 concludes by discussing the results and draws connections to R&D managers and policymakers.

2. Literature Review

Today' s firms recognize that they cannot innovate alone as technology becomes more advanced and complex. They need to collaborate with others to bring their technologies to the marketplace. This is particularly true concerning the development of the OLED, as discussed in the introduction. There exists a voluminous literature explaining firms' incentives to enter into alliances, which are voluntarily and independently initiated interfirm links that involves exchange, sharing, or co-development of new products and technologies (Contractor and Lorange, 1988; Gulati, 1995; Harrigan, 1986). Explanations for alliance formation include risk and/or cost sharing, gaining access to complementary resources, and learning and developing new competencies from the partners (Hagedoorn, Link, & Vonortas, 2000). Firms can enjoy these benefits in various forms of alliance while avoiding the rigidity associated with mergers and acquisitions, gaining access to resources not available in market transactions. An alliance isn't a panacea, however. Transaction cost theory, for example, pointed out that an alliance involves costs for negotiating, monitoring, and controlling exchange transactions (Brockhoff, 1992; Williamson, 1989). A related issue is appropriation concerns associated with knowledge specifity, which is exacerbated particularly in an R&D alliance (Gulati &Singh, 1998; Oxley, 1997). Nevertheless, many alliances are formed annually. The Strategic Alliance database from the Security Data Company (SDC), one of most commonly used in empirical studies of alliances (Schilling, 2009), recorded approximately 4,800 alliance formations worldwide in 2005 and a peak of 10,500 alliances in 2000.

This study uses the standard event study method, which has been widely used in management research, to assess the impact of alliances on firm value[1] The method, in short, uses financial market data to assess the impact of an event on firm value, with the assumption that rationality and efficiency exist in the market. Putting it differently, the method assumes that the effect of an event on firms is processed by the market and reflected in a firm' s stock price immediately. An abnormal stock price is inferred as reflecting the significance of the focal event. If it is higher than the trend projection, for example, the event is understood to have had a positive impact on the firm. The method has been widely applied in the alliance studies. The overall finding is a positive and significant abnormal return as summarized in Table 1.

Some researchers paid attention to the influence of the nature of alliances on firm value (Campart & Pfister, 2007; Chan et al., 1997; Das et al., 1998; Koh & Venkataraman, 1991). Their common finding was that alliances that focused on R&D and technology performed better than those that did not as summarized in Table 2. This was because the uncertainty and high costs associated with new technologies, coupled with the public-good nature of knowledge and technology, which characterize R&D and technological alliances, made them more valuable than other kinds of alliances. In addition, they had a longer horizon of benefits and were thus perceived to increase firm value more. Those studies analyzed alliances in multiple industries or the biotechnology-pharmaceutical industry, which is more mature and stable than the OLED industry.

In a mature industry, manufacturing alliances face only relatively minor technological difficulties in the product manufacturing process because they use proven and well-established technologies to avoid costly manufacturing mistakes. In an emerging

Table1　Abnormal returns from previous studies

Study	Alliance of interest	Sample period	Abnormal return at the event day (%)	Cumulative abnormal return (%)†
Anand & Khanna (2000)	Multi-sector alliances	1990-1993	0.675**	0.866[a]
Brooke and Oliver (2005)	Technology-oriented alliances	1994-2001	0.014	0.016
Campart & Pfister (2007)	biotechnology and pharmaceutical alliances	1995-2000	n/a	3.91***
Chan, Kensinger, Keown & Martin (1997)	Multi-sector alliances	1983-1992	0.64***	0.85[b]
Das, Sen & Sengupta (1998)	Information technology alliances	1987-1991	n/a	0.005**, [c]
Koh & Venkataraman (1991)	Information technology alliances	1972-1986	0.876***, [d]	n/a
McNonnell & Nantel (1985)	Multi-sector alliances	1972-1979	0.73***, [e]	n/a
Mitsui (2009)	Fuel cell alliances in Japan	1980-2008	0.20	0.21[f]
Neill, Pfeiffer & Young-Ybarra (2001)	Information technology R&D alliances	1987-1994	0.568**	n/a

† 3-day return around the event day.

[a] Our calculation from Table 2; significance level is not available. [b] Our calculation from Table 3; significance level is not available.

[c] Two-day return (days -1, 0). [d,e] Two-day average (days -1, 0). [f] Our calculation from Table 3; significance level is not available.

***significant at 1% level; **significant at 5% level; *significant at 10% level.

Table 2 Abnomal returns by alliance type

Study	Alliance firm type	Abnormal return at the event day (%)	Cumulative abnormal return (%)†
Campart & Pfister (2007)	R&D alliances	n/a	4.20***
	Production/marketing alliances	n/a	2.64***
Chan, Kensinger, Keown & Martin (1997)††	High-tech firms	1.12***	n/a
	Low-tech firms	0.10	0.85[a]
Das, Sen & Sengupta (1998)	Technology alliances	n/a	1.1***, [b]
	Marketing alliances	n/a	0.2**, [b]
Koh & Venkataraman (1991)	Technology exchange	0.80***	n/a
	Marketing agreements	0.01	n/a

† 3-day return around the event day. †† Chan et al. (1997) compared high-tech and low-tech firms in alliances.

[a] Our calculation from Table 3; significance level is not available. [b] Two-day return (days -1, 0).

***significant at 1% level; **significant at 5% level; *significant at 10% level.

industry, in contrast, the manufacturing itself is likely to be challenging since the products are new and the manufacturing process is not yet established or standardized to a sufficient degree. Putting it differently, manufacturing alliances in an emerging industry are likely to perform like quasi-R&D alliances in mature industries. In a similar vein, R&D alliances in an emerging industry are likely to engage in research activity that is close to the basic research stage, which inherently suffers more severely from the public-good nature of knowledge and technology and is characterized by quite high uncertainties and costs (Arrow, 1962). Therefore, it is expected that the impact of alliances on firm value is most positive for manufacturing alliances and lower for R&D and marketing alliances in an emerging industry.

Industry technologies advance and become more mature as an industry grows. Products that are more complex and sophisticated are introduced in the market. Rycroft & Kash (1999) analyzed the relationship between the level of complexity of technologies and their importance in the international trade and found that many technologies becomes more complex and that complex technologies become increasingly more valuable than simple technologies. The OLED is a typical example. The first generation of OLED products was a display panel for car-audio or other applications that did not demand a color display or a wide display area, which thus required a relatively low level of technology maturation (low-complexity). As firms learned from their own R&D activities or the manufacturing process, the technology matured. More sophisticated OLED products were introduced, such as display panels for digital cameras and cell phones, which need to be high-resolution color displays (medium-complexity). The market is also larger than before. Recently, firms have introduced or plan to introduce highly sophisticated products such as OLED television or OLED lighting, and the OLED panels used will require highly complex technologies for production and wide application (high-complexity). It is thus expected that the impact of alliances on firm value is smallest for those that are working on low-complexity products. It is, however, also true that the technological uncertainties and costs are highest for high-complexity products, which would result in negative effects on firm value. Overall, impacts are not clear.

Previous studies classified high-tech and low-tech at an industry level.[2] Researchers paid attention to the effect of the technology level of the industry in which alliances are formed on the firm value. For example, Chan et al. (1997) reported that high-tech alliances showed larger positive abnormal returns than low-tech alliances, while Brooke and Oliver (2005) reported there was little difference between them. However, not all products in a high-tech industry or alliance are really “high-tech” products. Some are “low-tech” compared to others. This is particularly likely when an industry is in its infancy and advancing rapidly. This study thus uses the complexity level (Rycroft & Kash, 1999) in its analysis to describe the trajectory of the OLED instead of the high-tech and low-tech classification. We are not aware of any studies paying attention to specific technologies or products to examine the impact of alliances on firm performance.

3. Data and Methodology for Analysis

Data

We used the *NIKKEI TELECOM21*, a major business database to collect information about the purpose and characteristics of alliances and the involved partners from the archived articles of the *Nikkei Shimbun.* The database covers a wide range of publicly available Japanese sources, including national and local newspapers, industry publications, general and business journals, or securities filings that occurred as far back as 30 years ago. The coverage of business- and industry-related events is thus comprehensive. We used the *Nikkei Shimbun* because it is the major and only newspaper with special strengths in the areas of businesses and industries in Japan. The data is not free from limitations, however. It does not include business activities consummated by Japanese firms that were not reported in a newspaper. However, the *Nikkei Shimbun* is still ideal for empirical analysis focusing on industries in Japan since the data are probably the richest source of information on business activities there.

We used the keyword "*Yuuki-EL*," which is equivalent to OLED in Japanese, to identify OLED-related articles. The announcement date of the alliance was set as the event date. This search identified 126 alliances among 64 firms between 1999 and 2009. The first alliance that appeared in the data source was the collaborative research alliance between Kodak and Sankyo in 1999.

As for the financial data, event study methodology requires using the stock prices of publicly traded firms and a composite index to estimate the market normal returns. Based on the available financial data, we identified 90 events among 44 firms to be used in the analysis. Some firms enter into alliances multiple times and thus appear as different events.

Methodology

In this study, we used the standard event study methodology based on the market adjustment return model (Inoue & Kato, 2006; Mitsui, 2009) to measure the market response to alliance formation. Let $t = 0$ be the event date at which an alliance appears in the data source, and $R_{i,t}$ is the return of firm i in the stock market at day t. $R_{i,t}$ is defined by

$$R_{i,t} = (P_{i,t} - P_{i,t-1})/P_{i,t-1}$$

where $P_{i,t}$ is the stock price of firm i at day t. The market return, $R_{m,t}$ at the day t is also estimated in the same manner for the market index, $P_{m,t}$. Then the abnormal return of firm i at day t, $A_{i,t}$, is defined as the difference between the return of the firm i and the market return

$$A_{i,t} = R_{i,t} - R_{m,t}$$

The abnormal returns are summed across the three-day event window $[t-1, t+1]$, which is a common practice (Inoue & Kato, 2006; Mitsui, 2009). The cumulative abnormal return, CA_i is defined by

$$CA_i = \sum_{t=-1}^{+1} A_{i,t}$$

The standard event study methodology assumes market efficiency and that the market quickly reflects all the available information. It also assumes that the volatility of the stock is constant on the event day, so the methodology has some limitations because these assumptions are not necessarily assured (Campbell, Lo, & McKinlay, 1997; Compart & Pfister, 2007).

We used the *Nikkei225* Index as the benchmark to estimate the market returns. It is a composite index of the stock prices of the 225 most-actively-traded stocks listed in the Tokyo Stock Exchange's First Section. The stocks included in the index are reviewed annually and replaced with new ones to capture accurate market movements and sector balance. An alternative index would be the Tokyo Stock Price Index (TOPIX), which represents the market value of all stocks listed on the Tokyo Stock Exchange' s First Section. We chose the *Nikkei225* Index for the following reasons. First, a majority of firms in our sample are large and established firms in the manufacturing sectors (cf. Table 3 in Section 4), so their stocks are listed in the Tokyo Stock Exchange's First Section. Second, TOPIX is most affected by the changes in the market value of banks and other financial firms that tend to have a high aggregate market value. We consider the *Nikkei 225* to be an appropriate benchmark for this study since the abnormal return derived by this index best explains the returns attributed to the effect of an event of a relevant firm (Campbell, Lo, & Mckinley, 1997). Finally, we replaced the *Nikkei225* Index with TOPIX and repeated the analysis (Section 4) to see if the analysis might be influenced by the choice of benchmark index, and we found no qualitative change in the results.[3]

4. Analysis

Initial Analysis

Table 3 shows the distribution of 44 firms by

Table3　Industry-size distribution of firms

Industry	Number of employees†				Column sum
	less than 1,000	1,000 to 9,999	10,000 to 49,999	50,000 or more	
Chemical	1	1	3	1	6
Electronics	1	2	5	10	18
Machinery	4	2	1	1	8
Trading	1	3	1	0	5
Other (manufacturing)	0	4	3	0	7
Row sum	7	12	13	12	44

†Some firms enter into alliances multiple times, for which the average value are used.

Table5　Abnormal returns and alliance type

Alliance		Cumulative abnormal return (%)				Number of observations†
		Mean	Std. dev.	Min.	Max.	
	All	1.939	8.659	-32.128	51.280	90
Alliance type	R&D	0.362	5.948	-32.128	25.150	66
	Manufacturing	4.422**	11.559	-5.620	51.280	31
	Marketing	1.224	5.948	-8.827	13.971	20

†Some alliances have multiple purposes. They are counted multiple times in different alliance types.
**significance at the 5% level.

industry and size that are measured by number of employees. They are all Japanese firms. Thirty-seven firms (84% of the total) are large firms with 1,000 or more employees. Four firms are small-medium firms with less than 500 employees. As for industry distribution, 39 firms (89%) belong to the manufacturing sector. Eighteen firms (41%) belong to the electronics sector, followed by machinery (8 firms, 18%) and chemical (6 firms, 14%). Most noticeably, very large electronics firms (50,000 or more employees) are prominent in the sample, suggesting that the OLED technology requires a combination of a wide range of knowledge and technologies and that firms are required to possess a wealth of resources to support R&D activities in the technology field.

Table 4 summarizes the abnormal returns regarding the alliance formation, on average, over the three-day event window around event day 0, where event day 0 corresponds to the announcement day of the alliance formation. The table reports cumulative abnormal returns as well. The abnormal return for the announcement day is not only a statistically significant 1.34%, but larger than the abnormal returns reported in previous studies (Table 1). The initial analysis implies the importance of alliances in emerging industries. Cumulative abnormal returns for the announcement and next days are also statistically significant at 1.69% and 1.94%, respectively. We reference the cumulative abnormal returns hereafter, following the customary practices in management studies.

Table4　Abnormal returns

Event day	Daily abnormal return (%)	Cumulative abnormal return (%)
-1	0.347	0.347
0	1.343**	1.691**
1	0.248	1.939**

**significance at the 5% level.

Table 5 summarizes the cumulative abnormal returns by alliance type. The abnormal return for the manufacturing alliances is, at the highest, 4.42% and only statistically significant, which is a sign of the stock market' s expectation of large benefits in the near future. In contrast, the abnormal returns for R&D and marketing alliances are positive but small and insignificant. The reaction of the market is rather mixed.

Regression Analysis

We used the OLS regression to further examine the impacts of alliance type and technology complexity level of focal products on firm value.

We used a set of dummy variables, *R&D*, *Manufacturing* and *Marketing*, to assess the impact of alliance type on firm value. The dummy variable *R&D* was set at 1 if the purpose of the focal alliance was related to R&D activities, for example. We categorized alliances using the collected information. The dummy variables were not mutually exclusive because often alliances are intended to serve multiple purposes simultaneously. We expected that the most positive impact would be for *Manufacturing*, followed by *R&D* and *Marketing*.

We used another set of dummy variables, *Low-complexity*, *Medium-complexity* and *High-complexity*, to assess the impact of the complexity level of OLED products of interest to alliances on firm value. The dummy variable *Low-complexity* was set at 1 if the focal products required only a relatively low level of technological complexity, for example. Specifically, we categorized alliances as *Low-complexity* if their focal products did not demand color displays or a wide display area, such as display panels for car audio systems. We categorized display panels for digital cameras and cell phones as *Medium-complexity*, and those for television and lighting as *High-complexity*.

The direction of the impact of complexity level of focal products on firm value is ambiguous.

Firms' attempts to commercialize OLED technology often involve R&D activities focused on the manufacturing of equipment. Some alliances are, in fact, interested in the equipment. To distinguish them from the rest, we also included a dummy variable, *Equipment,* which was set equal to 1 for such alliances.

We also included several control variables in the estimation to control for firms' experience in alliance, firm size and growth, and their R&D efforts in the estimation. Specifically, we included the number of OLED alliances that the firms had entered prior to the focal alliance, firms' net sales (logarithm), growth of net sales compared to the previous year, the ratio of R&D expenditures to net sales and firm industry dummy variables, respectively. The inclusion of the control variables showed no qualitative change in the results, so we do not report them in this paper.[4]

Tables 6 and 7 provide descriptive statistics of the variables and the correlation matrix, respectively.

Regression results

Table 8 presents the estimation results. In the table, Model I uses the dummy variables for alliance type. Model II uses the dummy variables for the complexity level of focal products. Model III uses the variables from Model I and Model II. We added the interaction between alliance type, R&D and the complexity level of focal products in Model IV. We also assessed the interaction between other alliance types (Manufacturing and Marketing) and the complexity level of focal products. However, we did not find any qualitative changes or significant impacts of the interaction terms in the results, so we do not report them in this paper.[5]

First, the estimation results for alliance type are quite strong. All variables are statistically significant. No signs reverse across models, and the size of the coefficients remains relatively stable. Specifically, the coefficient for *Manufacturing* is positive, while those for *R&D* and *Marketing* are negative. These results seemingly contradict the general understanding about the impact of alliances on firm performance. One should recall, however, the case of Kodak. The company had struggled in the commercialization of the OLED technology for eight years prior to R&D project termination. The results suggest that the stock market assessed the OLED industry as being still in its infancy, and thus it shied away from uncertain R&D activities or marketing of under-matured products during the analysis period (1999-2009).

Second, the variables for the complexity level of the products in which alliances are interested are non-significant across all models with one exception, suggesting that the complexity level of focal products plays only a small role there. Instead, the expected market size seems to matter more. The coefficient for *Equipment* is positive across models, though not significant, suggesting that the stock market favors equipment alliances since they may result in positive spillover, regardless of the complexity level of focal products, from manufacturing of consumer products.

Table6　Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.
Alliance type				
R&D	0.733	0.445	0	1
Manufacturing	0.344	0.478	0	1
Marketing	0.222	0.418	0	1
Complexity level				
Low-complexity	0.067	0.251	0	1
Medium-complexity	0.156	0.364	0	1
High-complexity	0.444	0.500	0	1
Equipment	0.167	0.375	0	1

Table7　Correlation among variables

Variable			1	2	3	4	5	6	7
Alliance Type	1	R&D	1						
	2	Manufacturing	-0.197	1					
	3	Marketing	-0.343	0.231	1				
Complexity level	4	Low-complexity	0.060	0.275	0.179	1			
	5	Medium-complexity	-0.088	0.399	0.066	0.377	1		
	6	High-complexity	0.337	0.058	-0.155	-0.239	-0.322	1	
	7	Equipment	-0.337	-0.073	0.191	-0.120	-0.192	-0.400	1

Table8　Regression results

	Model I	Model II	Model III	Model IV
Alliance type				
R&D	-6.539***		-5.567**	-8.254**
	(2.077)		(2.328)	(4.118)
Manufacturing	3.439*		4.798**	6.894***
	(1.867)		(2.219)	(2.378)
Marketing	-4.210*		-4.543*	-7.669***
	(2.226)		(2.300)	(2.476)
Complexity level				
Low-complexity		-1.572	-0.698	5.460
		(4.042)	(4.019)	(8.950)
Medium-complexity		0.745	-2.719	-7.771
		(2.980)	(3.075)	(5.703)
High-complexity		-0.179	-0.547	-14.061**
		(2.285)	(2.332)	(5.893)
Equipment		4.242	2.659	5.093
		(2.916)	(2.843)	(4.207)
Complexity level of R&D (Interaction term)				
Low-complexity product R&D				-6.832
				(10.374)
Medium-complexity product R&D				4.877
				(6.271)
High-complexity product R&D				14.554**
				(6.279)
Equipment R&D				-7.969
				(5.630)
Constant	6.485***	1.300	5.647**	8.168**
	(2.078)	(1.861)	(2.498)	(3.560)
# of observations	90	90	90	90
R^2	0.1507	0.0371	0.1792	0.3022
F-value	5.09***	0.82	2.56**	3.07***

***significant at 1% level; **significant at 5% level; *significant at 10% level.

An interesting result is the combination of the negative coefficient for *High-complexity* and the positive coefficient for the interaction between *R&D* and *High-complexity* in Model IV. We observe here the market's second thoughts about R&D activities in highly complex products. The market expects that the outcome from alliance activities involving highly complex products could be quite large in the future, enough to counterbalance the market's unfavorable attitude regarding R&D activities in highly complex products although the combined effects are not large enough to compensate for the market's unfavorable attitude regarding R&D activities in general.

5. Conclusion

In this study, we aimed to evaluate how alliance type and complexity level of focal products influence the firm value in an emerging industry. We applied the standard event study method to data on alliance formation in the OLED industry in Japan for the assessment.

The cumulative abnormal returns for the alliance formation, 1.94% on average, are larger in the OLED industry than in other industries previously studied, which suggests that forming an alliance is quite a valuable strategy in an emerging industry. The values of abnormal returns are quite different across alliance types, however. The abnormal return for the manufacturing alliances is large and only statistically significant. In contrast, R&D and marketing alliances show positive but small and insignificant abnormal returns. The regression analysis also shows that the market favors manufacturing over R&D and marketing alliances. Recall that the OLED industry is an emerging and rapidly growing industry and that the industry technologies are not mature or stable yet, and the manufacturing itself is closer to R&D activities in mature industries. Manufacturing alliances therefore perform like quasi-R&D alliances in mature industries. R&D activities in the OLED industry are, in turn, closer to the basic research stage where the government, instead of firms, plays an important role. These results, therefore, confirm that the OLED is still in its infancy while they seem to contradict the findings of previous studies reporting higher abnormal returns from technology-oriented alliances at first glance. As for marketing alliances that are not technology-oriented, the regression analysis shows that their impacts on firm performance are not only smaller than those of manufacturing alliances, but they are negative. Das et al. (1998) found negative impacts of marketing alliances with event study analysis and argued that marketing alliances are, in general, formed when products enter the mature or declining phase of their life cycle. A firm's entry into such alliances would be bad news for the market. In the case of the OLED industry, the marketing alliance could be perceived as a signal of unsuccessful R&D activities halfway to the realization of higher-complexity products that involve higher uncertainty and costs but also potentially large gains.

The regression analysis also shows that the complexity level of focal products has little impact on the market. However, when we introduced the interaction between R&D and the complexity level into the analysis, an interesting outcome emerged. The market's expectation for R&D alliances involving highly complex products is large enough to counterbalance the market's unfavorable attitude regarding R&D activities related to highly complex products, which suggests that the market has high expectations regarding the introduction of revolutionary products (i.e., OLED television and lighting). However, the combined effects are not large enough to compensate for the market's unfavorable attitude regarding R&D activities in general, perhaps for the reasons we have discussed in this section.

The findings provide important managerial implications. It is now widely recognized that forming an alliance is an effective business strategy. This study not only confirms that alliances are important in emerging industries but also goes a step further. An alliance is not a panacea. R&D managers need to scrutinize the use of alliance formation as a strategy. It is a preferable strategy for product manufacturing in emerging industries, which is close to R&D activities in mature industries. Firms can gain the access to complementary resources, learning and developing new competencies from the partners, and risk and/or cost sharing through alliances, among which the aspects of access, learning, and developing are particularly important for industries like the OLED since it requires a wide range of knowledge and technologies, each of which is likely to be possessed by different firms. This also implies that the firms need to experiment with several combinations of partners (i.e., technologies) to find an optimal configuration. An alliance can facilitate this process. On the other hand, managers need to carefully assess the costs and benefits associated with alliances in R&D projects or marketing in emerging industries, since there might be cases when the costs, including those associated with a negative signal perceived by investors, outweigh the benefits.

There are some limitations in this study. We used a time scale between 1999 and 2009, which is short, especially for an industry, like the OLED, which is still in its infancy. The industry should be revisited in the future for reexamination. Another limitation concerns the sample population. This study's interest is Japanese firms in the OLED industry since they are major players in early years worldwide. The industry structure has changed quickly in recent years, however. Korean firms and those from other countries have been gaining a greater presence. More studies are necessary to examine the industry in the global context in the future.

This study contributes to the extant literature by adding empirical evidence concerning the effectiveness of alliance formation as a corporate strategy. It also expands the scope of the existing studies to emerging industry and reveals a more detailed picture of the trajectory of a particular technology. More studies should be encouraged to validate the results of this study concerning alliances in other industries in various stages of technology development and/or market contexts.

Acknowledgement

The authors would like to acknowledge the anonymous reviewers for their valuable comments and suggestions to improve the paper.

《Notes》

1.There exists a large body of literature on or using event study method, such as Campbell, Lo, & McKinlay (1997) or McWilliams & Siegel (1997).

2.Brooke & Oliver (2005) classified high-tech and low-tech at an alliance level. They classified an alliance as high-tech if it is an R&D alliance.

3.They are available from the corresponding author upon request.

4. ibid.

5. ibid.

《References》

1. Anand, Bharat N. and Khanna, Tarun (2000) "Do firms learn to create value? The case of alliances," Strategic Management Journal, Vol. 21, No. 3, pp. 295-315.

2. Arrow, Kenneth J. (1962) "The economic implications of learning by doing," The Review of Economic Studies, Vol.29, No.3, pp. 155-173.

3. Brockhoff, Klaus (1992) "R&D cooperation between firms - A perceived transaction cost perspective," Management Science, 38 (4), pp.514-524.

4. Brooke, Jesse and Oliver, Barry (2005) "The sources of abnormal returns from strategic alliance announcement," Pacific-Basin Finance Journal, Vol. 13, No. 2, pp.145-161.

5. Campart, Sandy and Pfister, Etienne (2007) "Technology, cooperation and stock market value: An event study of new partnership announcements in the biotechnology and pharmaceutical industries," Economics of Innovation and New

Technology, Vol.16, No.1, pp.31-49.
6. Campbell, John Y., Lo, Andrew W. and MacKinlay, Archie C. (1997) The Econometrics of Financial Markets, Princeton, NJ: Princeton University Press.
7. Chan, Su H., Kensinger, John W., Keown, Arthur, J., Martin, John D. (1997) “Do strategic alliances create value?” Journal of Financial Economics, Vol.46, No. 2, pp.199-221.
8. Contractor, Farok J. and Lorange, Peter (1988), “Why should firms cooperate? The strategy and economics basis for cooperative ventures,” in Contractor, Farok, J. and Lorange, P. eds., Cooperative Strategies in International Business: Joint Ventures and Technology Partnerships between Firms, Lanham, MD: Lexington Books, pp.3-30.
9. Das, Somnath, Sen, Pradyot, K. and Sengupta, Sanjit (1998) “Impact of strategic alliances on firm valuation,” Academic of Management Journal, Vol.41, No. 1, pp. 27-41.
10. Fuji Chimera Research Institute (2003) Advanced Organic Materials R&D Report, 2003, Tokyo: Fuji Chimera Research Institute.
11. Fuji Chimera Research Institute (2010) LCD Market 2010 Vol. I-II - Present Aspect & Future Outlook, Tokyo: Fuji Chimera Research Institute.
12. Gulati, Ranjay (1995) “Does familiarity breed trust? The implications of repeated ties for contractual choice in alliances,” Academy of Management Journal, Vol. 38, No.1, pp.85-112.
13. Gulati, Ranjay and Singh, Harbir (1997) “The architecture of cooperation: Managing coordination costs and appropriation concerns in strategic alliances,” Administrative Science Quarterly, Vol. 43, No. 4, pp.781-814.
14. Hagedoorn, John, Link, Albert L. and Vonortas, Nicholas S. (2000) “Research partnerships,” Research Policy, Vol. 29, No. 4-5, pp.567-586.
15. Harrigan, Katheryn R. (1986), Managing for Joint Ventures Success. Lexington, MA: Lexington Books.
16. Inoue, Kotaro and Kato, Hideaki (2006) M&A and Stock Prices, Tokyo: Toyo Keizai Inc. (in Japanese).
17. Johnstone, Bob (2001) “A bright future for display,” Technology Review, Vol. 104, No.3, pp.81-85.
18. Kido, Junji (2003) All about OLED, Tokyo: Nippon Jitsugyo Publishing (in Japanese).
19. Koh, Jeongsuk and Venkatraman, N. (1991) “Joint venture formations and stock market reactions: An assessment in the information technology sector,” The Academy of Management Journal, Vol.34, No.4, pp. 869-892.
20. McConnell, John J. and Nantell, Timothy J. (1985) “Corporate Combinations and Common Stock Returns: The Case of Joint Venture,” The Journal of Finance, Vol. 40, No.2, pp. 519-536.
21. McWilliams, Abagail and Siegel, Dan (1997), “Event Studies in Management Research: Theoretical and Empirical Issues,” Academy of Management Journal, Vol. 40, No. 3, pp. 626-657.
22. Mitsui, Ayako (2009) “Empirical analysis of strategic alliances between fuel-cell companies,” The bulletin of the Graduate School of Commerce, Vol. 68, pp. 233-249, Tokyo: Waseda University (in Japanese).
23. Neill, John D., Pfeiffer, Glenn M. and Young-Ybarra, Candace E. (2001) “Technology R&D alliances and firm value,” Journal of High Technology Management Research, Vol. 12, No. 2, pp.227-237.
24. New Energy and Industrial Technology Development Organization (2010) Interim Report on the Development of Basic Technology for Next-generation Large-screen Organic Light-emitting Diode Displays (Green IT Project).
25. Oxley, Joanne E. (1997) “Appropriability hazards and governance in strategic alliances: A transaction cost approach,” Journal of Law, Economics, and Organization, Vol. 13, No. 2, pp.387-409.
26. Rycroft, Robert W. and Kash, Don E. (1999) The Complexity Challenge: Technological Innovation for the 21st Century, London: Pinter Publishers.
27. Schilling, Melissa A. (2009) “Understanding the alliance data,” Strategic Management Journal, Vol. 30, No. 3, pp.233-260.
28. Williamson, Oliver (1989) “Transaction cost economics,” in Schamalensee, Richard & Willig, Robert D. eds. Handbook of industrial organizations, Amsterdam, Holland: Elsevier Science, pp. 135-182.